J.Animal and Poultry Prod., Mansoura Univ., Vol.9 (4): 211 – 218 , 2018

Nutritional and Economical Evaluation of Watania Corn Hybrids Silages

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ABSTRACT

Four corn hybrids included 3 white hybrids, single crosses (SC) Watania 4 (W4) and Watania 6 (W6) and three way cross (TWC) Watania 11 (W11) and 1 yellow hybrid (SC) Watania 97 (W97) were cultivated in the Experimental Farm of National Seed Company, Minya El Qamh, El Sharkeya Governorate, Egypt. Whole corn plants were harvested after 92 days of planting at the dough stage of maturity and chopped to 1-1.5 cm of length. Five hundred kg of each chopped hybrid was ensiled in double plastic bags with 80 kg weight for each, pressed by hand to exclude the air from the bags and ensiled for 35 days. Four digestibility trials were conducted to determine the nutritive values of different corn hybrids silages using Rahmany rams. Results indicated that yield of whole plant, stems and leaves were mostly significant higher with the hybrids W11 and W97 than those of W4 and W6 ones. Watania 6 showed significant higher ear content (36.60%) than that of the other experimental hybrids, while W11 had significant higher leaves content (18.65%) and W97 showed the higher stems content (52.47%) compared with the other hybrids. Watania 97 hybrid recorded significantly ($P<0.05$) the higher yield of DM, TDN, CP, DCP and DE than those of other hybrids, being W4 had the lowest values. The contents of DM and CF were higher in W97 than others hybrids, whereas, the contents of OM and ash were slightly differed among the different corn hybrids. Watania 11 showed slightly higher CP content and W6 had the higher contents of EE and NFE than those of other hybrids. Moreover, the contents of DM, OM, CP, CF and NFE tended to decrease, whereas, the contents of EE and ash tended to increase after ensiling for the different corn hybrids. The contents of all fiber fractions (NDF, ADF, ADL, hemicellulose and cellulose) were higher in W11 and W97 than those of the other hybrids, being the lowest values of fiber fractions were occurred with W6 hybrid. All tested corn silages were free from mold, characterized with suitable fermentation characteristics, yellowish green color and good smell. The pH values of the different tested silages ranged between 4.05 and 4.40 and lactic acid concentration ranged between 4.48% of DM for W97 silage and 5.49% of DM for W6 silage. Total VFA's concentration ranged between 2.01 and 3.02% of DM with accepted values for NH_3-N concentration were recognized in the different kinds of silage. Watania 6 recorded the highest DM intake (1175 g/day), while W97 had the lowest one (1113 g/day). Watania 6 silage showed significantly ($P<0.05$) higher digestibility of DM, OM, EE and NFE and also the values of TDN and DE than those of the other corn silages. While, W11 silage recorded significantly ($P<0.05$) highest CP digestibility and DCP value compared with other tested silages. Whereas, W97 silage revealed significantly ($P<0.05$) highest digestibility of CF, NDF, ADF, hemicellulose and cellulose than the other ones. Ruminal pH value was significant the highest ($P<0.05$) in W97 followed by W11, while W4 and W6 had the lowest values. Whereas, W6 recorded significantly ($P<0.05$) the highest ruminal TVFA's concentration followed by W4, while W11 and W97 had the lowest concentrations. Moreover, the concentration of NH_3-N was significant higher ($P<0.05$) with W11 than that of the other silages, being the lowest values were occurred with W4 and W6 hybrids. Net revenue and economic efficiency were significantly higher ($P<0.05$) for W11 and W97 than those of W4 and W6. It could be concluded that white third cross Watania 11 and yellow single cross Watania 97 corn hybrids recorded the best results concerning forage crop yield, nutrients yield and economic efficiency and should have corn breeding programs to increase their ear content of at least 35% in order to maximize the output of TDN and DCP and profitability.

Keywords: Corn hybrids silages, yield, composition, quality, nutritive values, economic efficiency.

INTRODUCTION

Corn (*Zea mays*. L) silage is a major component of diets fed to dairy cows because of the high energy yield per unit area, the ease of mechanization and storage, and the uniformly high feeding value. Even though the grain to stalk ratio and whole plant dry matter (DM) yields are important determinants of the adaptability of a corn hybrid to silage production. The moisture content of whole plant corn is inversely related to the stage of maturity at harvest, and the DM content of early-maturing hybrids is probably higher than that of mid- or late-maturing hybrids when they are planted in the same region and harvested at the same time. The DM content of herbage affects not only the plant DM yield but also the effluent loss (McDonald *et al*., 1991). No effluent would be formed from silage under conditions when the DM content of ensiled crop is approximately 290 g kg^{-1} or more. Therefore, differences in maturity among corn hybrids may affect not only the DM yield per unit area (Valdez *et al*., 1989), but after the fermentative quality of silage and the nutritive value of corn silage (Bal *et al*., 1997). Agronomic trials have shown that the DM yields of whole plant corn are maximized by harvesting at the two-thirds milk line to the black-layer stage (Ganoe and Roth, 1992).

This large use of maize for silage making is mainly because of its chemical composition, which meets the requirements to making good silage, has high productivity, low buffering power and adequate levels of soluble carbohydrates (Nussio *et al*., 2001). With good rate between stems, leaves and grains, and high digestibility, since there is a high correlation between the nutritional value of a culture and its silage (Pereira Filho and Cruz, 2001). The higher proportion of grain in the material to be ensiled is desirable, for it contributes to the increase of the dry matter content of the silage, as far as there is no high proportion of straw and corn cob, which can reduce the effect of the ear in its quality (Almeida Filho *et al*., 1999). It is also necessary to consider other fractions of the plant, as the nutritional quality of the stem has strong correlations with the nutritional quality of the whole plant (Nussio *et al*., 2001). Xu *et al*. (1995) reported that corn silage hybrid and maturity affected the DM concentration of various plant parts including leaves, ear, husk, stalk and stover.

Corn hybrids should have a grain content of at least 35% in order to maximize profits and output for TDN and DCP; furthermore, these relationship should be incorporated in the respective plant breeding programs in the future (Gaafar, 2004). Maize silage is a

stabilizing component of rumen fermentation in terms of content and structure of saccharides in feed rations. High-quality maize silage is a good source of structural as well as non structural saccharides as an efficient source of ruminal proteosynthesis (Juráček *et al*., 2013). The selection of appropriate hybrids is critical for the production of quality maize silages (Bíro *et al*., 2007 and Araújo *et al*., 2012). Yet hybrid selection for agronomic potential and nutritive value is one of the most important management decisions influencing corn silage production (Allen *et al*., 1997). Silage hybrid affects maturity at harvest, digestibility of nutrients, nutritive value, composition of epiphytic microflora, dry matter yield, energy and nutrients yield (Weiss and Wyatt, 2002 and Donkin *et al*., 2003).

There are variable differences in the yield production of digestible nutrients as the result of ensiling commercial hybrids and varieties of corn in Egypt. However, during plant breeding programs it can be possible to select corn hybrids and varieties especially for making silage with high yield of grains and stover to achieve maximum profit (Bendary *et al*., 2001). Corn plant silage has high nutritional value and energy content. However, it is important to determine corn silage characteristics that affect its nutritional value, such as cell wall constituents (Thomas *et al.*, 2001; Rodrigues *et al.*, 2002 and Ferreira *et al.*, 2005). The lignification level of the cell wall constitutes is a limiting factor in forage digestibility (Baucher *et al.*, 1998 and Boudet, 2000).

High quality silage production requires between 30 and 35% DM contents, soluble carbohydrates, pH decrease in silage fermentation, brief aerobic period and oxygen consumption in the silage biomass, intense anaerobiosis with lactic bacteria action and a fermentation process of adequate occurrence (Ferrari Junior *et al*., 2005). Corn hybrid choice is important to the success of the process. In contrast, silage chemical composition is dependent on factors as genetic constitution, climate and soil conditions, harvest stage, fermentation process and storage (Carvalho *et al*., 2013). It is preferred to cultivate yellow corn hybrids for making silage as well as saving white grain for human nutrition and it should be planted in summer season with plant density of about 30 thousand plants per feddan and harvested at dough stage of maturity to achieve the highest yield of silage crop as well as the yield of digestible nutrients (Gaafar, 2009).

The present investigation was undertaken to study the yield, chemical composition, quality and nutritive value of silages with determining the yield of digestible nutrients and the output of different Watania corn hybrids.

MATERIALS AND METHODS

Four corn hybrids included 3 white hybrids, single crosses (SC) Watania 4 (W4) and Watania 6 (W6) and three way cross (TWC) Watania 11 (W11) and 1 yellow hybrid (SC) Watania 97 (W97) were cultivated in the Experimental Farm of National Seed Company, Minya El Qamh, El Sharkeya Governorate, Egypt.

A split plot design with four corn hybrids, the size of each plot was 175 m^2 (14 rows each row 17.86 m long and 70 cm rows spacing). Organic fertilizer was added to the soil before plowing at 20-30 cubic meters, 150 kg super phosphate and 50 kg potassium sulphate per feddan. All hybrids were cultivated at 20 June with 30 thousand plants per feddan using 15 kg corn grains. Grains were planted in hills spaced 17 cm apart within the row. Maize plants were later thinned to one plant per hill.

Handing hoeings were done before the first and second irrigations and pesticides were sprayed as necessary. The fertilization by adding 120 nitrogen units per feddan, equivalent to 6 bags of urea, or 8 bags of nitrate per feddan, and therefore to obtain the highest production and divide the compost in the first two steps after the haze and before the prehistoric and the second before the next larvae of the soil and add compost below and below plants.

The first irrigation was applied after 21 days from sowing, while the following irrigations were applied at two or three weeks intervals and stopping irrigation before harvesting about two weeks.

Three sub-plots with area of 1 m per row for each corn hybrid were taken randomly to estimate the yield of whole plant corn forage crop its parts. Ears, stems and leaves were weighed for each sub-plot of each corn hybrid and calculated per feddan. Whole corn plants were harvested after 92 days of planting at the dough stage of maturity and chopping using Holland Chopper machine to 1-1.5 cm of length. Five hundred kg of each chopped hybrid was ensiled in double plastic bags with 80 kg weight for each, pressed by hand to exclude the air from the bags and ensiled for 35 days.

Color and odor of each tested silage were examined and samples were taken for chemical analysis, where silage pH was directly determined using Orian 680 digital pH meter, while lactic acid, TVFA's, ammonia nitrogen concentrations were determined according to the methods described by Analytical Chemistry of Foods (1995), Warner (1964) and Bergen et al. (1974), respectively.

Four digestibility trials were conducted at Sakha Animal Production Research Station, Animal Production Research Institute, Agricultural Research Center, Giza, Egypt to determine the digestion coefficients and nutritive values of the experimental corn hybrid silages. Three Rahmany rams in each trial with average body weight of 50±0.58 kg and 3 years old were used. Rams were housed individually in digestion crates for fifteen days as preliminary period followed by seven days as collection period. Digestion crates permitted total collection of feces. Ninety percent of ad libtum intake of maize silage was offered for each ram in two meals at 8 a.m. and 4 p.m. during the days of collection period. The water was available all the day round in plastic buckets. Fecal samples were collected twice daily for 7 days during the collection period. Representative samples of different silages and feces were analyzed according to the methods of AOAC (1990). Fiber constituents, neutral detergent fiber (NDF) was determined according to Van Soest and Marcus (1964). Acid detergent fiber (ADF) and acid detergent

lignin (ADL) was determined according to Van Soest (1963).

The data were statistically analyzed using General Linear Models procedure adapted by IBM SPSS Statistics (2014) for user's Guide, with One-Way ANOVA, mean were separated using Duncan's multiple range tests (Duncan, 1955).

RESULTS AND DISCUSSION

Forage yield of corn hybrids:

The yield of whole plant and its parts and relative parts yield in Table 1 showed significant differences (P<0.05) among some corn hybrids. The yield of whole plant and leaves were significantly higher (P<0.05) in Watania 11 and 97 than in Watania 4 and 6 corn hybrids, with the highest values in W97 (30.65 and 5.42 ton/fed., respectively) and lower values in W6 (25.51 and 4.26 ton/fed.). The ear yield was insignificant higher with W6 (9.33 ton/fed.) than that of W97, and significant higher than that of W4 (8.64 ton/fed) and W11 (8.75 ton/fed.). Watania 97 was significant higher respecting stems yield (16.08 ton/fed.) than that of the other corn hybrids, being the lowest value that occurred with W4 hybrid. Similar trend was observed among experimental treatments regarding leaves yield.

Table 1. Forage yield and relative plant parts for different corn hybrids.

Items	W4	W6	W11	W97	MSE
Forage yield (ton/ feddan, fresh basis)					
Whole plant	25.70^{b}	25.51^{b}	28.71^{a}	30.65^{a}	0.71
Ear	8.64^{b}	9.33^{a}	8.75^{b}	9.15^{a}	0.10
Stems	12.78^{c}	11.92^{c}	14.61^{b}	16.08^{a}	0.51
Leaves	4.28^{b}	4.26^{b}	5.35^{a}	5.42^{a}	0.18
Relative plant parts (%)					
Ear	33.64^{b}	36.60^{a}	30.47^{c}	29.84^{c}	0.84
Stems	49.72^{b}	46.71^{c}	50.88^{ab}	52.47^{a}	0.68
Leaves	16.64^{c}	16.69^{c}	18.65^{a}	17.69^{b}	0.28

a, b, c: Values in the same row with different superscripts differ significantly (P<0.05).

The relative weight of plant parts revealed that W6 showed the highest ear content (36.60%) followed by W4, whereas W97 had the lowest value (29.84%). Watania 97 showed the highest stems content (52.47%) followed by W11, but W6 had the lowest content (46.71%). Moreover, the highest leaves content was in W11 (18.65%) followed by W97, while W4 had the lowest one. The yield of whole plant crop, stems and leaves increased by 20.15, 34.90 and 27.23% for W97 compared with W6. Whereas, the yield of ears increased by 7.99 and 5.90% for W6 and W97 compared to W4, respectively. These results agreed with those obtained by Bendary *et al*. (2001) who found that the differences in the yield of whole plant forage and its relative parts may be attributed to the potential hybrid as well known as the scientific fact. Even though the grains to stalk ratio and whole plant dry matter (DM) yields are important determinants of the adaptability of a corn hybrid to silage production (McDonald *et al*., 1991). Corn hybrids should have a grain content of at least 35% in order to maximize profits and output for TDN and DCP; furthermore, these relationship should be incorporated in the respective plant breeding programs in the future (Gaafar, 2004). Earlier results obtained by Avcioglu *et al.* (2003) proved that yield, plant height, protein and ash contents of the maize varieties were significant differ among them.

Yield of major nutrients for different hybrids:

Data in Table 2 showed that Watania 97 hybrid recorded significant (P<0.05) highest yield of DM, TDN, CP, DCP and DE than those of the other hybrids and also W11 had significant higher values for the mentioned items than those of W4 and W6. This increase might be attributed to the increase of forage yield for W97, where there are high positive correlations between forage yield and the yield of DM, TDN, CP, DCP and DE being 0.99, 0.98, 0.99, 0.98 and 0.98, respectively. Watania 97 recorded an increases by 29.41, 25.69, 32.31, 39.02 and 25.61% for DM, TDN, CP, DCP and DE, respectively compared to Watania 4. Similar results were obtained by Bendary *et al.* (2001) who found significant differences in the yield of DM, TDN, CP, DCP and DE among the different corn hybrids. On other investigation on maize hybrids of different maturity groups, Milenkovic *et al.* (2003) found that both fresh forage and dry matter yield of the hybrids differed significantly between the tested maturity groups. There were also differences in quality ie. the contents of CP, CF, EE, ash and NFE in both the whole plants and in the plant parts.

Table 2. Nutrients yield for different corn hybrids (ton/fed.).

Items	W4	W6	W11	W97	MSE
DM	8.16^{c}	8.31^{c}	9.41^{b}	10.56^{a}	0.32
TDN	5.45^{c}	5.61^{c}	6.14^{b}	6.85^{a}	0.18
CP	0.65^{c}	0.66^{c}	0.78^{b}	0.86^{a}	0.03
DCP	0.41^{b}	0.42^{b}	0.54^{a}	0.57^{a}	0.02
DE (Mcal/fed.)	24045^{c}	24733^{c}	27076^{b}	30202^{a}	805

a, b, c: Values in the same row with different superscripts differ significantly (P<0.05).

Chemical composition of forage hybrids and its silages:

Chemical composition of whole plant corn forage and silages for the different corn hybrids in Table 3 revealed that DM was slightly higher in W97 than that of the others hybrids and this might be due to that yellow hybrid mature early than white hybrids. The contents of OM and ash were typically similar among the different corn hybrids. Watania 11 showed highest CP content, W97 had the highest CF content, while W6 had higher contents of EE and NFE in comparison with the other hybrids. The contents of OM, EE and NFE increased with increasing ear content (r= 0.65, 0.91 and 0.92, respectively). The content of CP increased with increasing leaves content (r= 0.89) and contents of CF and ash increased with increasing stems content (r= 0.90 and 0.52, respectively). Moreover, the contents of DM, OM, CP, CF and NFE tended to decrease, whereas, the contents of EE and ash tended to increase after ensiling for the different corn hybrids. Similar results were obtained by Gaafar (2001) and Bendary *et al.* (2001) who found some differences in chemical composition among the different corn hybrids due to the differences in relative plant parts content. Gaafar (2004) indicated

that the contents of DM, OM and NFE increased and the contents of CP, CF, EE and ash decreased significantly ($P<0.05$) with increasing grain content.

Table 3. Chemical composition of whole plant corn forage and silage for different corn hybrids.

Items		W4	W6	W11	W97
DM %	Forage	32.14	32.60	32.75	34.45
	Silage	31.20	31.65	31.80	33.45
		Composition of DM %			
OM	Forage	95.57	95.45	95.34	95.30
	Silage	93.65	93.54	93.44	93.40
CP	Forage	7.94	7.98	8.27	8.16
	Silage	7.82	7.86	8.15	8.04
CF	Forage	26.93	26.28	27.43	28.35
	Silage	26.53	25.89	27.02	27.92
EE	Forage	2.77	2.85	2.68	2.56
	Silage	2.83	2.91	2.73	2.61
NFE	Forage	57.93	58.34	56.96	56.23
	Silage	56.47	56.88	55.54	54.83
Ash	Forage	4.43	4.55	4.66	4.70
	Silage	6.35	6.46	6.56	6.60

Fiber fractions of forage and silages of different corn hybrids in Table 4 revealed that the contents of all fiber fractions (NDF, ADF, ADL, hemicelluloses and cellulose) were mostly slightly higher in W11 and W97 followed by W4 and were lower in W6. The contents of fiber fractions was positively correlated with the content of stems (r= 0.87, 0.92, 0.91, 0.58 and 0.89, respectively) and negatively correlated with ear content (r= -0.96, -0.96, -0.87, -0.75 and -0.96, respectively). Hemken *et al*. (1971) and Joanning *et al*. (1981) showed that increasing grain content resulted in diluting the fiber components.

Table 4. Fiber fractions (% on DM basis) of forage and silage for different corn hybrids.

Items		W4	W6	W11	W97
NDF	Forage	52.11	51.12	54.20	54.38
	Silage	50.84	49.87	52.88	53.05
ADF	Forage	31.06	29.75	32.08	32.41
	Silage	30.60	29.31	31.61	31.93
ADL	Forage	5.75	5.38	5.77	5.94
	Silage	5.81	5.43	5.83	6.02
Hemicelluloses	Forage	21.05	21.37	22.12	21.97
	Silage	20.24	20.56	21.27	21.12
Cellulose	Forage	25.31	24.37	26.31	26.47
	silage	24.79	23.88	25.78	25.91

Silage fermentative measurements (quality):

Observation concerning silage quality (Table 5) indicated that, all tested corn silages were free from mold, characterized with suitable fermentation characteristics, yellowish green color and good smell. The results indicated that pH values of the different tested silages ranged between 4.05 and 4.40, which seems to be in the normal ranges of the good quality silages as reported by McDonald *et al.* (1995). Lactic acid is the main product of fermentation in well preserved grass silage. Moreover, both the extent and pattern of silage fermentation may vary considerably depending on the ensiling management. Obtained values of lactic acid concentration ranged between 4.48% of DM for W97 silage and 5.49% of DM for W6 silage, indicated the good quality as recommended by McDonald *et al.* (1995). There was an inverse relationship between silage pH value and lactic acid concentration for different silages (r= -0.84) and positive relationship between ear content and lactic acid concentration (r= 0.95), which agreed with those obtained by Abd El-Malik (1972). Total VFA's concentration in all kinds of tested silages ranged between 2.01 and 3.02% of DM and positively correlated with stems content (r= 0.96), which indicated acceptable silage fermentation. Accepted values for NH_3-N concentration (0.035-0.045% of DM and 4.45-5.52% of total-N) in the different kinds of silage were obtained and positively correlated with leaves content (r= 0.97). Since, Sheperd and Kung (1996) and Chen *et al.* (1994) showed that NH_3-N concentration for corn silage ranged between 0.04 and 0.15% of DM, respectively. Also, McDonald *et al.* (1995) recommended that NH_3-N% of total-N for good quality silage should be less than 10%. It is worthy to note that species specific flora might produce different fermentation patterns, however, it is not know if the epiphytic flora differs between species grown at the same time and on the same site (Isselstein and Daniel, 1996). Also, Wyss and Vogel (1998) indicated various factors determine the ensilability of plant crops such as dry matter content, sugar and protein content, buffering capacity, plant structure, soil contaminations and epiphytic microflora and many of these factors are a direct consequence of the botanical composition. Moreover, Cunderlikova *et al.* (2002) revealed that ensilage capacity of herbage is depended on its chemical composition, mainly on the content of water soluble carbohydrates (WSC) and CP that are of great influence in the fermentation process. The content of WSC in grasses varies in relation to species and cultivars, vegetation phases, weather, cuts and fertilizer application. Fertilizes N application increases CP content in herbage but WSC content decreases (Holmes, 1989) and as a result, the ensilage capacity deteriorates (Zilakova and Knotek, 1997).

Table 5. Quality characteristics for different corn hybrids silage.

Items	W4	W6	W11	W97
pH value	4.10	4.05	4.20	4.40
Lactic acid % of DM	5.05	5.49	4.57	4.48
TVFA's % of DM	2.45	2.01	2.93	3.02
NH_3-N % of DM	0.037	0.035	0.045	0.041
NH_3-N % of total-N	4.73	4.45	5.52	5.10

Dry matter intake:

Results in Table 6 revealed significant difference ($P<0.05$) among most tested silages in respect of DM intake were found. Watania 6 recorded the highest DM intake (1175 g/day), while W97 had the lowest one (1113 g/day). From these results and the quality of tested silages (Table 5) it can be seen that the DM intake decreased with increasing pH value, ammonia-N and TVFA's concentrations of silage, but increased with increasing lactic acid concentration. Also, DM intake increased with increasing ear content and decreasing stems content (Table 1). The present results are in

accordance with those obtained by McDonald *et al*. (1995) and Bendary *et al*. (2001).

Digestibility and nutritive values:

Digestibility coefficients and nutritive values of the different corn hybrid silages are presented in Table 6. Watania 6 silage showed significantly (P<0.05) the highest values of digestibility of DM (67.12%), OM (68.35%), EE (77.80%) and NFE (73.07%) as well as the values of TDN (67.47%) and DE (2.97 Mcal/ kg DM). These outcomes may be due to the high ear content of this hybrid as shown in Table 1. While, W11 silage recorded significantly (P<0.05) the highest CP digestibility (69.89%) and DCP value (5.70%) compared with other tested silages, as the result of the high leaves content. Whereas, W97 silage revealed significantly (P<0.05) the highest digestibility of CF (67.35%), NDF (70.30%), ADF (65.87%), hemicellulose (72.10%) and cellulose (65.03%), which may be attributed to the highest stems content in comparison with the other silages. The present results are in accordance with those obtained by Bendary *et al*. (2001) who found that differences among some corn plant hybrids in relative plant parts led to significant differences in digestibility and nutritive values among the its produced. Gaafar (2004) reported that the digestibility of DM, OM and NFE and TDN and DE values increased significantly (P<0.05) with increasing grain content of corn silage. In support to these results, Hoglind and Bonesmo (2002) found that cell wall digestibility of leaves and stems was markedly affected by different cultivars of timothy forage and as well as due to the longer days in Norway. Definitely, maize silage become a popular forage for feeding ruminant animals, when excellent corn hybrids with short vegetation period, high forage yield and high quality were selected. The quality and feeding values of the silages depends on the in-silo fermentation, on the other. Lactic bacteria specifically homofermentative species are considered to be good, microorganisms in silage preservation (Davies *et al*., 2002).

Table 6. Dry matter intake, nutrients digestibility and nutritive values for different corn hybrids silage.

Items	W4	W6	W11	W97	MSE
DM intake (g/day)	1149^{b}	1175^{a}	1122^{c}	1113^{c}	7.52
Nutrients digestibility %:					
DM	65.66^{b}	67.12^{a}	64.12^{c}	63.59^{c}	0.43
OM	66.93^{b}	68.35^{a}	65.23^{c}	64.89^{c}	0.45
CP	64.56^{c}	64.81^{c}	69.89^{a}	67.54^{b}	0.70
CF	63.87^{b}	60.83^{c}	65.26^{b}	67.35^{a}	0.74
EE	76.56^{ab}	77.80^{a}	75.04^{bc}	73.68^{c}	0.47
NFE	70.44^{b}	73.03^{a}	67.26^{c}	66.21^{c}	0.83
NDF	66.67^{b}	63.49^{c}	68.12^{b}	70.30^{a}	0.78
ADF	62.47^{b}	59.49^{c}	63.83^{b}	65.87^{a}	0.73
Hemicelluloses	68.38^{b}	65.12^{c}	69.87^{b}	72.10^{a}	0.80
Cellulose	61.68^{b}	58.74^{c}	63.02^{b}	65.03^{a}	0.72
Nutritive values:					
TDN %	66.64^{ab}	67.47^{a}	65.30^{bc}	64.87^{c}	0.32
DCP %	5.05^{c}	5.09^{c}	5.70^{a}	5.43^{b}	0.08
DE (Mcal/kg DM)	2.94^{ab}	2.97^{a}	2.88^{bc}	2.86^{c}	0.01

a, b, c: Values in the same row with different superscripts differ significantly (P<0.05).

Ruminal fermentation:

Data of ruminal liquor parameters in Table 7 revealed that W97 pH value was significant (P<0.05) higher than that of hybrids W4 and W6 and insignificant higher than that of hybrid W11. According to Sung *et al*. (2007), the pH level is one of the most important factors in the rumen environment because fibrolytic bacteria are very sensitive towards pH changes. The pH values of all silages were between 6.34 and 6.50. It was probably due to the suitable particle length and sufficient content of fiber in the diets that promotes chewing and rumination process in the rumen. Particle length or fiber content of the diet can be manipulated to increase the chewing time and, consequently, to increase saliva production. The saliva serves as a buffering capacity within the rumen and it is related to level of pH. In relation to this point, it is well known that low rumen pH can seriously damage rumen fermentation of cellulose. pH less than about 6.2 will cause a depression in rate of degradation of fibrous feeds and at about 5.8 it is virtually stopped all together (Ørskov, 1992). Whereas, W6 recorded significantly (P<0.05) the highest ruminal TVFA's concentration followed by W4, while W11 and W97 had the lowest concentration. It was observed that TVFA's concentration increased with increasing NFE content of silage (r= 0.92). According to Firkins *et al*. (2006), the proportion of VFA produced in the rumen depends largely on the composition of diets consumed by the animals in particular the fractions contained in the feed. The production of TVFA's in the rumen is affected by numerous factors such as substrate composition and availability of specific types of rumen microbes to degrade the received diets (Dijkstra, 1994). Regarding, the concentration of ruminal NH_3-N, W11 hybrid was significant higher (P<0.05) than that of W4 and W6, where, also W97 had significant higher value than that of the other two hybrids. This results showed that ruminal NH_3-N concentration increased with increasing CP content in corn hybrid (r= 0.89). It was indicated that the concentrations of NH_3-N obtained in all silages were sufficient for optimum rumen fermentation and microbial growth. According to Leng (1990), the level of NH_3- N which appeared to be within the range of 10-20 mg dL^{-1} is required to optimize digestion of fibrous feed for rumen microorganisms. Moreover, the optimal

rumen NH_3 concentration for maximal rate of fermentation in the rumen is associated with dietary source and level of energy to be fermented in the rumen.

Table 7. Rumen liquor parameters of rams fed different corn hybrids silage.

Items	W4	W6	W11	W97	MSE
pH value	6.37[b]	6.34[b]	6.42[ab]	6.50[a]	0.02
TVFA's (mq/100 ml)	12.62[b]	13.73[a]	11.43[c]	11.19[c]	0.32
NH_3-N (mg/100 ml)	16.64[c]	16.69[c]	18.64[a]	17.69[b]	0.28

a, b, c: Values in the same row with different superscripts differ significantly (P<0.05).

Economic evaluation:

Data in Table 8 showed that the rent of land and the cultivation cost were the same for the different corn hybrids, being the total cost was 6000 LE/feddan. Whereas, the output of silage yield calculated from the yield of whole plant corn yield per feddan multiplied by the price of one ton corn silage (450 LE/ton), net revenue as the difference between the price of total silage yield and total cost and economic efficiency expressed as the ratio between the price of output of silage yield and total cost of silage prepared. Silage of W11 and W97 were achieved significant better net revenue and economic efficiency with each of W11 and W97 hybrids in comparison with W4 and W6 ones. These results revealed similar trend to the forage crop yield. Net revenue of W11 and W97 increased by 1492 and 2364 LE/fed. or 27.48 and 43.54% compared to W4 and 1445 and 2317 LE/fed. or 26.38 and 42.30% compared to W6, respectively. Economic efficiency obtained in this study ranged from 1.91 to 2.30, which was higher than the values obtained by Bendary *et al.* (2001) being 1.38-1.82, may be attributed the planting density (30 thousand plants/fed.) and subsequently increasing the yield of whole plant corn forage per feddan. Gaafar (2009) found that the corn forage crop increased with increasing plant density resulting in increasing economic efficiency.

Table 8. Economical evaluation of different corn hybrids.

Items	W4	W6	W11	W97	MSE
Rent of land (LE/fed./3 month)	3000	3000	3000	3000	
Cultivation cost (LE/fed.)	3000	3000	3000	3000	
Total cost (LE/fed.)	6000	6000	6000	6000	
Output of silage yield (LE/fed.)	11430b	11477b	12922[a]	13794[a]	343
Net revenue (LE/fed.)	5430b	5477b	6922[a]	7794[a]	343
Economic efficiency	1.91b	1.91b	2.15[a]	2.30[a]	0.06

a, b, c: Values in the same row with different superscripts differ significantly (P<0.05).

CONCLUSION

From this study it could be concluded that white third cross Watania 11 and yellow single cross Watania 97 corn hybrids recorded the best results concerning forage crop yield, nutrients yield and economic efficiency and should have plant breeding programs to increase their ear content of at least 35% in order to maximize the output for TDN and DCP as well as the profitability.

ACKNOWLEDGMENT

All thanks and appreciations to Accountant / Yahya Kamel Barsoom, Chairman Board of Directors; Accountant / Mohamed Abdel Khalek Mohamed, General and Managing Director; Eng. / Salah Anwar, Deputy General Manager and Production Manager; Prof. Dr. / Nabil Khamis, Head of Researchs and Experiments Department and Eng. / Osama Bisher, Director of Marketing, National Seeds Company for the cultivation of corn hybrids at its Experimental Farm and its full financial support for conducting this work, chemical analysis and publishing the paper.

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التقييم الغذائى والاقتصادى لسيلاج هجن الذرة الوطنية

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أجريت هذه الدراسة على أربعة هجن من الذرة تتضمن ثلاثة هجن بيضاء هى هجن فردية وطنية 4، وطنية 6 وهجين ثلاثى وطنية 11 وهجين أصفر واحد هو هجين فردى 97، زرعت بالمزرعة البحثية للشركة الوطنية لانتاج التقاوى، منيا القمح، محافظة الشرقية، مصر. تم حصاد النباتات الكاملة بعد 92 يوما من الزراعة فى طور النضج العجينى وفرمها بطول 1-1.5 سم. تم حفظ 500 كجم من محصول الذرة المفروم فى أكياس بلاستيك مزدوجة تزن 80 كجم، كبست جيدا باليد للتخلص من الهواء وحفظت لمدة 35 يوما. ثم أجريت أربعة تجارب هضم على الكباش الرحمانى لتقدير القيم الغذائية لسيلاج هجن الذرة المختلفة0 أوضحت النتائج ارتفاع انتاجية الفدان من النباتات الكاملة، السيقان والأوراق معنويا فى هجن وطنية 11، 97 عنه فى هجن وطنية 4، 06 ارتفاع محتوى الكيزان فى هجين وطنية 6 (36.60%) عن الهجن الأخرى، بينما ارتفع محتوى الأوراق فى هجين وطنية 11 (18.65%) ومحتوى السيقان فى هجين وطنية 97 (52.47%) عن الهجن الأخرى0 ارتفاع انتاجية الفدان من المادة الجافة، المركبات الكلية المهضومة، البروتين الخام، البروتين المهضوم والطاقة المهضومة فى هجين وطنية 97 عن الهجن الأخرى، بينما كانت أقل القيم مع هجين وطنية 04 ارتفاع محتوى كل من المادة الجافة والألياف الخام فى هجين وطنية 97عنه فى الهجن الأخرى، بينما اختلف محتوى المادة العضوية والرماد طفيفا بين هجن الذرة المختلفة0 ارتفاع محتوى البروتين طفيفا فى هجين وطنية 11، وارتفاع محتوى كل من المستخلص الايثيرى والمستخلص الخالى من الأزوت فى هجين وطنية 6 عن الهجن الأخرى0 أكثر من ذلك يميل محتوى كل من المادة الجافة، المادة العضوية، البروتين الخام، الألياف الخام والمستخلص الخالى من الأزوت الى النقص بينما يميل محتوى كل من المستخلص الايثيرى والرماد الى الزيادة بعد النقص بعد السيلجة لهجن الذرة المختلفة0 ارتفاع محتوى كل مكونات الألياف (الألياف الذائبة فى المحلول المتعادل، الألياف الذائبة فى المحلول الحامضى، اللجنين، الهيميسيليلوز والسيليلوز) فى هجن وطنية 11 و 97 عن الهجن الأخرى، بينما لوحظت أقل قيم لمكونات الألياف مع هجين وطنية 06 خلو سيلاج هجن الذرة المختلفة من العفن وتميزه بصفات تخمر جيدة واللون الأخضر الفاتح والرائحة الجيدة0 تراوحت قيم درجة الحموضة لسيلاج هجن الذرة المختلفة من 4.05 الى 4.40 وتركيز حامض اللاكتيك بين 4.48% فى المادة الجافة فى سيلاج هجين وطنية 97 الى 5.49% فى المادة الجافة فى سيلاج هجين وطنية 06 بينما تراوح تركيز الأحماض الدهنية الطيارة الكلية من 2.01 الى 3.02% فى المادة الجافة وقيم تركيز أزوت الأمونيا مقبولة فى سيلاج هجن الذرة المختلفة. ارتفاع المادة الجافة المأكولة فى سيلاج هجين وطنية 6 (1175 جم/يوم) وأقل مأكول فى هجين وطنية 97 (1113 جم/يوم). ارتفاع معاملات هضم كل من المادة الجافة، المادة العضوية، المستخلص الايثيرى، المستخلص الخالى من الأزوت وأيضا محتوى كل من المركبات الكلية المهضومة والطاقة المهضومة معنويا فى سيلاج هجين وطنية 6 عنه فى سيلاج الهجن الأخرى0 ارتفاع معامل هضم البروتين ومحتوى البروتين المهضوم فى سيلاج هجين وطنية 11 عنه فى سيلاج الهجن الأخرى. بينما ارتفع معامل هضم الألياف ومكوناتها فى سيلاج هجين وطنية 097 ارتفاع درجة حموضة سائل الكرش معنويا مع سيلاج هجين وطنية 97 تلاه هجين وطنية 11، بينما انخفضت مع هجن وطنية 4، 06 بينما ارتفع تركيز الأحماض الدهنية الطيارة الكلية فى سائل الكرش معنويا مع سيلاج هجين وطنية 6 تلاه هجين وطنية 4 ولوحظ أقل تركيز مع هجن وطنية 11، 097 علاوة على ذلك ارتفع تركيز نيتروجين الأمونيا فى سائل الكرش مع سيلاج هجين وطنية 11 عنه مع سيلاج الهجن الأخرى وكان أقل تركيز مع سيلاج هجن وطنية 4، 06 ارتفاع العائد الصافى والكفاءة الاقتصادية معنويا لهجن وطنية 11، 97 عنه فى هجن وطنية 4، 06 نستخلص من هذه الدراسة أن الهجين الثلاثى الأبيض وطنية 11 والهجين الفردى الأصفر وطنية 97 حققا أفضل النتائج من حيث انتاجية محصول السيلاج، والعناصر الغذائية والكفاءة الاقتصادية ويجب أن تعمل برامج تربية النبات على زيادة محتواها من الكيزان لتصل على الأقل الى 35% لتعظيم انتاجية من المركبات الكلية المهضومة والبروتين المهضوم وكذلك الأرباح