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EFFECT OF PARTIAL REPLACEMENT OF MAIZE SILAGE BY WATER HYACINTH SILAGE ON THE PERFORMANCE OF LACTATING CROSSBRED FRIESIAN COWS

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ABSTRACT

Nine lactating crossbred Friesian cows were used just after the lactation peak along with the "Swing Over" method, to examine the effect of replacing maize silage with ears (MS) by water hyacinth silage (WHS) in3 rations on nutrierit digestibility and milk production. Cows averaged 472 kg live body weight, at 2nd to 4th parities. Cows were fed for 140 days according to allowances of NRC for dairy cattle (1989). Tested rations consisted of : concentrate feed mixture (CFM)+ (100% MS) as Control ration (CR), CFM + (75% MS + 25% WHS) as tested ration 1 (TR1), CFM + (50% MS + 50% WHS) asTR2 .

The results obtained didn't reveal any significant differences between CR and TR1 in the digestion coefficients of CP , EE , CF , NFE and feeding value as TDN & DCP. All values of CR and TR1 were significantly ($P<0.05$) higher than those of TR2. Total DM, TDN, DCP intake were in the following order: CR>TR1>TR2. The daily milk yield, FCM and fat% were significantly ($P<0.05$) higher for CR and TR1 than that obtained with TR2. Only fat percentage, among milk constituents showed significantly ($P<0.05$) higher values for cows fed CR and TR1 than those of TR2. Cows fed TR1 attained the best feed conversion, economic efficiency and feed cost/ kg milk as compared with those fed CR or TR2. It could be recommended to use WH silage along with MS, in a proportion of 1:3 beside CFM, in dairy ration to improve considerably milk productivity and decrease cost of milk production / kg than that obtained by using ration contained 100% MS with CFM.

Keywords: Crossbred lactating Friesian cows, Water hyacinth, Silage, Maize silage, Digestibility, Milk yield, Milk composition, Economic efficiency.

INTRODUCTION

Water hyacinth (*Eichhornia crassipes*) has become a major problem in Egypt. Rapid growth and accelerated propagation of this troublesome weed in the river Nile have profound impacts on fishing, aquatic transportation, water wealth and irrigation and drainage systems. Moreover, it creates an environment favorable to the vectors of bilharzias (Zahran and Mansour, 1983; Gopal, 1987). Water hyacinth control programmes currently involve manual or mechanical removal of plants from water surfaces or application of chemical herbicides. Chemical control leads to a serious environmental pollution and fatal hazards for Nile water, affecting fishery wealth, plants, animal and human health.

In the last three decades, water hyacinth (WH) has been recognized as a potential feed resource for ruminants (El-Serafi *et al.* 1980; Gopal, 1987; Abdel-Khabir *et al.*, 1996; Thu and Preston, 1999; Abdur Rashid et al., 2001), but its high ash and silica contents (Becker *et al.*, 1987) and its content, of some anti-nutritional factors as tannins, oxalates, heavy metals and high

alkali Dutta *et al.,* 1984, Abdelhamid and Gabr, 1991) make it unpalatable and little consumable, for its bitter taste to ruminants, whether as fresh or hay forms.

Ensiling green crop residues, plant by-products and wastes could provide green and succulent feed rich in minerals and vitamins content beside some digestive enzymes. Several workers (Bendary and Younis, 1997; El-Saadany et al., 2001; Zaki *et al.,* 2001; Moawd *et al.,* 2001) have shown that using maize silage improves dairy cattle performance, reduces feeding cost and concentrate consumption.

The present work aimed at studying the effect of utilizing WH as silage in dairy rations on milk production, digestibility, feed conversion and economic efficiency.

MATERIALS AND METHODS

This study was conducted at El-Serw Experimental Station Domiat Governorate, belonging to Animal Production Research Institute.Nine lactating crossbred Friesian cows in the 2nd to 4th season of lactation, aging 4-7 years and weighing an average of 472 kg were selected just after lactation peak, in three treatments using "Swing over method" as mentioned by (El-Serafi, 1968). Feeding experiment continued for 140 days divided into four equal experimental periods (5 weeks each), in each period, preliminary stage lasted for 14 days, while the experimental stage lasted for 21 days as a collection period for obtaining data and samples of feeds and milk. Cows were individually fed according to allowances of NRC (1989) for dairy cattle. Cows were fed three experimental rations consisted of: concentrate feed mixture (CFM) + 20 kg maize silage with ears as control ration (CR), CFM + 20 kg mixed silage (75% MS + 25% water hyacinth silage (WHS) as tested ration 1 (TR1) and CFM + 20 kg mixed silage (10 kg MS + 10 kg WHS) as (TR2). The CFM consisted of: 30.8%undecorticated cotton seed meal, 30.0% wheat bran,4% soyabean meal ,17,2% ground corn , 10% rice bran, 5.0% molasses, 2.0% limestone and 1.0% salt. Water was offered to cows three times daily.

Milk yield was recorded individually two successive days weekly, milk samples were collected one day weekly through the collection stages from all cows. Composite milk samples of evening and morning milking were prepared for each cow and kept in the refrigerator for chemical analysis purpose. Three digestion trials were carried out during feeding experiment to determine digestibility coefficients and nutritive values of experimental rations, using three cows. Fecal samples were collected twice daily for 7 days during the collection stages. Acid insoluble ash was used as a natural marker in determination of feces amount (Van Keulen and Young 1977). Representative samples of feces and feed ingredients were kept during collection periods in deep freeze until analysis.

Sufficient amounts of fresh water hyacinth plants were collected from irrigation canals at Domiat province, also sufficient amounts of whole maize plants with ears were harvested and processed to silage using two trenches.

from whole maize plants with ears or water hyacinth plants. Cost of making silage included: raw material, transportation, plastic sheet, labor cost and tractor rent. The cost of MS amounted L. E 100 / 1 ton, while that of WHS amounted L. E 50 / 1 ton.

Proximate analyses of feeds, feces and milk samples were carried according to the methods of A. O. A. C. (1984). Milk fat was determined using Gerber's method as described by Ling (1963). Milk protein was determined by Formol method as described by Abd-Eltawab and Hamdy (1967). Statistical analysis was carried out according to Snedecor and Cochran (1980). Significant differences between means were determined using Duncan's multiple range test (1955).

RESULTS AND DISCUSSION

The results in Table 1 indicated that the proximate chemical analysis of water hyacinth silage (WHS) was practically similar to the findings of Gohl (1981) who worked on WHS in Philippines, but he obtained lower percentages of DM, OM and EE than that recorded herein. On the other hand, in Florida, Bangnal and Hentges (1979) have demonstrated similar results to that of the present findings except for CP and ash which were lower than that of the present results. This difference might be due to the fact that the chemical composition of water hyacinth differs by sites, water quality and environmental conditions (Abd El-Hafiz, 1989). Moreover, Abdur Rashid *et al.* (2001) reported that the composition of WH varied according to the composition of water where it grows. The WHS contained considerably lower DM, OM, CF, NFE and higher ash content than the corresponding values of MS, but both silages contained about similar CP content.

Table (1): Dry matter content and chemical composition of feeds and experimental rations % on DM basis.

Item	Chemical composition % (on DM basis)						
	DM%	OM	CP	EE	CF	NFE	Ash
CFM	89.96	89.99	17.25	3.88	9.20	59.66	10.01
MS	35.07	89.63	9.82	2.44	25.40	51.97	10.37
WHS	20.60	84.45	10.90	3.05	20.70	49.80	15.55
Calculated composition of the experimental rations							
CR	51.44	89.82	13.69	3.19	16.95	55.99	10.18
TR1	48.32	89.43	13.89	3.26	16.34	55.94	10.57
TR2	44.36	88.94	14.00	3.32	15.86	55.76	11.06

CFM = Concentrate feed mixture, MS = Maize silage, WHS = Water hyacinth silage.

The present results (Table 1) further show that the chemical composition of whole maize plants silage (MS) is in conformity with the results obtained by Maklad *et al.* (2000), Mostafa et al (2000), Moawd et al (2001), El-Saadany *et al.* (2001) and Abdur Rashid et al (2001). On the other hand, Bendary et al (2001) and Mohsen et al (2001) found higher OM and

NFE, but lower CP, CF and ash contents than that of the present finding. The results in Table (1) also indicated that the control ration (CR) has higher DM than TR1 and TR2. This may be attributed to the fact that both TR1 and TR2 contained WHS which was low in its DM content. However, all tested rations were nearly similar in their chemical nutrients.

It could be deduced from the results given in Table 2, that the mineral composition of WHS was within the range reported by Gopal and Sharma (1981) and others, except for sodium value which was higher than that recorded by the previous investigator. The average ranges of mineral contents of WH reported by those authors were as follows: P, 0.46-0.94; Ca, 0.79-3.06; K, 2.14-5.53; Na, 0.27-1.68%; Mn, 20-1669; Cu, 3.33-27.5; Pb, 0.2; Zn, 11.15-15.67 and Fe, 700-3420 ppm.

Table (2): Mineral composition of water hyacinth (on DM basis).

Item	Macro element (%)				Micro element (ppm)				
	P	Ca	K	Na	Mn	Cu	Pb	Zn	Fe
WH	0.39	0.81	3.79	3.63	1038.8	0.15	0.2	11.15	1067

The data presented in Table 3 show that the digestion coefficients of DM and OM of CR were significantly ($P<0.05$) higher than that of TR1 and TR2; meanwhile those of TR1 were significantly ($P<0.05$) higher than TR2.

Table(3): Digestibility coefficients and nutritive values of experimental rations.

Item	CR	TR_1	TR_2
	CFM+100%MS	CFM+75%MS + 25%WHS	CFM+50%MS + 50%WHS
Digestibility coefficient %			
DM	67.58^a	66.57^b	63.83^c
OM	69.49^a	68.20^b	65.90^c
CP	67.73^a	67.07^a	61.11^b
EE	75.84^a	75.65^a	71.84^b
CF	58.04^a	57.82^a	55.61^b
NFE	75.23^a	74.53^a	71.63^b
Nutritive values (% on DM basis)			
TDN	66.67^a	66.01^a	62.682^b
DCP	9.272^a	9.316^a	8.555^b

a, b and c Means with different superscripts in the same row are significantly different at ($P<0.05$).

On the other hand, there were no significant differences in the digestibility coefficients of CP, EE, CF, NFE and nutritive value as TDN and DCP between CR and TR1, but both rations were significantly ($P<0.05$) higher than their corresponding values for TR2. This might be due to higher palatability of maize silage which might enhance microbial affinity (Abdur Rashid *et al.*, 2001).

Perusal of the data presented in Table 4, the experimental rations appeared profound effects on milk production as compared with the values expected by calculations. Expected milk production was calculated at mid day of each experimental period considering the natural decrease of milk production during lactation period between mid day of first and final control ration which was 0.0752 kg/h/h. Nevertheless, tested ration TR1 brought about greater difference than calculated (being 13.46% higher than the expected production), while TR2 resulted in 11.49% increment than expected production. These results might be attributed to the moderating effect of silage as succulent feed and its content of digestive juice which might have a positive biological effect in improving milk productivity (El-Saadany et al , 2001). A complementary associative effect of different feed sources might also be a plausible explanation for the observed improvement in milk productivity brought about by the experimental tested rations.

Table (4): Milk productivity for the experimental rations with lactating crossbred cows.

Item	Average milk yield kg/h/day			
	Actual (1)	Calculated (2)	Difference kg	Difference %
Initial yield of the control (CR) (CFM+ 100% MS)*	16.397	16.397	0.00	0.00
TR1(CFM+75%MS+25%WHS)	15.615[a]	13.763[b]	1.852	13.455
TR2(CFM+50%MS+50%WHS)	12.409[a]	11.13[b]	1.279	11.493
Final yield of the control (CR)*	8.496	8.496	0.00	0.00
Mean control ration	12.447	12.447	0.00	0.00

a and b: Mean have different superscripts in the same row of columns 1 and 2 are significantly (P<0.05) different.
The daily natural decrease of milk during experimental periods of initial and final CR = 0.0752 kg/d.

Data demonstrated in Table 5 reveal that there were no significant differences in milk protein, lactose, SNF and TS percentages among the experimental groups. However, both of CR and TR1 were significantly higher (P<0.05) in milk fat % than that of TR2 and no significant difference was observed between the former two rations in this respect. It is of interest to note that average FCM of groups fed TR1 and TR2 was lower by about 3.18 and 28.21%, respectively, than that of group fed CR. However, no significant difference between CR and TR1 in FCM yield was observed but both were significantly higher (P<0.05) than that of TR2 (Table 6). Results obtained herein are in the same trend with the finding of Moawd et al (2001).

Table (5): milk composition % of lactating crosspred cows fed the experimental rations.

Item	Initial control ration CR	TR1	TR2	Final control ration CR	Mean control ration
Fat	3.35 a	3.45 a	3.04 b	3.43	3.39
Protein	3.57	3.49	3.35	3.62	3.60
Lactose	4.47	4.55	4.59	4.51	4.49
Solids not fat (SNF)	8.92	8.81	8.94	8.98	8.95
Total Solids (TS)	12.27	12.26	11.98	12.41	12.34

a, b Means with different superscripts in the same row were significantly differed at (P<0.05).

Table (6): Average daily feed intake, feed conversion and economic efficiency of milk production of lactating cows as affected by feeding experimental rations.

Item	Experimental rations		
	CR	TR1	TR2
Av. Daily milk yield (kg)	16.397	15.615	12.409
Av. Daily 4% FCM (kg)	14.798	14.327	10.623
Av. Daily feed intake (kg/h/d):			
CFM	8.50	8.10	7.25
MS	20.00	15.00	10.00
WHS	---	5.00	10.00
Total intake as fed	28.50	28.10	27.25
Total intake as DM	14.66	13.58	12.09
Total intake as TDN	9.77	8.96	7.58
Total intake as DCP	1.359	1.265	1.034
Feed conversion to 4% FCM:			
Kg DMI/1kg 4% FCM	0.991	0.948	1.138
Kg TDN/1kg 4% FCM	0.661	0.626	0.713
Kg DCP/1kg 4% FCM	0.092	0.088	0.097
Economic efficiency:			
Feed cost, L.E/h/d	6.59	6.124	5.415
Price of milk production, L.E/h/d	16.397	15.615	12.409
Feed cost of 1kg milk, L.E	0.402	0.392	0.436
Economic efficiency *	2.488	2.550	2.292
Economic return **, L.E/h/d	9.807	9.491	6.994
Economic return, %	100.00	96.88	71.32

Calculates based on the price of tested ingredients being 100, 50, 540 and 1000 LE/1ton of MS, WHS, CFM and milk, respectively.

*** Economic efficiency = Price of milk production ÷ Feed cost**

**** Economic return = return from milk increase + decrease of feeding**

Results in Table 6 show that DM intake of cows fed CR or TR1 was higher than TR2. This could be due to the higher palatability of both CR & TR1 rations which contained higher proportions of MS than that TR2 contained lower amount of MS. In this respect, West *et al.* (1998) and Ruiz *et*

al. (1995) reported that cattle consumed more of the corn silage than the other forage silages. The daily feed units intake as TDN and DCP/ kg/ h/ d showed the highest values with cows fed CR followed by those fed TR1 whereas the lowest value was recorded with cows fed TR2. This increase may be due to better associative effect among nutrients digested of CR and TR1 compared with those of TR2. Similar trend was obtained by Nichols et al (1998) and Moawd et al (2001).

Feed conversion expressed as Kg of DM, TDN and DCP per kg of FCM (Table 6) of lactating cow fed TR1 attained the best values compared with those fed CR or TR2. The values of economic efficiency were 2.488, 2.550 and 2.292 for CR, TR1 and TR2, respectively. While the feed cost per kg milk production were, P.T., 40.2, 39.2 and 43.6 for lactating cows fed CR, TR1 and TR2, respectively. It was noticed that TR1 had the cheapest cost. This showed that better feed conversion, economic efficiency of milk production and the cheapest value was obtained with cows fed TR1 contained MS and WHS at the rate of 3 : 1 followed by CR contained MS alone then TR2 contained MS + WHS at the rate of 1 : 1 besides the CFM.

In conclusion, these results strongly exhibited the high potential of WHS as a new forage silage which could nutritionally and economically replace a high quality maize silage in rations of lactating cows, and consequently, it would result in a great reduction in the feeding costs.

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تأثير إحلال سيلاج نبات ورد النيل جزئيا محل سيلاج نبات الأذرة علي إنتاج اللبن و مكوناته في علائق الأبقار خليط الفريزيان الحلابة

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استخدمت في هذه الدراسة تسع بقرات خليط فريزيان حلابة ، متوسط وزنها ٤٧٢ كجم في مواسم الحليب من الثاني حتى الرابع عقب قمة إنتاج الأبقار من اللبن مع توظيف طريقة "عود الي بدء" لاختبار تأثير إحلال سيلاج نبات ورد النيل جزئيا محل سيلاج نبات الذرة (النبات الكامل بالكيزان) في ثلاث علائق علي معاملات الهضم وإنتاج اللبن. قد غذيت الأبقار طبقا لمعدلات مجلس البحوث القومي الأمريكي للأبقار الحلابة (١٩٨٩) علي عليقه مقارنة (ع م) في الفترتين الأولي والأخيرة وغذيت في الفترتين الوسطيتين علي العليقتين المختبرتين ع م ١ ، ع م ٢ بالتعاقب . تكونت العلائق من: علف مركز + ١٠٠ % سيلاج ذرة كعليقه مقارنة (ع م) ، علف مركز + ٧٥ % سيلاج ذرة + ٢٥ % سيلاج ورد النيل كعليقة مختبرة ١ (ع م ١) ، علف مركز + ٥٠ % سيلاج ذرة + ٥٠ % سيلاج ورد النيل كعليقة مختبرة ٢ (ع م ٢). ويمكن إيجاز أهم النتائج فيما يلي:

(١) لم يلاحظ وجود فروق معنوية بين عليقه المقارنة و ع م ١ في معاملات هضم البروتين والدهن والألياف الخام المستخلص خالي الأزوت والقيمة الغذائية علي صورة مجموع المركبات الغذائية المهضومة والبروتين الخام المهضوم بينما كانت هذه القيم أعلي معنويا ((مستوى ٠,٠٥) عن مثيلاتها في ع م ٢.

(٢) أظهر الغذاء المأكول على صورة مادة جافة ، مركبات غذائية مهضومة وبروتين خام مهضوم ارتفاعا للأبقار الحلابة المغذاة على عليقة المقارنة ع م عن الأبقار الحلابة المغذاه على ع م١ يليها ع م٢.

(٣) أظهر متوسط إنتاج اللبن اليومي واللبن معدل الدهن والنسبة المئوية للدهن زيادة معنوية (مستوى٠,٠٥) عند تغذية الأبقار على عليقة المقارنة أو العليقة المختبرة ع م١ يليها ع م٢.

(٤) لم يلاحظ وجود فروق معنوية بين العلائق الثلاث المختبرة بالنسبة للتركيب الكيميائي للبن.

(٥) أظهرت الأبقار التي غذيت على العليقة المختبرة ع م١ أحسن قيمة للتحول الغذائي مقدرة بالكيلوجرام للمادة الجافة المأكولة ومجموع المركبات الغذائية المهضومة والبروتين الخام المهضوم لكل كيلوجرام من اللبن معدل الدهن، والكفاءة الإقتصادية وتكاليف الغذاء لكل كيلو جرام من اللبن عند مقارنتها بعليقة المقارنة او العليقة المختبرة ع م٢ التي تحتوي مقدارين متساويين من سيلاج الذرة وسيلاج ورد النيل .هذا وقد تبين أن العليقة المختبرة ع م١ هي الأرخص، وأنها ملائمة كعليقة المقارنة لتغذية الأبقار الحلابة. وعلى ضوء هذه النتائج فإنه يمكن التوصية بتحويل نبات ورد النيل إلى سيلاج من أجل استخدامه مع سيلاج الذرة بنسبة ١ : ٣ بجانب العلف المركز لتغذيه الأبقار خليط الفريزيان الحلابة حيث تبين أن العليقة المكونة من٢٥% سيلاج ورد النيل + ٧٥% سيلاج الذرة مع العلف المركز تؤدي إلى تحسين إنتاج الأبقار للبن وتقلل من تكلفة إنتاج الكيلوجرام الواحد من اللبن مقارنة بعليقة الكنترول الخالية تماما من سيلاج نبات ورد النيل.