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Comparison between the Effect of Feeding Corn Silage or Berseem as a Basal Diet on: 1- Milk Production and Economic Efficiency of Lactating Friesian Cows.

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ABSTRACT

Twelve lactating Friesian cows with the average body weight of 490-560 kg were used in this study. All animals were in the second to fourth lactation season. Cows were randomly distributed into three similar groups (four for each group) to study the effect of the tested rations on milk production and its composition. All groups were individually fed according to NRC (2001) recommendations. The experimental period lasted for 140 days (20 weeks) after calving. The three experimental rations were formulated nearly as follows: (Control): 40 % concentrate feed mixture (CFM) + 32 % rice straw (RS) + 28 % corn silage (S), (Exp.1): 40 % concentrate feed mixture (CFM) + 32 % rice straw (RS) + 28 % berseem (B) and (Exp.2): 40 % concentrate feed mixture (CFM) + 32 % rice straw (RS) + 14 % corn silage (S) + 14 % berseem (B). The average daily milk yield was the highest ($p < 0.05$) with group fed exp.1 from W1 to W12 compared with the control ration, while there were no significant effect between exp.1 and exp.2 or exp.2 and control ration. The average milk yield were 12.69, 16.05 and 15.17 Kg/day with feeding on control, exp.1 and exp.2 respectively. The milk composition of protein% was higher ($p < 0.05$) with feeding on exp.2 (2.51%) than feeding on exp.1 (2.29%), but there was no significant effect between exp.1 and control ration (2.37%) or feeding on exp.2 and control ration. The net energy (NEL Mcal/kg milk) values were significantly ($p < 0.05$) higher with feeding on control or exp.2 (0.64 and 0.63 Mcal/kg milk respectively) than feeding on exp.1 (0.60 Mcal/kg milk). The protein yield and lactose yield (kg/day) were increased ($p < 0.05$) with feeding on exp.1 and exp.2 rations than feeding on control ration. The highest values of feed conversion (DMI kg/kg FCM) and net energy of the milk (Mcal/kg milk) were with feeding on rations containing corn silage (control) or corn silage with berseem (exp.2) than ration which containing berseem only (exp.1). The highest values ($p<0.05$) of feed cost were estimated with exp.1 (40.01 LE) and exp.2 (38.07 LE) than feeding on the control diet (36.09 LE), but there was no significant affect between the control and exp.2 or exp.1 and exp.2. With the same trend the profit (LE) values were higher ($p<0.05$) with feeding an exp.1 (21.63 LE) or feeding with exp.2 (18.69 LE) than feeding with the control (15.35 LE). Corn silage is an important source of digestible effective fibre and can be an economical source of CP in diets for lactating cows, but increased passage rate with feeding berseem which is more digestible forage NDF might increase efficiency of milk production and composition. So feeding on exp.1 or exp.2 resulted in improving milk production, feed conversion and economic efficiency.

Keywords: Lactating Friesian cows, Corn silage, berseem, milk production, milk composition.

INTRODUCTION

Forage utilization is still inconsistent. The cow's requirements receive most her dietary nutrients from the forage. Dry matter intake (DMI) reduce as crude protein in forage fell below about 7% (Adams, 1997).

Maximizing feed intake is important in increasing energy and glucose supply from acetate and propionate. Also, increasing amino acids supply which is required for synthesis of milk protein. As a result of large amounts of nutrients obtained from diet, cow's dependence on body stores will be reduced giving more chance to produce milk without great losses from the body condition. After calving, metabolic diseases occurrence will be reduced by increasing feed intake (Emery, 1993). Starch is a more suitable energy source than glucose for maximum capture of ammonia-N for microbial synthesis (Grishwold *et al* 1996). The growth of mixed ruminal bacteria is a linear function of the amounts of carbohydrate fermented in the rumen. Microbial digestion within the rumen has always caused difficulties with prediction of nutrient supply to ruminant animals. Starch and fibre digestion are influenced by high corn silage diets which results in affecting both energy metabolism and DMI in lactating dairy cows (Allen *et al*, 2009).

The nature and the proportion of the concentrate as well as the quality of the roughage control the extent of the concentrate effect on digestion of fibre. Diet formulation of ruminants depends on the net energy of lactation (Belyea *et al* 1999). Information about efficiency of energy consumption by ruminants is important for ideal production of milk from lactating dairy cows (Jhonson *et al* 2003) and essentially the nutritive value of rely on cell content : cell wall ratio and on the capability of microorganisms in rumen to break down the cell wall of the plant. Plant cell walls made up of polysaccharides which cross linked with proteins and phenolic compounds as lignin which present in cell wall commonly. Mostly, the fiber fractions originate from cell walls of the plant and considered as a necessary part of diet in the ruminants. Cellulose, hemicelluloses and pectic polysaccharides considered as the main polysaccharides of cell wall of the plant. The nitrogen input and high quality fodder can be provided by forage legumes. Comparing grasses with grassland legumes, it is found that the latter has better feeding value, higher intake and animal production (Frame *et al* 1998).

The main target of this study was to estimate the feeding effect of corn silage or berseem as a basal diet on milk production and economic efficiency of lactating Friesian cows.

MATERIALS AND METHODS

The present study was conducted at El-Karada Animal Production Research Station, Animal Production Research Institute, Agricultural Research Centre, Ministry of Agricultural. Twelve lactating Friesian cows from the herd of the station were ranging from 490-560 kg were used in this study. All animals were in the second to fourth lactation season. Cows were randomly distributed into three similar groups (four for each group) to study the effect of the tested rations on milk production and its composition. All group were individually fed according to NRC (2001) recommendations, based on their live body weight and milk yield (requirement for maintenance was 1% of LBW concentrate +1% of LBW roughage and requirement for lactation was 1/2Kgconcentrat per 1Kg milk yield). The experimental period lasted for 140 days (20 weeks). The three experimental rations were formulated nearly as follows: (Control): 40 % concentrate feed mixture (CFM) + 32 % rice straw (RS) + 28 % corn silage (S), (Exp.1): 40 % concentrate feed mixture (CFM) + 32 % rice straw (RS) + 28 % berseem (B) and (Exp.2): 40 % concentrate feed mixture (CFM) + 32 % rice straw (RS) + 14 % corn silage (S) + 14 % berseem (B).

Management of feeding the concentrate feed mixture was offered firstly at morning, while corn silage or berseem and rice straw was offered after consumption of the concentrate feed mixture. Drinking fresh and clean water was available at all times.

Milk yield was recorded individually twice daily for each cow and about 0.5% of the total milk yield was taken for analysis from each animal individually during the experimental periods (proportionate sample from morning and evening) of both control and tow tested rations in the end every four weeks. The analysis included fat, total protein, lactose, total solids (TS) and solids non-fat (SNF) in milk. The chemical analysis of milk samples was carried out according to Ling (1963). Samples of concentrate mixture, corn silage, berseem and rice straw were taken at the beginning, middle and at the end of each trial. At the end of the collection period composite samples were dried in a forced air oven at 65^{o}C for 48 hours, then ground and kept for chemical analysis. Dried samples were composted for each cow and representative samples were taken, ground and kept for chemical analysis.

Chemical analysis of samples of concentrate mixture, corn silage, berseem and rice straw were carried out to determine dry matter (DM), crude protein (CP), crude fiber (CF), ether extract (EE) , ash and fiber fractions (NDF,ADF ADL, Hemi. and Cell.) according to the methods of AOAC (1990) and the experimental rations were formulated as shown in Table (1).

Data were statistically analyzed by variance test method according to Snedecor and Cochran (1982) while the differences among means were tested using Duncan's Multiple Test (Duncan, 1955).

Table 1. The chemical composition of the ingredients and experimental rations.

Item	DM	Chemical composition (% as DM)														
		OM	CP	EE	CF	NFE	ash	NDF	ADF	Hemi.	Cell.	ADL	NFC*	UNDF^1	ANDF^2	NDS^3
Ingredients																
Concentrate feed mixture (CFM)	91.25	84.36	13.69	2.29	11.35	57.03	15.64	39.91	23.00	16.91	14.00	9.00	29.41	8.62	31.29	60.09
Corn Silage (S)	30.95	88.07	10.67	3.31	21.24	52.95	11.93	44.34	33.02	11.32	27.67	5.35	31.65	5.69	38.65	55.66
Berseem (B)	13.01	84.60	19.08	1.65	25.50	38.37	15.40	44.91	27.06	17.85	24.43	2.63	20.66	2.84	42.07	55.09
Rice straw (RS)	90.19	80.99	3.87	1.56	32.78	42.78	19.01	74.47	59.84	14.63	43.24	16.60	3.80	29.67	44.80	25.53
Experimental rations																
Control	74.99	84.42	9.82	2.36	20.74	51.50	15.58	51.76	37.15	14.61	26.86	10.29	22.20	12.78	38.98	48.24
Exp.1	70.19	83.35	12.05	1.88	22.17	47.25	16.65	52.38	35.94	16.44	26.28	9.66	18.75	12.14	40.24	47.62
Exp.2	72.42	83.99	10.83	2.08	21.30	49.78	16.01	52.21	36.43	15.78	26.62	9.81	18.87	12.29	39.92	47.79

Control: 40% CFM + 32% RS + 28% S; Exp.1: 40% CFM + 32% RS + 28% B; Exp.2: 40% CFM + 32% RS + 14% S + 14% B.
*** Non fiberous carbohydrates%= OM% - (CP %+ NDF %+ EE %), Calsamiglia *et al.*, 1995.**
(1) UNDF: Unavailable NDF = NDF x 0.01 x ADL x 2.4 (Fox *et al.*, 2000).
(2) ANDF: Available NDF = NDF – UNDF
(3) NDS: Neutral detergent solubles = 100 – NDF

RESULTS AND DISCUSSION

Average monthly milk yield and its chemical composition are presented in Tables (2 and 3 respectively) and as shown in Figures (1 and 2). The average daily milk yield was the highest ($p < 0.05$) with group fed exp.1 from W1 to W12 compared with the control ration, while there were no significant effect between exp.1 and exp.2 or exp.2 and control ration.

Table 2. Effect of feeding the experimental rations on average monthly milk yield of the lactating Friesian cows

Items	Control	Exp.1	Exp.2
W1-4	15.43 ^{b}	19.09 ^{a}	18.22 ^{ab}
W5-8	12.43 ^{b}	16.60 ^{a}	15.32 ^{ab}
W9-12	12.56 ^{b}	15.39 ^{a}	14.75 ^{ab}
W13-16	11.33	14.88	13.83
W17-20	11.73	14.28	13.72
Average	12.69 ^{b}	16.05 ^{a}	15.17^{ab}

a, b and ab: Means within the same raw with different superscripts are significantly different (p<0.05)

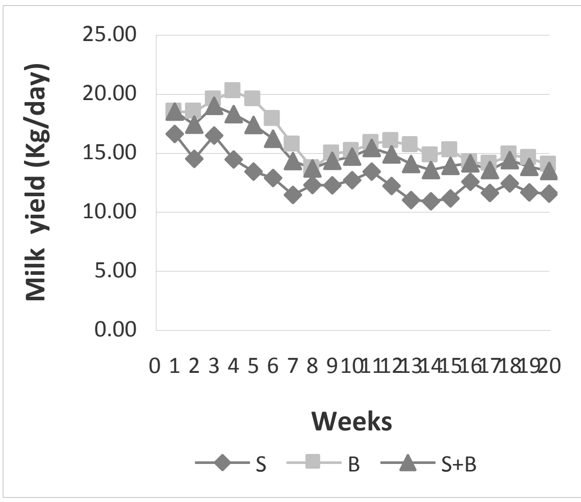

Fig. 1. Effect of feeding the experimental rations on average weekly milk yield of the lactating Friesian cows

The average milk yield was the highest ($p < 0.05$) with feeding on ration exp.1 (16.05 kg/day) compared with the control ration (12.69 kg/day). Milk production in the first month of lactation influences the production in later months. Practically, it is difficult to obtain high energy intake by using diets rich in fibre and low in non fibrous carbohydrates. This can be achieved if highly digestible fibre is used in diet. The fibre used should not put physical constraints on intake. So, the forage is chopped or grinded to reduce these physical constraints (Cannas, 2002).

Table 3. Effect of feeding lactating caws on experimental rations on some chemical composition of milk.

Items	Control	Exp.1	Exp.2
T.S%	11.04	10.09	10.62
Fat%	3.56	3.26	3.38
Lactose%	4.57	4.39	4.53
Protein%	2.37 ^{ab}	2.29 ^{b}	2.51 ^{a}
SNF%	7.48	6.83	7.15
NEL(Mcal/Kg) *	0.64 ^{a}	0.60 ^{b}	0.66 ^{a}
Fat corrected milk FCM **	12.86	15.41	14.15
Fat yield Kg/day	0.454	0.522	0.479
Protein yield Kg/day	0.301 ^{b}	0.367 ^{a}	0.339 ^{a}
Lactose yield Kg/day	0.577 ^{b}	0.704 ^{a}	0.647 ^{a}

a, b and ab: Means within the same raw with different superscripts are significantly different ($p<0.05$)
*** NEL (Mcal / kg) = (0.0929 x Fat %) + (0.0547 x Protein %) + (0.0395 x Lactose %) (NRC, 2001)**
****FCM: Average of dairy production of calculated 3.5% fat corrected milk (Kg/day)**
FCM (Kg/day) = 0.432 X milk (Kg) + 16.23 X fat (Kg) (Britt *et al* 2003)

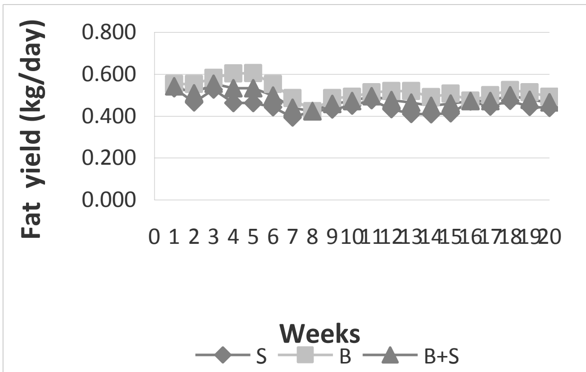

Fig. 2. Effect of feeding the experimental rations on average weekly fat milk yield of the lactating Friesian cows

Regarding the milk composition (Table 3), protein% was higher ($p < 0.05$) with feeding on exp.2 (2.51%) or control ration (2.37%) than feeding on exp.1 (2.29%), but there was no significant effect between exp.1 and control ration. The net energy (NEL Mcal/kg milk) values were significantly ($p < 0.05$) higher with feeding on control or exp.2 (0.64 and 0.63 Mcal/kg milk respectively) than feeding on exp.1 (0.60 Mcal/kg milk).

The protein and lactose yield (kg/day) were increased ($p < 0.05$) with feeding on exp.1 and exp.2 rations than feeding on control ration. Since the fibre content of the ration of dairy cows is inversely proportional to its energy content (NRC, 1989). Replacing neutral detergent fibre with non fibrous carbohydrates results in higher milk production, higher energy content of the diet and lower milk fat content. The effect of dietary protein on milk fat is not obvious. Dietary protein is manipulated to increase milk production and DM intake. Ammonia-N may be provided to fibre digesting bacteria by ruminal protein degradation. Buffering the rumen environment can be achieved because of releasing ammonia by protein degradation (Santos *et al* 1998).

Ration crude protein (CP) levels in rations should be reduced for two primary reasons. One of these reasons is to increase profitability by improving the efficiency of converting feed N intake to milk N output while at least maintaining milk production. The capability of the dairy cow to store nitrogen is limited compared with energy. Evaluation of nitrogen use efficiency in the dairy cow can be done by using (MNE) index. The MNE values observed in commercial dairy herds usually ranges between 20 and 35%. This means that 65 to 80% of the consumed N is excreted in the manure (Olmos Colmenero and Broderick, 2006).

The net energy of lactation (NEL) requirement of the cow generally defines the maximum amount of NDF to include in a ration. The maximum NDF in the ration is also the minimum amount of NFC needed for good ruminal fermentation and to avoid negative affects on dry matter intake related to high NDF levels (Akins *et al* 2012).

Table (4) data indicated that the highest values of feed conversion (DMI kg/kg FCM) were with feeding on rations containing corn silage (control) or corn silage with berseem (exp.2) than ration which containing berseem only (exp.1).

Table 4. Effect of feeding experimental rations on feed conversion of lactating Friesian cows.

Items	Control	Exp.1	Exp.2
DMI (Kg/h/day)	16.59	16.33	16.46
Fat corrected milk FCM	12.86	15.41	14.15
DMI Kg/ Kg FCM	1.30 ^{a}	1.06 ^{b}	1.18 ^{a}

a and b : Means within the same raw with different superscripts are significantly different ($p<0.05$)

Some researches reported that feeding corn silage (CS) ad libitum increased DMI and performance of cattle (Keady *et al* 2007). Corn grain is incorporated within the whole plant so there is energy from grain along with fibre from the rest of the plant. Mazzenga *et al* (2009) reviewed the diets included along with (wheat straw and CS), dried beet pulp, soybean meal, corn meal, wheat bran and mineral premix, with the stepped substitution of wheat straw with CS, the forage to concentrate ratio were as follows: 40:60, 50:50, 60:40 and 70:30 respectively.

The highest digestibility data was that of 50% inclusion of CS (for DM, OM, CP, NDF and ADF). They stated that CS had a positive effect on DM digestibility through the increase of NDF and OM digestion while increasing CS inclusion.

In addition, it was reported that body weight gain (BWG), DMI, yield of 4% fat corrected milk and milk fat concentration were greater for cows fed CS harvested at 36% DM but decreased as cows were fed diets containing 46% DM.

Table (5) showed that the highest values ($p<0.05$) of feed cost were estimated with exp.1 (40.01 LE) and exp.2 (38.07 LE) than feeding on the control diet (36.09 LE), but there was no significant affect between the control and exp.2. With the same trend the profit (LE) values were higher ($p<0.05$) with feeding an exp.1 (21.63 LE) or feeding with exp.2 (18.69 LE) than feeding with the control (15.35 LE).

Table 5. Economic efficiency with lactating cows fed the experimental rations.

Items	Control	Exp.1	Exp.2
Average daily feed consumption (as fed):			
Concentrate feed mixture Kg	7.33	7.08	7.21
Silage (S) Kg	15.00	0.00	7.50
Berseem (B) Kg	0.00	35.00	17.50
Rice straw (RS) Kg	5.50	5.67	5.58
Average daily production			
Fat corrected milk (FCM Kg/day)*	12.86	15.41	14.15
Price of FCM (LE)	51.44	61.64	56.76
Cost of total feeds (LE)	36.09^{b}	40.01^{a}	38.07^{ab}
Profit (LE) as total feed	15.35^{b}	21.63^{a}	18.69^{ab}

a, b and ab : Means within the same raw with different superscripts are significantly different ($p<0.05$)
*** FCM: Average of dairy production of calculated 3.5% fat corrected milk (Kg/day)**
FCM (Kg/day) = 0.432 ×milk (Kg) + 16.23 × fat (Kg), (Britt *et al* 2003)
Market price LE./kg of : FCM = 4.00 LE, Feed mixture = 3.6 LE, Silage = 0.50 LE, Berseem = 0.35 LE and Rice straw = 0.40 LE.

CONCLUSION

Corn silage is an important source of digestible effective fibre and can be an economical source of CP in diets for lactating cows, but increased passage rate with feeding berseem which is more digestible forage NDF might increase efficiency of milk production and composition. So feeding on exp.1 or exp.2 resulted in improving milk production, feed conversion and economic efficiency.

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مقارنة بين تأثير التغذية على سيلاج الأذرة أو البرسيم كعليقة أساسية على
١ - إنتاج اللبن والكفاءة الإقتصادية فى الأبقار الفريزيان الحلابة

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أُجري هذا البحث بهدف دراسة مقارنة تغذية أبقار الفريزيان الحلابة بإستخدام سيلاج الأذرة بالكيزان أو البرسيم الأخضر أو كلاهما معاً بالإضافة إلى العلف المُصنع مع قش الأرز على إنتاج اللبن ومكوناته وكذلك الكفاءة الإقتصادية. التجربة عبارة عن ثلاث مجموعات، كل مجموعة تشتمل على أربعة أبقار فريزيان حلابه فى المواسم من الثاني إلى الرابع وبمتوسط وزن (٤٩٠ – ٥٦٠ كجم)، واستمرت هذه التجربه عشرين إسبوعاً، وتم التغذية على العلائق التاليه:- ١- ٤٠% علف مُصنع + ٣٢% قش أرز + ٢٨% سيلاج أذرة بالكيزان (مجموعة المقارنة). ٢- ٤٠% علف مُصنع + ٣٢% قش أرز +٢٨% برسيم أخضر. ٣- ٤٠% علف مُصنع + ٣٢% قش أرز +١٤% سيلاج أذرة بالكيزان +١٤% برسيم أخضر. وكانت أهم النتائج المتحصل عليها كما يلى: ١- كان متوسط الإنتاج اليومي من اللبن خلال فترة التجربه يزداد معنويا على مستوى (٠,٠٥) من الأسبوع الأول وحتى الثانى عشر وفى المتوسط العام عند التغذية على المجموعة الثانية (البرسيم) بالمقارنة بمجموعة الكنترول (سيلاج) بينما لم يكن هناك فروق معنوية عند مقارنة المجموعة الأخيرة(برسيم + سيلاج) بباقى المجموعات الأخرى. ٢- كان متوسط الإنتاج اليومي من بروتين ولاكتوز اللبن خلال فترة التجربة يزداد معنويا عند التغذية على علائق المجموعة الثانية (البرسيم) والمجموعة الأخيرة(برسيم + سيلاج) بالمقارنة بمجموعة الكنترول (سيلاج). ٣- قيم كلا من (الكفاءة الغذائية فى صورة المادة الجافة المأكولة بالكجم/كجم لبن معدل الدهن) و (الطاقة الصافية لـ اللبن بالميجاكالورى/كجم لبن) كانت الأعلى عند التغذية على علائق مجموعة الكنترول (سيلاج) والمجموعة الأخيرة(برسيم + سيلاج) بالمقارنة بالمجموعة الثانية (البرسيم). ٤- كان متوسط تكاليف التغذية اليومية على علائق المجموعة الثانية (البرسيم) والمجموعة الأخيرة (برسيم + سيلاج) ومجموعة الكنترول (سيلاج) ٤٠,٠١ ، ٣٨,٠٧ ، ٣٦,٠٩ جنيه مصري على التوالي، وفي نفس الوقت فقد حققت هذه المجموعات بنفس الترتيب متوسط أرباح يومية كما يلى ٦٣،٢١ ، ١٨,٦٩ ، ١٥,٣٥ جنيهاً مصرياً. يُعتبر سيلاج الأذرة بالكيزان مصدراً هاماً للألياف والبروتين الجيد ذو القيمة الإقتصادية العالية فى علائق المجترات ، أما بالنسبة للبرسيم فلا يخفى تأثيره الإيجابى على رفع كفاءة و جودة المُنتج من اللبن، إلا أن التغذية عليه كمادة خشنة غنية بالبروتين يُقلل من الإستفادة من بروتين العليقة و بالتالى ينخفض بروتين اللبن. لذلك يستنتج من هذه الدراسة أن التغذية على العليقة الثانية أو الثالثة يعمل على تحسين الكفاءة الغذائية وبالتالى يرفع الكفاءة الإقتصادية الناتجة عن إستخدام هذه الخلطات العلفية.