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A COMPARISON BETWEEN FRESH RYEGRASS AND RYEGRASS SILAGE WITH RESPECT TO THEIR NUTRITIVE VALUE FOR SHEEP

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SUMMARY

The objective of this study was to compare between fresh ryegrass and ryegrass silage in the ability of sheep to consume the material, retained its nitrogen in their body with a special reference of some inorganic elements. A digestibility and nitrogen and minerals balance trials were conducted to compare between fresh ryegrass and ryegrass silage. Twelve mature cross breed rams aged 4 years old and weighted around 42 kg in average were assigned randomly into two experimental groups, 6 animals each and fed the fresh ryegrass (grass group) and its ryegrass silage (silage group) as a sole source of feedstuffs in the rations. Results indicated that dry matter (DM) intake and digestion were reduced by feeding silage ($P<0.05$), whereas dry matter digestibility in the fresh ryegrass group was equivalent to that in the ryegrass silage ($P>0.05$). Lead intake and retention was higher in fresh grass group than silage group ($P<0.05$). Values of nitrogen intake and retention were insignificant ($P>0.05$) higher in grass group than silage group. There was no significant difference ($P>0.05$) between grass group and silage group for sodium, magnesium, manganese, iron, cobalt, cupper. Whereas, values of potassium, calcium and zinc (intake and retention) were ($P<0.05$) higher in grass group than silage group. It could be concluded that fresh ryegrass was the better when compared with ryegrass silage but preserving ryegrass as silage to be used in the rations of ruminant is favorite during fodder scarcity season.

Keywords: *ryegrass, silage, intake, digestibility, minerals, nitrogen balance.*

INTRODUCTION

The major constraints of livestock production in Egypt are the scarcity and fluctuating quantity and quality of the year-round feed supply. These constraints have a negative impact on development of livestock production. Green fodder and crop residues are the main feedstuffs which play essential role in ruminant animals' nutrition in tropical and sub-tropical countries. Supply of green fodder to livestock is greatly influenced by fodder shortage periods (Shahzad *et al*., 2009 a, b). Silage making is considered one of the most effective practical substitutes to ensure sustainable fodder supply during fodder scarcity season (Sohail *et al*., 2011). Ryegrass is an annually winter plant which produces high quality forage that can be grazed, or harvested as green chop, silage, or hay (Bernard *et al.,* 2002). Bernard, 2003 reported that ryegrass contains moderate concentration of degradable protein and highly concentration of digestible energy which support animal growth or milk production. Lisa *et al.*, 2012 reported that Italian ryegrass (*Lolium multiflorum Lam., var. italicum*) evolved in the Mediterranean region, and in northern Italy, its cultivation as forage for livestock dates back as far as the 12th century. Annual ryegrass has moderate to high concentrations of nitrogen and the fiber is highly digestible when harvested in a vegetative maturity stage. Much of the nitrogen in ryegrass silage is soluble or is readily degraded in the rumen (Cooke *et al*., 2009 and Van Vuuren *et al*., 1990). Also, Aganga *et al*., 2004 reported that ryegrass is considered high quality forages and their high digestibility makes them appropriate for all types of ruminants. The objective of the study was to compare between fresh ryegrass and ryegrass silage in the ability of sheep to consume the material, retained its nitrogen in their body with a special reference to some inorganic elements.

MATERIALS AND METHODS

This study was carried out at Ras Sedr experimental Station in South Sinai which belongs to Desert Research Center, Mtarya, Cairo, Egypt, Labs of Animal Production Department, Faculty of Agriculture, Ain Shams University, National Research Centre, and Environmental Studies and Research Institute, University of Sadat City.

Animals and management:

Twelve mature cross breed rams (4 years old, 42 kg body weight) were divided randomly into two similar groups, six animals each. The animals were randomly assigned to receive one of the two tested diets, the first fed fresh ryegrass (grass group) and the second fed ryegrass silage (silage group) as a sole source of feedstuffs in the rations.

Silage preparation:

The silo was made as a hole in the ground measured 2×1×1 m and was built by building blocks away from the underground water. Its bottom was furnished by a ten cm layer of stones. The ryegrass was cut into small pieces (2-5 cm in length) to be easy to keep in the silo in an anaerobic condition, otherwise the material decays to an inedible and frequently toxic product. The small pieces of grass was put in layers mixed with 5% of its weight crushed white corn to mediate the pH and hence the fermentation. The material was thorough packing in the silo by a mean of plastic sheet to reduce the amount of oxygen and encourage a good fermentation. Another plastic sheet was used to cover the silo and a layer from seeds and dust was also added by a thickness of around 5 cm. A tractor was passed over the silo content to make sure from the pressing process and to explode the remaining air thoroughly. After 8 weeks the silage was used to feed the experimental animals in the same time at which green grass was used to feed the other group. The quality of silage was thoroughly evaluated and its pH was around 4 and its dry matter (DM) content was around 30%. Table (1) showed the organic and inorganic chemical components of fresh ryegrass and ryegrass silage on DM basis.

Digestibility and nitrogen balance trial:

A digestibility and nitrogen balance trials conducted for 21 day, 14 day as a preliminary period and 7 days as a collecting period. Animals were fed ad lib and the drinking water was introduced twice times daily at 9 a.m. and 5 p.m. Feed also was introduced to the animals twice daily at 8 a.m. and 4 p.m. The feed residues, feces and urine were collected daily 30 minutes before morning feeding.

The animals were weighed at the beginning and at the end of digestibility and nitrogen balance trials. The average initial weight of the rams around 40 kg and the final weight was about 43 kg. Animals were confined in individual metabolic cages during the experimental period. Feces were quantitative collected, daily samples of 10% of feces were taken from each animal, sprayed with a solution of 10% formaldehyde and 10% sulphoric acid, then all were dried in the oven at 70 C^o for 24 h. Dried feces samples were mixed and kept in plastic bottles until analysis.

Urine was collected in 5 L volume plastic containers containing 50 ml solution of 10% sulphoric acid, daily samples of 10% were taken from each animal and a composite sample was made of the 7 days urine collection and kept in dark glass containers for N determination.

Analytical methods

Chemical composition of fresh and ryegrass silage, feed residues, feces and urine were analyzed for proximate analysis according to AOAC (2007). Minerals profile was analyzed to calculate for minerals concentrations in intake, feces and urine to determine minerals balance and apparent absorption using atomic absorption and spectrophotometer Mo aa/ae 5/12 according to Sotera and Stux (1979).

Statistical analysis:

Statistical analysis of dry matter intake, digestibility, nitrogen balance, apparent absorption data and retention of minerals was performed by one way ANOVA using the GLM procedure of SAS (2003).

RESULTS AND DISCUSSION

Chemical composition and Intake:

Chemical composition of fresh ryegrass and ryegrass silage are shown in Table (1). Results showed that crud protein (CP), crud fiber (CF), ether extract (EE) and ash contents were higher for ryegrass silage compared to fresh ryegrass, while nitrogen free extract (NFE) was higher in fresh ryegrass compared with ryegrass silage. This may be due to chemical changes during ensilaging (Nishino *et al*., 1995).

The finding regarding CP content of fresh ryegrass and ryegrass silage were close to those found by Bernard (2003) (18.8 vs. 20.3, respectively), While were opposite in direction and higher than those found by Ozelcam et al. (2015) (12.83 for fresh ryegrass vs. 8.91 for ryegrass silage) and Aganga et al. (2004) (14.13 for fresh ryegrass vs. 13.95 for ryegrass silage).

Table (1) also, shows that the values of CF, EE and NFE is in agreement with Ozelcam et al. (2015) found that NFE was higher in fresh ryegrass compared with ryegrass silage (44.09 vs. 42.67) whereas, CF and EE were higher in the ryegrass silage compared to fresh ryegrass (35.06 vs. 30.90 for CF and 2.83 vs 2.49 for EE). The ash value obtained in this study for fresh ryegrass and ryegrass silage was in the same trend and close to that reported by Aganga *et al.* (2004) (8.0 vs. 8.25). Some of the differences between reports may be based on the differences between plant variety, growth age, soil structure, climate and pasture management (Aganga *et al.* 2004).

Most of the values of major and minor elements were narrowly higher in fresh ryegrass than ryegrass silage (Table 1). These may be attributed to the losses of liquids during the pressing process and to explode the remaining thoroughly air.

Table (2) shows that sheep in fresh ryegrass group consumed more DM than those in the ryegrass silage group ($P<0.05$) by a ratio of 22.3%. This result is in agreement with Sohail *et al.* (2011) who reported that decreased intake of silage has been observed in sheep than those fed fresh or dried fodder. Thiago and Gill (1986) demonstrated that the fermentation which occurs during ensiling has two major effects on composition of ensiled forage, both of which have a marked influence on the intake and efficiency. These are firstly, the degradation of soluble proteins and carbohydrates which is likely to have a determinate effect on the efficiency of microbial protein synthesis in the rumen and hence on voluntary intake. Secondly, the production of fermentation end products such as amines and organic acids can also have a marked effect on silage intake.

Table (1): Organic and inorganic chemical constituents of fresh ryegrass and ryegrass silage.

Item	Grass	Silage
Component%		
Crud protein (CP)	18.13	19.65
Crud fiber (CF)	30.30	34.04
Ether extract (EE)	1.73	3.85
Nitrogen free extract (NFE)	42.46	34.89
Ash	7.38	7.57
Major elements%		
Na	0.318	0.616
K	1.91	1.88
Ca	0.32	0.25
Mg	0.16	0.15
Minor elements (ppm)		
Mn	125	150
Fe	160	170
Zn	23.5	21.0
Cu	10.5	11.0
Co	5.0	3.5
Se	0.50	0.35
Pb	38.5	36.0

Digestibility:

According to the findings had been shown in Table (2), there was no significant difference between the two groups in DM digestibility ($P>0.05$). This result was close to that reported by Ozelcam *et al*.

(2015) (73.07 for fresh ryegrass vs. 73.01 for ryegrass silage). Values of DM digestibility for fresh ryegrass and ryegrass silage were higher than those reported by Catanese *et al.* (2009), Zhang *et al.* (1995) and Ohshima *et al.* (1988), while it was lower than those obtained by Amaral *et al.* (2011) and Nishino *et al.* (1995). The results may be due to the difference in harvest season and silage process. In a term of digested intake of DM g/day and g/kg LBW, the difference was significant (P<0.05), this results may be due to higher intake of grass group and probably for the previous mentioned reasons of Thiago and Gill (1986).

Nitrogen balance:

Table (2) showed that the values of total nitrogen intake, nitrogen excretion and nitrogen retention were higher in fresh ryegrass group than ryegrass silage group with no significant difference (P>0.05). Also, the nitrogen retention in terms of g/day, g/g NI and g/g DMI was remarkably higher in fresh grass than silage group. The reason of that might be due to the degradation of soluble proteins in rumen of animals fed silage which might have a detrimental effect on microbial protein synthesis efficiency (Thiago and Gill, 1986). Generally, the superiority in N retention in one group than another is affected by several factors. From these, possible production of microbial protein synthesis, increased fermentable energy presence (Hagemeister *et al.*, 1981), differences in availability of fermentable energy (Tagari *et al.*, 1976) availability of N that might escape fermentation from the rumen, an increased utilization of NH_3 in the rumen (Holzer *et al.*, 1986) and the effect of the free fats in protein synthesis (Sutton *et al.*, 1983).

Table (2): Means of dry matter intake, digestibility and nitrogen balance of sheep fed fresh grass and silage of ryegrass.

Item	Grass group	Silage group	Sig.
Live body weight, Kg	42	42	
Dry matter intake			
g/h/day	1099.7[a]	854.3[b]	*
g/Kg W	26.3	20.4	*
Dry matter digestibility,%	72.37	72.61	NS
Digested intake of dry matter			
g/h/day	796.0[a]	620.2[b]	*
g/Kg W	19.0[a]	14.8[b]	*
Total nitrogen intake			
g/h/day	31.90	26.86	NS
g/g DMI	0.029	0.032	NS
g/Kg W	0.77	0.64	NS
Nitrogen excretion			
In feces	8.53	6.57	NS
In urine	19.92	19.76	NS
Total	28.45	26.33	NS
Nitrogen retention			
g/h/day	3.45	0.53	NS
g/g NI	0.107	0.038	NS
g/g DMI	0.003	0.001	NS

Means in the same row with the different letter are significantly different at (P<0.05).
NS: Not significant.

Minerals metabolism:

Major elements:

Sodium (Na):

Table (3) showed that Sodium intake was higher in silage than in fresh grass group (P<0.01). However, no significant difference was detected between the two groups in Na retention and apparent absorption (P>0.05). That might be due to the higher output of Na via urine in silage group compared with fresh ryegrass group (P<0.05).

Table (3): Apparent absorption and retention of major elements (means on DM basis).

Item	Grass group	Silage group	Sig.
Sodium (Na):			
Intake, g/day	3.430	5.270	**
g/Kg W	0.082	0.128	
Fecal Na, g/day	0.875	0.631	NS
Urine Na, g/day	2.227	4.555	*
Retention Na, g/day	0.328	0.384	NS
App. Absorb., %	75.4	84.20	NS
% in intake	0.31	0.62	
Recommended level+	0.1-0.34	0.1-0.34	
Potassium (K):			
Intake, g/day	21.503	16.126	*
g/Kg W	0.514	0.385	
Fecal K, g/day	2.042	1.807	NS
Urine K, g/day	15.066	11.912	NS
Retention K, g/day	4.395	2.407	*
App. Absorb., %	90.53	88.72	NS
% in intake	1.96	1.89	
Recommended level	0.5	0.5	
Magnesium (Mg):			
Intake, g/day	1.834	1.266	*
g/Kg W	0.0438	0.0303	
Fecal Mg, g/day	1.168	0.863	*
Urine Mg, g/day	0.463	0.370	NS
Retention Mg, g/day	0.203	0.033	*
App. Absorb., %	36.30	31.96	*
% in intake	0.17	0.15	
Recommended level	0.06	0.06	
Calcium (Ca):			
Intake, g/day	3.514	2.139	**
g/Kg W	0.0839	0.0510	
Fecal Ca, g/day	1.172	0.987	NS
Urine Ca, g/day	0.860	0.834	NS
Retention Ca, g/day	1.482	0.318	**
App. Absorb., %	66.89	53.78	**
% in intake	0.32	0.25	
Recommended level+	0.24-0.34	0.24-0.34	

+: According to NRC (1980) as % of intake.
**: P<0.05.*
***: P<0.01.*
NS: Not significant.

Regardless type of feed input, NRC (1980) demonstrated that approximately 80% of the sodium that enters the gastrointestinal tract arises from internal secretion such as saliva, gastric fluids, bile and pancreatic juice. Thus, large variations in salt intake have relatively small effects on the total amount of Na entering the gastrointestinal tract. In addition, any increase in Na intake is accommodated by ready excretion in the kidneys as the case in this study.

In general, dietary concentration recommended by NRC (1980) for Na is 0.2% and ranged from 0.1 being required by growing beef calves to 0.35% being required by horses. The maximum tolerable level was as 9% and our values of total intake were among this value, being around 0.3% in grass and 0.6% in silage group. The higher level of intake from Na in silage group might have a negative effect in reduced intake from the silage group compared to grass group (El-Shaer *et al.*, 1990).

Potassium (K):

Also, Table (3) showed that Potassium intake (g/d) was higher in grass group than in silage group (P<0.05). It looked that the main pathway outside the body was via urine (NRC, 1980). The K retention was also higher (P<0.05) in grass group than silage group, but there was no significant difference between the two groups in apparent absorption (P>0.05).

Both recommended and tolerant levels of K were emphasized by NRC (1980) to be 0.5 and 3% of intake. K intake in our study for grass and silage groups was 1.96 and 1.89%, respectively. The amount excreted in feces was low being around 10% of intake. Powell *et al.* (1978) obtained close results and they concluded that the regression of fecal K on its intake was no significant. Ward (1966) emphasized that there are usually an inverse relationship between Na and K excretion and that was the case in this study since the higher amount of Na excreted via urine was in silage group, while the opposite proved true in case of K element (Table 3). Apparent absorption of K was high in both groups (90.53 for grass group and 88.72 for silage group) with no significant difference (P>0.05) and it was near from the obtained values by Kemp *et al.* (1966) working with dairy cows (89%) and Powell *et al.* (1978) working on lambs fed fresh herbage (89.2%).

Magnesium (Mg):

Table (3) showed that a significant increase in Mg intake by grass than the silage group (P<0.05). There was significant difference between grass group and silage group in excreted Mg via feces (P<0.05). The results indicated that grass group was higher in excreted Mg via feces than silage group. L'Estrange *et al.* (1967) obtained a linear relationship between Mg intake and fecal output in weathers fed harvested herbage at different growth stages. There was significant difference between the two groups in Mg retention and apparent absorption (P<0.05) and the grass group was the higher than silage group. It seemed that there a reverse relationship between each of K and Mg results as described by Powell *et al.* (1978). NRC (1980) recommended a daily level of Mg intake to be 0.06% in sheep and the maximum tolerable level is 0.5% in DM basis. Our study covered the requirement of Mg (0.16%) and was away from the maximum tolerable level described by the literatures.

Calcium (Ca):

Table (3) indicated that higher calcium intake was recorded for grass than silage group (P<0.01). The same observation was recorded for Ca retention (g/day) and apparent absorption (P<0.01). Values were higher than those recorded by Kemp *et al.* (1966) and Powell *et al.* (1978). However several factors might effect on these results such as; intake (Grace *et al.*, 1974), plant maturation (Butler and Jones, 1973), grass species (Reid *et al.* 1978) and cultivars (Patil and Jones, 1970). The recommended level of Ca for sheep was found to be 0.24 up to 0.34% and the maximum tolerable level was found to be 2% of the intake. The obtained values in this study were in the range of 0.32 and 0.25% of grass and silage group, respectively. There was no significant difference in Ca secretion in fecal and urine for the two groups (P>0.05).

Minor elements:

There was no significance difference (P>0.05) was detected in intake**,** retention and apparent absorption between the two groups in manganese, iron and copper elements (Table 4). Meanwhile there was a significance difference in intake in cobalt and zinc (P<0.01) and lead (P<0.05) where grass group was higher than silage group. There was also a significant difference (P<0.05) in retention in zinc and lead and the grass group had the higher value. No significance difference was recorded in apparent absorption between the two groups through the different tested micro minerals. All elements found in the two groups were more than the recommended values (NRC, 1980) and below than the maximum tolerable level.

In comparison with the recommended levels in the Tables (3) and (4), it was found that Ca and Zn were within the normal ranges in the two groups, while K, Mg, Mn, Fe, Co and Cu were high. Na levels in silage group were marginally toward high level. Excessively high Fe levels in the forge might inhibit use of Cu and leading to cessation of hemopoiesis (SAC/SARI, 1982). Adequacy of Ca and Cu for example should be interpreted with caution because concentration of a mineral in blood is due to an interaction of many factors, which can initiate mobilization of body reserve such as mineral level in the forage, availability and stored amount in the body tissue demand from the element and production requirements (Musalia, *et al.*, 1989). In addition, some plasma minerals (Mg and P) were affected by their concentration in the diet, while Ca is not (Underwood, 1981). However, a study on plasma levels of these minerals might be conducted since low plasma levels are indicative of low mineral intake which of not due to low levels in forages, is due to low availability of the mineral to animals (Musalia, *et al.*, 1989).

Table (4): Apparent absorption and retention of minor elements (means on DM basis).

Item	Grass group	Silage group	Sig.
Manganese (Mn):			
Intake, g/day	0.139	0.127	NS
g/Kg W	0.003	0.00304	
Fecal Mn, g/day	0.109	0.1000	NS
Urine Mn, g/day	-	-	
Retention Mn, g/day	0.030	0.0274	NS
App. Absorb., %	21.96	21.49	NS
ppm in intake	130	150	
Recommended level+	5-20	5-20	
Iron (Fe):			
Intake, g/day	0.175	0.146	NS
g/Kg W	0.0042	0.00353	
Fecal Fe, g/day	0.130	0.0979	
Urine Fe, g/day	0.0017	0.0015	NS
Retention Fe, g/day	0.0427	0.0464	NS
App. Absorb., %	25.85	32.84	NS
ppm in intake	159	170	
Recommended level+	80	80	
Cobalt (Co):			
Intake, g/day	0.0056	0.00295	**
g/Kg W	0.00013	0.00007	
Fecal Co, g/day	0.0051	0.0026	**
Urine Co, g/day	-	-	
Retention Co, g/day	0.0005	0.00035	NS
App. Absorb., %	9.32	11.84	NS
ppm in intake	5	3	
Recommended level+	0.05-0.1	0.05-0.1	
Cupper (Cu):			
Intake, g/day	0.0111	0.0093	NS
g/Kg W	0.00027	0.00032	
Fecal Cu, g/day	0.0103	0.0083	NS
Urine Cu, g/day	0.0002	0.00022	NS
Retention Cu, g/day	0.0006	0.00078	NS
App. Absorb., %	7.46	10.82	NS
ppm in intake	10	11	
Recommended level+	4-5	4-5	
Zinc (Zn):			
Intake, g/day	0.0257	0.0179	**
g/Kg W	0.00062	0.00042	
Fecal Zn, g/day	0.0201	0.0140	**
Urine Zn, g/day	0.0014	0.0019	NS
Retention Zn, g/day	0.0042	0.0020	*
App. Absorb., %	21.62	21.62	NS
ppm in intake	23	21	
Recommended level+	20-40	20-40	
Lead (Pb):			
Intake, g/day	0.0421	0.03095	*
g/Kg W	0.0010	0.00074	*
Fecal Pb, g/day	0.0380	0.0285	*
Urine Pb, g/day	0.0001	0.0001	NS
Retention Pb, g/day	0.0041	0.0024	*
App. Absorb., %	9.47	7.92	NS
ppm in intake	38	36	
Recommended level+	-	-	

Table (4): Continue (table continued above from Cupper onward)

*+: According to NRC (1980) as ppm of intake. *: P<0.05. **: P<0.01. NS: Not significant.*

CONCLUSION

Fresh ryegrass was the better in DM intake and digestion, nitrogen intake and retention, potassium, calcium intake and retention and lead intake compared to ryegrass silage. While dry matter digestibility in the ryegrass group, was equivalent to that in the ryegrass silage. No difference between grass group and silage group for sodium, magnesium, manganese, iron, cobalt, copper and zinc retention. Results indicated that fresh ryegrass was the better when compared with ryegrass silage and preserving ryegrass as silage to be used in rations of ruminant is favorite during fodder scarcity season.

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مقارنة بين القيمة الغذائية لحشيشة الراى الطازجة وسيلاج حشيشة الراى فى الأغنام

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أجريت تجربة هضم وميزان النتروجين والمعادن للمقارنة بين الراى جراس الطازج وسيلاج الراى جراس. أستخدم فى التجربة 12 كبش ناضج خليط عمر 4 سنوات ووزن 42 كجم فى المتوسط ، تم تقسيم الحيوانات عشوائيا إلى مجموعتين فى كل مجموعة 6 حيوانات وتم تغذية إحدى المجموعتين على الراى جراس الطازج وغذيت الأخرى على سيلاج الراى جراس كمصدر وحيد للغذاء.

أشارت النتائج إلى أن المادة الجافة المأكولة والمهضومة إنخفضت بالتغذية على سيلاج الراى جراس وكان هناك فرق معنوى بين المجموعتين. فى حين أن معامل هضم المادة الجافة فى المجموعة المغذاه على الراى جراس الطازج كان يعادل معامل ضم المادة الجافة فى المجموعة المغذاه على سيلاج الراى جراس مع عدم وجود فرق معنوى بين المجموعتين.

كما أشارت النتائج إلى أن الرصاص المأكول والمحتجز كان عاليا فى المجموعة المغذاه على الراى جراس الطازج بالمقارنة بالمجموعة المغذاه على السيلاج وكان الفرق بين المجموعتين معنويا. أيضا قيم النتروجين المأكول والمحتجز كانت أعلى فى المجموعة المغذاه على الراى جراس الطازج بالمقارنة بالمجموعة المغذاه على سيلاج الراى جراس وكان الفرق بين المجموعتين معنوى.

أوضحت النتائج أيضا عدم وجود فرق معنوى بين المجموعتين بالنسبة لكل من الصوديوم والماغنسيوم والمنجنيز والحديد والكوبلت والنحاس فى حين كانت قيم الكالسيوم والزنك (المأكول والمحتجز) عالية فى المجموعة المغذاه على الراى جراس الطازج بالمقارنة بالمجموعة المغذاه على سيلاج الراى جراس وكان الفرق بين المجموعتين معنوى.

نستخلص من هذه الدراسة أن الراى جراس الطازج كان الأفضل عند إستخدامه فى تغذية الاغنام بمقارنته بسيلاج الراى جراس، لكن حفظ الراى جراس الطازج كسيلاج هو المفضل خلال موسم ندرة الأعلاف.