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UTILIZATION FROM NEW NUTRITIONAL RESOURCES IN RUMENANT FEEDING:
1- EFFECT OF USING DRIED DISTILLERS GRAINS WITH SOLUBLES(DDGS) IN RATIONS FOR FATTENING FRIESIAN CALVES

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ABSTRACT

Forty-five male Friesian calves averaging 309.86 kg live body weight (L.B.W.), were divided into three similar groups (15 in each) and used in feeding trial which lasted 172 days. Animals were assigned to receive 2% of L.B.W. concentrate feed mixture which containing dried distiller grains with solubles (DDGS) at the rate of 0%, 10% and 20% in rations A, B and C, respectively. All animals offered rice straw at the rate of 1.0% of L.B.W., plus 2 kg berseem hay/day. In addition, three digestibility trials (3 calves in each) were conducted to determine the digestibility coefficients of all nutrients and feeding values of experimental rations.

The results obtained showed significantly ($P<0.05$) higher digestibility coefficients and nutritive value of ration C (containing 20% DDGS) than the control ration (ration A).

Average daily gains were 0.898, 0.955 and 1.110 kg for animals fed rations A, B and C, respectively. Animals given ration C grew significantly($p<0.05$) higher than those given ration A or B. Significant ($P<0.05$) improvements were recorded for animals fed ration C with respect to feed conversion efficiency expressed as kg, DM, TDN, SE or DCP/kg gain. Results of ruminal measurements of animals fed rations B and C containing 10% and 20% DDGS showed high pH, NH_3-N and VFA's concentrations. At the same time, serum blood parameters (Total protein, albumin and globulin) showed similar trend. Moreover, animals fed rations containing both 10% and 20% DDGS grew faster and had lower cost of feeding with better economical efficiencies, than the control group.

INTRODUCTION

There are limited protein and energy sources for use in ruminant feeds in Egypt. Yellow corn is the main source of energy and is an essential component in cattle feeding. However, the price of yellow corn has increased greatly due to the expansion in its use in the ethanol production as a fuel. Dried distillers grains with solubles (DDGS) is a co-product of the ethanol industry. This product is high in both energy(85%TDN) and protein(27%). Additionally, it is a palatable product and has higher value of available phosphors compared to other protein sources. It also reduces feed cost, improves feed conversion efficiency, fiber digestion in rumen, good source of ruminally undegraded protein and less starch with highly digestible fiber and fats (Harold Harpster, 2007).

This product have been used in many trials as source of energy or protein in ration formulations of dairy animals, beef steers, heifers, sheep,

poultry and swine (May *et al*., 2009, Leupp *et al*., 2009, Widmers, *et al*., 2008 and Reed *et al*., 2006).

This study aimed to include DDGS as a feed ingredient at the rate of 10% and 20% in place of yellow corn and soyabean meal in rations for fattening Friesian calves. Moreover, digestibility coefficients, feeding values, animal performance, feed conversion and economical efficiencies were studied.

MATERIALS AND METHODS

Forty-five male Friesian calves averaging 309.86 kg live body weight (L.B.W.) were used in the feeding trial, during 2009 at Dina El-Maadawy private farm located in the desert road . The trial aimed to evaluate DDGS as a feed ingredient and as a source of protein and energy in fattening Friesian calves.

Animals were randomly chosen and divided into three similar groups according to live body weight and age (15 in each). The three animal groups were fed experimental rations as follows: A) Concentrate feed mixture without DDGS; B) concentrate feed mixture with 10% DDGS and C) concentrate feed mixture with 20% DDGS. Dried distillers grains with solubles (DDGS) is a by-product of ethanol production from yellow corn . All animal groups were fed concentrate feed mixture at the rate of 2% L.B.W. along with 1% rice straw, in addition to 2 kg berseem hay/head/day. Weekly body weights and feed intakes were recorded during feeding trials which lasted 172 days. The feed allowances were adjusted every two weeks according to body weight changes using NRC (1989) as reference.

The concentrate feed mixtures were offered to animals twice daily at 8:00 a.m. and 4:00 p.m. followed by berseem hay, while rice straw and water were available during the whole day.

On the other hand, digestibility trial using nine calves in three groups (3 in each) was conducted to determine and evaluate the previous experimental rations. The digestibility trial lasted three weeks, the first two weeks were used as preliminary period along with one week as collection period.

Chemical composition of all ingredients and feces were carried out according to A.O.A.C. (1995).

Blood samples were withdrawn from the jugular vein of calves in each group during the digestibility trial (3 hrs post feeding). Serum was separated from blood and kept it in frozen at-20°C for chemical analysis to determine total protein (Cornell *et al*., 1949), albumin (Doumas *et al*., 1971), Creatinine (Young, 1990), while globulin concentration was determined by difference between total protein and albumin concentration. On the other hand, rumen liquor samples were taken from three calves in each group before morning feeding and at 3 hrs and 6 hrs post feeding. Each sample was divided into two parts, the 1st for determine the pH value and the 2nd part was preserved to determine the ammonia-N concentration (Warner, 1964).

Data were statistically analyzed by using GLM Programs of the Statistical Analysis System [SAS] (SAS, 1996).

The differences among means were tested using Duncan Multiple Range Test (Duncan, 1955).

RESULTS AND DISCUSSION

Chemical composition of the feed ingredients and the concentrate feed mixture as well as the analysis of rice straw and berseem hay are shown in Table (1).

Table (1): Ingredients of concentrate feed mixtures of three experimental rations

Items	Experimental rations			Rice straw	Berseem hay
	A	B	C		
Ingredients (%):					
Yellow corn	52	47	42		
Wheat bran	18	18	18		
Soya bean meal (44%)	10	5	-		
Brewers pulp	12	12	12		
Undecorticated cotton seed cake	5	5	5		
Dried distiller grains (DDGS)*	-	10	20		
Line stone	2	2	2		
Salt	1	1	1		
Chemical composition of concentrate feed mixture, rice straw and berseem hay:					
DM	92.20	90.14	90.60	92.10	91.16
OM	96.71	96.69	96.68	85.76	89.62
CP	14.50	14.56	14.62	4.86	12.44
EE	.3.10	3.60	4.11	1.76	2.86
CF	7.72	8.08	8.44	39.94	26.65
NFE	71.39	70.45	69.51	39.20	47.67
Ash	3.29	3.31	3.32	14.24	10.38

***DDGS contains: 29,61% CP, 8.79% Starch, 36.43% NDF and 18.38% ADF(Reed *et al*., 2006)**

It could be noticed that the nutrients contents for the concentrate feed mixtures were almost equal especially in organic matter(OM), crude protein(CP), nitrogen free extractives(NFE) and ash contents. There was a slight increase in the CP and ether extract(EE) contents of concentrate feed of rations B and C due to the higher protein and energy content of DDGS which is included in the rations B and C.The results of the chemical analysis of rice straw and berseem hay were similar with those reported by (Etman *et al*., 2001).

The calculated compositions of experimental rations are presented in Table (2), which shows that the different rations were almost similar in nutrient contents.

Moreover, rations B and C containing DDGS at the rate of 10% and 20%, respectively, tended to have slightly higher EE and lower CF contents compared with the control ration. The digestibility coefficients of all nutrients for tested rations (B and C rations) were significantly ($P<0.05$)

higher than those recorded for ration A (control ration), except for EE and NFE digestibilities, while differences between ration B and both of ration A and ration C with respect to CF digestibility was not significant (Table, 2).

Table (2): Average daily feed intake, calculate composition, digestibility coefficient and nutritive value of different experimental rations

Items	Experimental rations		
	A	B	C
Average daily feed intake (kg DM/head):			
Concentrate feed mixture	6.825	6.860	7.023
Rice straw	1.950	1.960	2.015
Berseem hay	0.975	0.980	1.008
Total DM intake	9.750	9.800	10.075
Calculate composition of experimental rations:			
DM	90.08	90.63	92.96
OM	93.79	93.80	93.81
CP	12.36	12.40	12.44
EE	2.81	3.16	3.52
CF	16.57	16.32	16.06
NFE	62.05	61.92	61.79
Ash	6.21	6.20	6.19
Digestibility coefficients, (%):			
DM	75.45^{b}	80.16^{a}	80.84^{a}
OM	79.81^{b}	82.11^{a}	83.53^{a}
CP	85.42^{b}	90.00^{a}	90.28^{a}
EE	90.61^{a}	90.24^{a}	90.16^{a}
CF	75.48^{b}	79.16^{ab}	82.78^{a}
NFE	80.35^{a}	80.32^{a}	80.18^{a}
Nutritive value, (%):			
TDN	75.67^{b}	80.38^{a}	81.20^{a}
SE	64.73^{b}	69.81^{a}	70.92^{a}
DCP	10.55^{b}	11.16^{a}	11.23^{a}

a and b : Means in the same row with different superscripts are differ (P<0.05).

Generally, using DDGS as a partial replacement of yellow corn and soyabean meal in rations for fattening Friesian calves appeared to have higher digestibility coefficients for most nutrients. Also , the nutritive values of the rations containing DDGS (B and C rations) in terms of TDN, SE and DCP had significantly (P<0.05) higher values, being 80.38, 69.81 and 11.16%,respectively for ration B; 81.20, 70.92 and 11.23% for ration C. Higher digestibility of most nutrients for the rations containing DDGS (rations B and C) might be attributed to higher digestibility and availability of nutrient contents of DDG as reported by DeHaan *et al*. (1982) and Kleinschmit *et al*. (2006).

Effect of feeding DDGS on growth performance

Results of growth performance presented in Table (3) showed higher daily live body weight gains for animals fed tested rations B and C, which containing DDGS being 0.955 and 1.110 kg, respectively. Adding DDGS as

a source of energy and protein ingredient to tested rations at the rate of 20% significantly (P<0.05) improved daily gain by 23.61%, but using DDGS at the rate of 10% showed only 6.32% higher daily gain with the control ration.

Table (3): Average daily gain, feed efficiency and feed cost of animals fed different experimental rations

Items	Experimental rations		
	A	B	C
No. of animals	15	15	15
Experimental periods, day	172	172	172
Av. initial L.B.W., kg	313.00	309.50	307.08
Av. final L.B.W., kg	467.50	473.73	498.10
Av. total L.B.W., kg	154.50	164.23	191.02
Av. daily L.B.W., kg	0.898^{b}	0.955^{ab}	1.110^{a}
Av. daily feed unit intake:			
kg DM	9.750	9.800	10.075
kg TDN	7.378	7.877	8.181
kg SE	6.311	6.841	7.145
kg DCP	1.029	1.094	1.131
Feed conversion efficiency:			
kg DM/kg gain	10.857^{a}	10.262^{a}	9.076^{b}
kg TDN/kg gain	8.216^{a}	8.248^{a}	7.370^{b}
kg SE/kg gain	7.028^{a}	7.163^{a}	6.437^{b}
kg DCP/kg gain	1.146^{a}	1.146^{a}	1.019^{b}
Feed cost and economical efficiency, LE:			
* Cost of feed intake /kg gain	9.779	9.484	9.399
Price of kg weight gain	13.470	14.325	16.650
Feed cost /kg weight gain	10.889	9.931	8.468
Economical efficiency	1.377	1.510	1.771
Improvement (%)	-	9.66	28.61

a and b : Means in the same row with different superscripts are differ (P<0.05).

*** Based on the assumption that the price of one ton of rice straw was 66 LE; Barseem hay was 600 LE; concentrate feed mixture was 1330, 1280 and 1235 LE; with rations A, B and C, respectively, while the price of one kg body weight on selling was 18.00 LE.**

Higher daily gain of animals fed rations containing DDGS might be attributed to higher protein and energy contents of DDGS along with its higher nutrients digestibility . The results reported by May *et al*. (2009), Leupp *et al*. (2009) and Trankle, (2003), support the present results.

Moreover, distiller dried grains (DDGS) is a good source of undegradable protein which is about 50% of its total protein, which could be absorbed post-ruminally as amino acids and it makes together with microbial protein to support more gains for animals. Also, rations containing DDGS was also useful for the animals owing to its content of fermented effective fiber (34% NDF) and (13% fat) on DM basis.

Effect of feeding DDGS on feed conversion efficiency

Data presented in Table (3) showed feed conversion efficiency expressed as amounts of kg DM, TDN, SE or DCP to get one kg gain. Results obtained revealed that, animals fed ration C containing 20% DDGS

had significantly ($P<0.05$) the highest feed conversion efficiency, being 9.076, 7.370, 6.437 and 1.019 kg DM, TDN, SE and DCP,respectively.The improved feed conversion efficiency for ration C (containing 20% DDGS) might be attributed to higher final and daily weight gain compared to animals given the others. On the contrary, ration B (containing 10% DDGS) tended to have lower feed conversion efficiency than ration C with no significant differences (Table 3).

Ham *et al*. (1994), Kleinschmit *et al*. (2006) and DeHaan *et al*. (1982),reported similar results on cattle,sheep and poultry

From these results, it could be noticed that the improvement in feed conversion efficiency was related to feed intake and average daily gains.

Economical efficiency

Results obtained in Table (3) showed that the lowest feed cost/kg weight gain was recorded with ration C (containing 20% DDGS) followed by ration B (containing 10% DDGS), being 8.468 and 9.931 L.E., respectively, while control ration (ration A) was the most expensive (10.889 L.E. feed cost/kg weight gain). The economical efficiency (feed cost of kg gain/cost of feed intake) recorded 1.377, 1.510 and 1.771 for rations A, B and C, respectively, showing the best economical efficiency was recorded for ration C (containing 20% DDGS) followed by ration B (containing 10% DDGS) and was least for ration A (without DDGS).The improvement in economical efficiency was 28.61 and 9.66% with ration C and B, respectively. Similar results have been reported by Harold Harpster (2007), Stephanie Veldman, (2006) and Lawrence and Mark, (2006). Considering to day prices of yellow corn and soyabean meal 44%,cost saving/MT of feed at the 20% level of DDGS inclusion is L.E.12($ 2.1)/ MT of feed (according to December, 2010).

Ruminal parameters

Data presented in Table (4) revealed that the ruminal pH value with different experimental groups appeared to gradually decrease with progress time after feeding. Moreover, significant ($P<0.05$) differences were found among group fed rations A and both of those fed rations B and C at 3 and 6 hours. The rumen pH values tended to be significantly ($P<0.05$) higher for animals fed the tested rations containing DDGS than those fed control ration. Overall mean of ruminal pH values showed the highest value (6.84) was recorded for the group fed ration C (containing 20% DDGS), followed by those fed ration B (containing 10% DDGS) and the lowest value was recorded with groups fed control ration (ration A).

Also, the rumen pH value is one of the important factors affecting fermentation in the rumen. It varies in a regular manner depending on the nature of the ration and on the time that it is measured after feeding and reflects change of organic acid quantities in the digestia (Abdel-Kareem, 1990).

Ammonia-N concentration in rumen liquor showed the lowest level at before feeding and increased to the highest level at 6 hrs after feeding. Adding 20% DDGS in ration (C) tented to significantly ($P<0.05$) induce higher NH_3-N concentration, while this increase with ration B was not significant (Table, 4). The overall means of ruminal NH_3-N concentration

recorded 26.16, 27.48 and 28.12 mg/100 ml for animals fed rations A, B, and C, respectively, showing higher values with animals fed rations containing DDGS (rations B and C).

Table (4): Ruminal parameters of Friesian calves fed experimental rations

Items	Time of sampling After feeding	Experimental rations		
		A	B	C
pH	0 hr	7.25[a]	7.58[a]	7.82[a]
	3 hr	6.14[a]	6.72[b]	6.91[b]
	6 hr	5.12[a]	5.60[b]	5.80[b]
Overall average for pH		6.17	6.63	6.84
NH_3-N (mg. /100 ml)	0 hr	24.16[a]	26.42[b]	26.51[b]
	3 hr	26.15[a]	27.19[ab]	28.02[b]
	6 hr	28.18[a]	28.82[ab]	29.84[b]
Overall average for NH_3-N		26.16	27.48	28.12
Total VFA's (meq. /100 ml)	0 hr	10.18[b]	11.73[a]	11.25[a]
	3 hr	9.34[b]	10.92[a]	10.84[a]
	6 hr	9.87[b]	11.20[a]	10.86[a]
Overall average for VFA's		9.79	11.28	11.02

a and b : Means in the same row with different superscripts are differ (P<0.05).

The concentrate of ruminal total VFA's had lower values at 3 hrs after feeding, then it increased at 6 hrs post feeding, showing significantly (P<0.05) higher values with tested rations (containing DDGS) at different periods, as shown in Table (4). The same trend was observed with overall averages which increase with rations containing the DDGS. In general, the higher TVFA's concentration might be attributed to several factors such as DM digestibility, rate of absorption, rumen pH, rate of passage of digestia and microbial population in the rumen and their activities (Allam *et al*., 1984). Also, such fluctuations in pH values and other ruminal parameters including NH_3-N and total VFA's concentration could be attributed to different variable factors, mainly ration composition, feeding type and its level, roughage to concentrate ratio and time sampling.

Blood parameters

Some serum blood parameters are illustrated in Table (5). The blood total protein recorded were 6.42, 6.85 and 6.76 gm/100 ml for animals fed rations A, B and C, respectively,with no significant differences. However, the animals fed rations containing either 10% or 20% DDGS tended to have higher blood total protein concentration. The same trend was observed with albumin and globulin concentration, with no significant differences too. Albumin/globulin ratio as the reflection of both albumin and globulin concentrations, indicating higher ratio with animals fed ration B. On the contrary, blood creatinin value appeared to have the highest concentration with animals fed ration A followed by those fed rations B and C (containing 10% and 20% DDGS, respectively). However, these differences were not significant (Table 5).

Results concerning albumin, globulin and A/G ratio were within the normal ranges as reported by Fouda (2005).

Table (5): Serum blood parameters of Friesian calves fed different experimental rations

Items	Experimental rations			Standard error (±SE)
	A	B	C	
Total protein, (gm/100ml)	6.42[a]	6.85[a]	6.76[a]	0.26
Albumin, (gm/100ml)	3.24[a]	3.65[a]	3.50[a]	0.10
Globulin, (gm/100ml)	3.18[a]	3.20[a]	3.26[a]	0.08
Albumin/globulin ratio	1.02	1.14	1.07	-
Creatinin, (mg/dl)	1.25[a]	1.12[a]	1.15[a]	0.08

a and b : Means in the same row with different superscripts are differ (P<0.05).

Conclusion

The present results showed that DDGS could be concluded that the incorporation DDGS at the rate up to 20% in the concentrate feed mixture of the rations for fattening Friesian calves significantly (P<0.05) increased digestibility coefficients of most of nutrients and the feeding values expressed as TDN and DCP,in addition to increase daily gain, improved feed conversion efficiency respectively. At the same time, animals fed rations containing DDGS at the rate up to 20% tended to give more weight with lower feed cost and higher feed and economical efficiencies. Further work is needed to explore the possibility of including DDGS at rates higher than 20% in fattening rations for beef animals. Also, the proper level of DDGS to be used in dairy cattle rations need to be explored.

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الإستفادة من مصادر غذائية جديدة فى تغذية المجترات:

١- إستخدام نواتج التقطيرالعرضية للأذرة (DDGS) فى تسمين عجول الفريزيان

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إستخدم فى هذا البحث عدد خمسة وأربعون عجل بقرى فريزيان بمتوسط وزن حوالى ٣٠٩.٨٦ كجم وقسمت عشوائياً إلى ثلاثة مجموعات متماثلة (١٥ فى كل مجموعة) طبقاً للعمر والوزن وأستمرت التغذية حوالى ١٧٢ يوماً فى مزرعة خاصة. وتغذت الحيوانات على علف مركز يحتوى على مادة نواتج تقطير الذرة (DDGS) بنسب صفر ، ١٠ ، ٢٠% فى المجموعات الثلاثة على التوالي بالإضافة إلى تغذية جميع الحيوانات على ١% من وزن الجسم قش أرز +٢كجم دريس برسيم/حيوان/يوم
أجريت ثلاث تجارب هضم لتقييم الأعلاف المقدمة للمجموعات الثلاثة وتقدير القيمة الغذائية والهضمية.
وكانت أهم النتائج المتحصل عليها كما يلى:

١- إرتفاع معاملات الهضم والقيمة الغذائية لكل العناصر الغذائية للعليقة المحتوية على نواتج تقطير الذرة بنسبة ٢٠% عن مجموعة المقارنة.

٢- كان معدل النمو اليومي يساوى ٠.٨٩٨ ، ٠.٩٥٥ ، ١.١١٠ كجم لحيوانات المجموعات التي تغذت علي العلائق أ، ب و ح على التوالي مبيناً ارتفاعاً معنوياً عند مستوى ٥% للمجموعة التي تغذت عل المعاملة الثالثة.

٣- زادت الإستفادة من العليقة المحتوية على ٢٠% نواتج تقطير الذرة (العليقة الثالثة) زيادة معنوية عند حساب الكميات المأكولة كمادة جافة أو طاقة أو بروتين لإعطاء واحد كيلو جرام نمو.

٤- أظهرت النتائج إرتفاع قيم الأس الأيدروجينى ونيتروجين الأمونيا وكذلك تركيزات الأحماض الدهنية الطيارة الكلية فى سائل كرش الحيوانات التى تغذت على العلائق المحتوية على نواتج تقطير الأذرة مقارنة بمجموعة الكنترول، وظهر هذا الإتجاه مع قيم سيرم الدم مثل البروتين الكلى، والألبيومين ، الجلوبيولين إلا أن قيم الكرياتينين كانت معاكسة لهذا الإتجاه.

توصى الدراسة بإن تغذية العجول الفريزيان الخليطة على علائق تحتوى على نواتج تقطير الذرة بنسب تصل إلى ٢٠% أدت إلى زيادة معدل النمو اليومي مع إنخفاض في تكاليف التغذية لإنتاج ١ كجم نمو وإرتفاع في الكفاءة الإقتصادية.

قام بتحكيم البحث

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