

EFFECT OF YUCCA EXTRACT SUPPLEMENTATION ON PRODUCTIVE PERFORMANCE OF GROWING FRIESIAN CALVES

A.M.A. Mohi El-Din, H.M.A. Gaafar and S.A. Swiefy

Animal Production Research Institute, Agricultural Research Center, Dokki, Egypt

SUMMARY

Fifty six male and female Friesian calves with initial live body weight of 119.43 and 117.32 kg, respectively were randomly divided into four similar groups (7 males and 7 females in each). Animals were individually fed a basal ration consisted on DM basis of 60% concentrate feed mixture + 20% berseem hay + 20% rice straw without supplementation (G_1 , control) or with 120, 160 and 200 g Yucca Schidigera extract (Ammonase-300) supplementation / ton concentrate feed mixture for G_2 , G_3 and G_4 , respectively.

Results showed that the digestibility coefficients of all nutrients, nutritive values, feed intake, ruminal TVFA's concentration, plasma glucose, total protein, albumin, globulin, AST and ALT concentrations, final body weight, total and daily weight gain and weight gain improvement, feed conversion, average daily feed cost, price of daily weight gain and economic efficiency increased significantly ($P<0.05$) with Yucca Schidigera extract supplementation compared with control group (G_1). However, ruminal pH value and ammonia-N concentration, plasma urea-N and creatinine concentrations and feed cost per kg weight gain decreased significantly ($P<0.05$) with Yucca Schidigera extract supplementation.

The ruminal pH value and feed cost per kg weight gain increased significantly ($P<0.05$) with increasing the level of Yucca Schidigera extract supplementation above 120 g / ton. However, the digestibility coefficients of all nutrients, nutritive values, feed intake, ruminal TVFA's and NH_3 -N concentrations, all blood plasma constituents, final body weight, total and daily weight gain and weight gain improvement, feed conversion, average daily feed cost, price of daily weight gain and economic efficiency decreased significantly ($P<0.05$) with increasing the level of Yucca Schidigera extract supplementation above 120 g / ton.

Moreover, the digestibility coefficients of all nutrients, nutritive values, feed intake, the final body weight, total and daily body weight gain, feed conversion, average daily feed cost, price of daily weight gain and economic efficiency were significantly higher ($P<0.05$), but feed cost per kg weight gain was significantly lower ($P<0.05$) for calves than heifers. While, rumen fermentation parameters, all blood plasma constituents were nearly similar for calves and heifers.

Yucca Schidigera extract supplementation at the level of 120 g per ton concentrate feed mixture for Friesian calves showed the best results which increased body weight gain and economic efficiency by 28.98 and 16.67%, respectively.

Keywords: *Friesian calves, yucca extract, digestibility, rumen activity, blood constituents, bodyweight gain, feed conversion and economic efficiency*

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INTRODUCTION

Steroidal saponins are present in a wide variety of plants, including the desert plant, *Yucca schidigera* (YS). Some of the physical and chemical properties of these compounds (e.g., surface active properties and ammonia binding capacity) have sparked research into its use in livestock production applications. Average daily gain of finishing steers fed high-grain diets was improved with supplementary yucca saponins (Goodall *et al.*, 1981 and 1982). Grobner *et al.* (1982) observed less ammonia and high propionate concentrations in continuous flow fermentors supplemented with yucca saponins. Yucca extract was found to decrease ruminal ammonia concentration (Hussain and Cheeke, 1995), to increase propionate concentration (Kil *et al.*, 1994) and in vivo OM digestibility (Valdez *et al.*, 1986), and to improve animal performance (Kil *et al.*, 1994). If digestibility of dietary fiber is not adversely affected by yucca supplement, it reduce protozoal populations in cattle which could improve nitrogen utilization in the rumen and increase microbial protein flow to the intestine (Williams and Coleman, 1991), thereby enhancing overall growth performance.

Plant extract of *Yucca Schidigera* has been reported to improve ruminal organic matter digestion (Goodall and Matsushima, 1980; Goetsch and Owens, 1985), and alter microbial protein synthesis (Grobner *et al.*, 1982). Gibson *et al.* (1985) reported a 27% decrease in ruminal ammonia levels by feeding yucca extract in diets containing 0.87% urea. A reduction in urea hydrolysis (urease activity) and associated ammonia levels would be beneficial by allowing greater quantities of urea to be utilized in high roughage ruminant diets (Glimp and Tillman, 1965). Research showed stimulatory effects of yucca extract added to diets on growth of steers (Goodall and Matsushima, 1979; Goodall *et al.*, 1979).

The objective of this study is to investigate the effect of *Yucca Schidigera* extract supplementation on nutrient digestibilities, feed intake, rumen activity, blood constituents, body weight gain, feed conversion and economic efficiency of Friesian calves.

MATERIAL AND METHODS

This work was carried out at Sakha Animal Production Research station, Animal Production Research Institute, Agricultural Research Center, Ministry of Agriculture during the period from May to December 2003.

Experimental animals and rations :

Fifty six male and female Friesian calves aged 4 months with initial live body weight of 119.4 kg for males and 117.3 kg for females, were randomly divided into four similar groups (7 males and 7 females in each). Animals were individually fed a basal diet composed of 60% concentrate feed mixture + 20% berseem hay + 20% rice straw on DM basis without supplementation (G₁, control) or with 120, 160 and 200 g *Yucca Schidigera* extract (commercial feed additives, Ammonase-300) supplementation / ton concentrate feed mixture for G₂, G₃ and G₄, respectively. *Yucca Schidigera* extract was mixed with 1 kg wheat bran and then added to the components of 1 ton concentrate feed mixture. *Yucca Schidigera* extract was

produced by Hangzhou New Asia International Co., Ltd, China. The action of yucca extract were:

1. The use of *Yucca schidigera* extract as feed helps to improve digestion of meals rich in nitrogenated compounds and allows for better absorption of them due to the fact that microbial activity is accelerated in the intestinal flora, lowering the volatile compounds that cause bad odors in the excretions.
2. It is also mentioned that the constant use of the *Yucca schidigera* extract as a nutritional complement is a valuable aid in the treatment of diabetes, high cholesterol, bursitis and high blood pressure, and its use is invaluable as an aid to improve and maintain good health.

Management :

The experimental calves were weighed in the morning before drinking and feeding at the beginning of the trial and biweekly thereafter. Animals were individually fed according to the NRC (1996) allowances for growing calves. Rations were adjusted to body weight every two weeks. Concentrate feed mixture was offered two times daily at 8 a.m. and 4 p.m., berseem hay once daily at 11 a.m. and rice straw was given two times at 9 a.m. and 5 p.m. *Yucca* extract (ammonase-300) was supplemented as a part of concentrate mixture. Calves were allowed to drink water three times a day at 7 a.m. and 1 p.m. and 7 p.m. Calves were kept under the routine veterinary care through the whole feeding trial. Chemical composition of tested ingredients and basal ration are shown in Table (1).

Table 1: Chemical composition ingredients and basal diet

Item	DM %	Composition of DM %					
		OM	CP	CF	EE	NFE	Ash
Ingredients							
Concentrate feed mixture*	90.10	93.67	17.45	5.68	3.91	66.63	6.33
Berseem Hay	88.09	89.34	12.60	29.24	1.62	45.88	10.66
Rice straw	91.90	81.35	3.18	35.20	0.86	42.11	18.65
Basal diet	90.04	90.35	13.63	16.37	2.84	57.51	9.65

Concentrate feed mixture consisted of 34% undecorticated cotton seed cake, 24% wheat bran, 22% yellow corn, 10% rice bran, 5% line seed cake, 2% molasses, 2% limestone and 1% common salt.

Digestibility trials:

Four digestibility trials were conducted during the feeding trial using six calves from each group (3 males and 3 females) to determine nutrient digestibilities and nutritive values. Nutrient digestibilities were determined using (1 N HCl) according to acid insoluble ash (AIA) methods suggested by Van Keulen and Young, (1977). Feces samples were taken from the rectum of each calf twice daily with 12 hours interval during the collection period. Samples of tested feedstuffs were taken at the beginning, middle and end of collection period. Representative samples of feedstuffs and feces were analyzed according to AOAC (1990).

Rumen liquor samples

Rumen liquor samples were collected from calves at 3 hours after the morning feeding by using a stomach tube and filtered through double layers of cheese cloth.

Value of pH was determined directly in rumen liquor using Orian 680 digital pH meter. The concentration of total VFA's was determined in rumen liquor samples by the steam distillation method (Warner, 1964) using Markham micro-distillation unit. The concentration of $\text{NH}_3\text{-N}$ was determined using a saturated solution of magnesium oxide distillation according to the method of AOAC (1990).

Blood samples:

Blood samples were withdrawn from the jugular vein of calves using sterile needle into clean dry heparinized tubes and spent at 4000 r.p.m. for 15 minutes. Blood plasma constituents (glucose, total protein, albumin, urea-N, creatinine, cholesterol, AST and ALT) were calorimetrically determined using commercial diagnostic kits (Test-combination, Pasteur lab.).

Feed conversion:

Feed conversion was calculated as the amounts of feed DM, TDN and DCP consumed (kg) per kg live body weight gain.

Economic efficiency:

Economic efficiency was expressed as a proportion of return to feeding cost based on 2007 market prices. The price of one ton was LE 1800 for concentrate feed mixture LE, 750 for berseem hay and 100 LE for rice straw. While, LE 25 for one kg *Yucca Schidigera* extract (ammonase-300) and LE 15 for 1 kg body weight gain.

Statistical analysis:

Data were subjected to statistical analysis as one way ANOVA, using general linear models procedure adapted by SPSS for windows (2004). Differences among means were tested according to Duncan (1955) whenever the differences were significant.

RESULTS AND DISCUSSION

Digestibility and nutritive values:

The effect of *Yucca Schidigera* extract supplementation on nutrient digestibilities and nutritive values by Friesian calves are presented in Table (2). Digestibilities of all nutrients and nutritive values were ($P<0.05$) increased as *Yucca Schidigera* extract supplement increased. These results agreed with those found by Goodall and Matsushima (1980) and Goetsch and Owens (1985) that *Yucca Schidigera* plant extract, improved ruminal organic matter digestion. Aregheore (2005) reported that apparent nutrient digestibility of DM, CP, CF, OM and energy by goats were ($P<0.05$) higher in the *Yucca* powder supplemented diets than the control one. Moreover, the digestibilities of all nutrients and nutritive values were ($P<0.05$) higher for males than females. Almost similar results were obtained by Gaafar *et al.* (2005).

Feed intake:

Feed intake by Friesian calves as affected by *Yucca Schidigera* extract supplementation are shown in Table (3). The intake of concentrate feed mixture (CFM), berseem hay (BH), rice straw (RS), DM, TDN and DCP ($P<0.05$) increased with *Yucca* extract supplemented groups than the control (G_1). However, the intake

of concentrate feed mixture, berseem hay, rice straw, DM, TDN and DCP ($P < 0.05$) decreased with increasing the level of *Yucca Schidigera* extract supplementation above 120 g / ton. Concerning the sex effect, the intake of concentrate feed mixture, berseem hay, rice straw, DM, TDN and DCP were ($P < 0.05$) higher for males than females. Aregheore (2005) found that dry matter intake by goats improved as the level of *Yucca Schidigera* powder in the diets increased.

Table 2. Nutrient digestibilities and nutritive values by male and female Friesian calves fed *Yucca* supplemented rations

Item	Yucca supplement (g/ ton)				Sex		SE
	0	120	160	200	Male	Female	
Nutrient digestibilities %							
DM	63.41 ^d	68.34 ^a	66.99 ^b	65.73 ^c	66.90 ^a	65.34 ^b	0.45
OM	64.68 ^d	69.70 ^a	68.33 ^b	67.04 ^c	68.24 ^a	66.64 ^b	0.42
CP	64.75 ^d	70.39 ^a	67.81 ^b	65.87 ^c	68.28 ^a	66.13 ^b	0.48
CF	61.43 ^d	68.94 ^a	66.06 ^b	63.52 ^c	66.05 ^a	63.93 ^b	0.63
EE	69.38 ^c	72.21 ^a	71.09 ^b	70.50 ^b	71.60 ^a	69.99 ^b	0.26
NFE	66.96 ^d	70.90 ^a	70.08 ^b	68.65 ^c	69.97 ^a	68.33 ^b	0.35
Nutritive values %							
TDN	61.82 ^d	66.27 ^a	64.91 ^b	63.36 ^c	64.93 ^a	63.25 ^b	0.39
DCP	8.82 ^d	9.59 ^a	9.24 ^b	8.98 ^c	9.30 ^a	9.01 ^b	0.09

^{a, b, c, d} Means in the same row within each factor, with different superscripts differ ($P < 0.05$).

Table 3. Average feed intake as fed by Friesian calves fed *Yucca* supplemented rations

Item	Yucca supplement (g/ ton)				Sex		SE
	0	120	160	200	Male	Female	
(kg / head / day)							
Concentrate feed mixture	3.32 ^c	3.66 ^a	3.58 ^{ab}	3.48 ^b	3.59 ^a	3.41 ^b	0.04
Berseem hay	1.10 ^c	1.22 ^a	1.19 ^{ab}	1.16 ^b	1.20 ^a	1.14 ^b	0.02
Rice straw	1.10 ^c	1.22 ^a	1.19 ^{ab}	1.16 ^b	1.21 ^a	1.14 ^b	0.02
Total DM	5.52 ^c	6.10 ^a	5.96 ^{ab}	5.80 ^b	6.00 ^a	5.69 ^b	0.10
TDN	3.41 ^d	4.04 ^a	3.87 ^b	3.67 ^c	3.90 ^a	3.60 ^b	0.07
DCP	0.49 ^c	0.58 ^a	0.55 ^{ab}	0.52 ^b	0.56 ^a	0.51 ^b	0.02

^{a, b, c, d} Means in the same row within each factor, with different superscripts differ ($P < 0.05$).

Rumen parameters:

Results in Table (4) showed that the three hour post feeding ruminal pH and ammonia-N concentrations ($P < 0.05$) decreased, while total VFA's concentrations ($P < 0.05$) increased with *Yucca* extract supplementation up to 120 g/ton concentrates. The pH value increased significantly ($P < 0.05$), while TVFA's and $\text{NH}_3\text{-N}$ concentrations decreased significantly ($P < 0.05$) with increasing the level of *Yucca Schidigera* extract supplementation above 120 g/ton. Rumen fermentation parameters were almost similar for males and females. These results agreed with those found by Grobner *et al.* (1982) that *Yucca Schidigera* plant extract, has been shown to alter microbial protein synthesis. *Yucca* extract decreased ruminal ammonia concentrations (Hussain and Cheeke, 1995). Gaafar *et al.* (2005) reported no

differences in rumen activity between suckling male and female Friesian calves as affected by probiotic supplements.

Table 4. Ruminal pH, total VFA's and ammonia-N of Friesian calves fed Yucca supplemented rations

Item	Yucca supplement (g/ ton)				Sex		SE
	0	120	160	200	Male	Female	
pH	6.80 ^a	6.43 ^c	6.53 ^{bc}	6.72 ^{ab}	6.62	6.61	0.10
TVFA's (meq/ 100 ml)	14.20 ^c	16.70 ^a	15.73 ^{ab}	14.98 ^{bc}	15.51	15.29	0.54
NH ₃ -N (mg/ 100 ml)	18.51 ^a	17.63 ^{ab}	16.73 ^{bc}	16.13 ^c	17.27	17.23	0.49

^{a, b, c} Means in the same row within each factor, with different superscripts differ (P<0.05).

Blood plasma constituents:

The effect of *Yucca* extract supplementation on the blood plasma constituents of Friesian calves is presented in Table (5). The concentrations of glucose, total protein, albumin, globulin, AST and ALT in plasma (P<0.05) increased but urea-N and creatinine concentrations (P<0.05) decreased with *Yucca* extract supplementation up to 120 g/ton then (P<0.05) decreased with higher supplementation levels. However, cholesterol concentration was not significantly (P>0.05) affected. Concentrations of blood plasma constituents were almost similar for males and females. The increase of plasma total protein, albumin and globulin concentrations and the decrease of urea-N and creatinine with yucca supplementation might be due to increasing ammonia utilization in the rumen, also increasing glucose concentration could be attributed increasing VFA's concentrations in rumen liquor for yucca supplemented groups, which convert to glucose (Table 4). The activity of AST and ALT were under the normal level being 70 and 40 U/ L, respectively as indicated by Kaneko (1989). Killeen *et al.* (1997) found that *Yucca* extract supplementation decreased serum urea concentrations.

Table 5. Blood plasma constituents of Friesian calves fed Yucca supplemented rations

Item	Yucca supplement (g/ ton)				Sex		SE
	0	120	160	200	Male	Female	
Glucose (mg/ dl)	70.02 ^c	82.24 ^a	77.77 ^b	70.87 ^c	75.70	74.75	1.35
Total protein (g/dl)	7.25 ^c	8.31 ^a	7.73 ^b	7.50 ^c	7.75	7.64	0.13
Albumin (g/ dl)	3.68 ^c	4.42 ^a	3.95 ^b	3.78 ^c	3.99	3.93	0.08
Globulin (g/ dl)	3.57 ^c	3.89 ^a	3.78 ^b	3.72 ^b	3.76	3.71	0.04
Urea-N (mg/ dl)	34.38 ^a	32.67 ^b	32.07 ^{bc}	31.29 ^c	32.86	32.34	0.41
Creatinine (mg/ dl)	1.61 ^a	1.51 ^b	1.49 ^{bc}	1.46 ^c	1.50	1.53	0.02
Cholesterol (mg/ dl)	65.04	65.68	65.23	65.32	65.09	65.54	0.53
AST (U/L)	35.99 ^d	43.26 ^a	40.64 ^b	38.69 ^c	39.74	39.55	0.85
ALT (U/L)	24.62 ^d	29.96 ^a	28.35 ^b	26.06 ^c	27.43	27.06	0.62

^{a, b, c, d} Means in the same row within each factor, with different superscripts differ (P<0.05).

Body weight gain:

Initial and final body weights are shown in Table (6). Final body weight, total and daily weight gain (P<0.05) increased with *Yucca* extract supplementation up to 120 g/ton, but (P<0.05) decreased with the higher levels of supplementation. Animals fed

Yucca extract at the level of 120 g/ton concentrate, showed highest final body weight and body weight gain by 29% compared with the control. These results might be due to the highest nutrient digestibilities (Table 2), feed intake (Table 3) and improved rumen activity (Table 4) for this group. Final body weight, total and daily body weight gain were ($P<0.05$) higher for males than females Gaafar *et al.* (2004). While weight gain improvement (weight gain expressed to initial weight) tended to be higher in females than males. Comparable effects of sarsaponin were found for steers (Goodall and Matsushima, 1979; Goodall *et al.*, 1979), and for finishing steers fed high-grain diets supplemented with *Yucca Saponins* (Goodall *et al.*, 1981, 1982). Aregheore (2005) found an ($P<0.05$) improvement in body weight change of goats fed *Yucca* powder supplemented diets.

Table 6. Body weight gain of Friesian calves fed calves fed *Yucca* supplemented rations for 195 days

Item	Yucca supplement (g/ ton)				Sex		SE
	0	120	160	200	Male	Female	
Initial body weight	118.14	118.36	118.50	118.50	119.43	117.32	0.74
Final body weight	250.00 ^d	288.14 ^a	278.86 ^b	267.86 ^c	280.32 ^a	262.11 ^b	2.76
Total weight gain	131.86 ^d	169.79 ^a	160.36 ^b	149.36 ^c	160.89 ^a	144.79 ^b	2.23
Daily weight gain	0.68 ^d	0.87 ^a	0.82 ^b	0.77 ^c	0.83 ^a	0.74 ^b	0.04

^{a, b, c, d} Means in the same row within each factor, with different superscripts differ ($P<0.05$).

Feed conversion:

Yucca extract supplementation improved feed conversion by Friesian calves as shown in Table (7). The amounts of DM, TDN and DCP per kg weight gain ($P<0.05$) decreased with *Yucca Schidigera* extract supplementation but ($P<0.05$) increased with increasing the level of *Yucca Schidigera* extract supplementation above 120 g/ton. Moreover, feed conversion was ($P<0.05$) higher for males than females, which the amounts of DM and TDN per kg weight gain were ($P<0.05$) lower for males than females, but DCP was nearly the same. Mader and Brumm (1987) found that feeding *Yucca* extract improved efficiency of feed conversion in finishing pigs and Gaafar *et al.* (2004 and 2005) reported that feed conversion by male was better than female calves.

Table 7. Feed conversion (kg/ kg gain) of Friesian calves fed experimental rations

Item	Yucca supplement (g/ ton)				Sex		SE
	0	120	160	200	Male	Female	
Total DM	8.20 ^a	7.02 ^c	7.25 ^c	7.59 ^b	7.31 ^b	7.72 ^a	0.13
TDN	5.06 ^a	4.65 ^b	4.71 ^b	4.81 ^b	4.74 ^b	4.88 ^a	0.09
DCP	0.72 ^a	0.67 ^b	0.67 ^b	0.68 ^b	0.68	0.69	0.01

^{a, b, c} Means in the same row within each factor, with different superscripts differ ($P<0.05$).

CONCLUSION

Supplementation with *Yucca Schidigera* extract at the level of 120 g per ton concentrate could improve body weight gain and feeding efficiency by Friesian calves.

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تأثير إضافة مستخلص اليوكا على الأداء الإنتاجي للعجول الفريزيان النامية

عبد الحليم محمد عبد السلام محي الدين، حامد محمد عبدالمجيد جعفر، سويقي عبدالرحيم سويقي

معهد بحوث الإنتاج الحيواني، مركز البحوث الزراعية، الدقى، مصر

استخدم في هذه الدراسة ٥٦ عجل وعجلة فريزيان عمر ٤ شهور ومتوسط وزنها ١١٩.٤٣ و ١١٧.٣٢ كجم على التوالي، قسمت عشوائيا الى ٤ مجموعات متماثلة (٧ ذكور و ٧ اناث في كل منها) غذيت فرديا على العليقة الأساسية المكونة على أساس المادة الجافة من ٦٠% مخلوط علف مركز + ٢٠% دريس برسيم + ٢٠% قش أرز بدون اضافة (ج)، المقارنة) أو مع اضافة ١٢٠، ١٦٠، ٢٠٠ جم مستخلص نبات اليوكا شيدرجا (الأمونيز-٣٠٠) / طن مخلوط علف مركز لكل من ج٢، ج٣، ج٤، على التوالي.

توضح النتائج المتحصل عليها زيادة معاملات هضم المركبات الغذائية والقيم الغذائية والغذاء المأكول وتركيز الأحماض الدهنية الطيارة الكلية في سائل الكرش وتركيز كل من الجلوكوز والبروتينات الكلية والألبومين والجلوبولين وأنزيمات وطاقف الكبد في بلازما الدم والوزن النهائي والزيادة الكلية واليومية في الوزن ومعدل التحويل معنويا على مستوى ٠.٠٥ مع اضافة مستخلص نبات اليوكا عن مجموعة المقارنة. بينما انخفضت درجة الحموضة وتركيز الأمونيا في سائل الكرش وتركيز أزوت اليوريا والكرياتينين في بلازما الدم وتكلفة التغذية لكل كجم زيادة في الوزن معنويا على مستوى ٠.٠٥ مع اضافة مستخلص نبات اليوكا عن مجموعة المقارنة.

زادت قيمة درجة حموضة سائل الكرش وتكلفة التغذية لكل كجم زيادة في الوزن معنويا بينما انخفضت معاملات الهضم والقيم الغذائية والغذاء المأكول وتركيز الأحماض الدهنية الطيارة الكلية والأمونيا في سائل الكرش وتركيز مكونات بلازما الدم والوزن النهائي والزيادة الكلية واليومية في الوزن ومعدل التحويل الغذائي معنويا على مستوى ٠.٠٥ مع زيادة مستوى اضافة مستخلص نبات اليوكا عن ١٢٠ جم / طن. ارتفاع معاملات الهضم والقيم الغذائية والغذاء المأكول والوزن النهائي والزيادة الكلية واليومية في الوزن ومعدل التحويل الغذائي معنويا على مستوى ٠.٠٥ في الذكور عن الاناث. بينما كانت قياسات نشاط الكرش ومكونات بلازما الدم متماثلة تقريبا للذكور والاناث.

نستخلص من هذه الدراسة أن اضافة مستخلص نبات اليوكا شيدرجا بمعدل ١٢٠ جم لكل طن من مخلوط العلف المركز قد يحسن معدل النمو والكفاءة الغذائية لعجول و عجلات الفريزيان.