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THE EFFECT OF *YUCCA SCHIDIGERA* EXTRACT IN DIET OF RABBITS ON NUTRIENT DIGESTIBILITY AND QUALITATIVE PARAMETERS IN CAECUM

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ABSTRACT

The aim of this study was to determine the effects of yucca (*Yucca schidigera*) powder extract added to the rabbit feed mixtures. The animals of experimental group (EG1) were fed diet enriched with supplement of *Yucca schidigera* dry extract 5g/100 kg feed; rabbits of EG2 had diet enriched with yucca dry extract 20g/100 kg feed for 42 days. The control group (CG) was fed untreated pellet diet. The experiment was carried out on commercial hybrid Hycole rabbits. Between 65 and 70 days of age, 3 male rabbits from each group were selected for digestibility tests using the balance method. The faeces were collected individually during 5 consecutive days according to the European reference method for rabbit digestion trials. Chemical analysis of the diets and faeces for dry matter, crude protein, crude fibre, crude fat, nitrogen free extract, organic matter and starch was carried out according to the same method. The caecal samples from each of three slaughtered rabbits were collected for analysis; pH, VFA, ammonia-N and lactic acid were determined. The rabbits in our experiment showed the lowest coefficients of digestibility of crude fibre, and higher digestibility of crude protein, crude fat and organic matter, but the differences were not statistically significant comparing with control diet. The effect of yucca extract addition is manifested in reducing ammonia levels in the caecum of rabbits.

Key words: rabbit; *Yucca schidigera*; nutrient; digestibility; caecum

INTRODUCTION

Yucca schidigera extract is prepared by drying and pulverizing of *Yucca schidigera* plant. Yucca plant is a source of steroidal saponins, and is used commercially as a saponin source. Yucca is also a source of polyphenolics, including resveratrol and a number of other stilbenes (yuccaoils A, B, C, D and E). *Yucca schidigera* has a very high level of saponins and phenolic compounds with antioxidant action. The products of *Yucca schidigera* are used as food additives, cosmetics and in the pharmaceutical industry. The bark from this yucca species has phenolic compounds called trans-3,4‘,5-trihydroxystilbene (trans-resveratrol), trans-3,3‘,5,5‘-tetrahydroxy-4‘-methoxystilbene, and yuccaoils A and C that have antiplatelet activity. Some of the physical and chemical properties of these compounds (e.g. active surface and ammonia binding capacity) have sparked research into their use in livestock production applications. In subsequent studies, an extract of yucca decreased ruminal ammonia concentration (Hussain, Ismail and Cheeke, 1996), increased propionate concentration (Killeen *et al*., 1998) and in vivo organic matter digestibility (Valdez *et al.*, 1986), and improved (Killeen *et al*., 1998b) or did not affect animal performance. If digestibility of dietary fibre is not adversely affected, reducing protozoal populations in cattle could improve nitrogen utilization in the rumen and increase microbial protein flow to the intestine (Williams and Coleman, 1991), thereby enhancing overall

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growth performance. Apparent nutrient digestibility coefficients - such as dry matter (DM), crude protein (CP) and crude fibre (CF) - showed that CP and CF digestibility improved numerically but not at a significant level (p>0.05) with incremental levels of Yucca schidigera dry extract powder in the concentrate mixtures. Application of *Yucca schidigera* products is positive in agriculture, poultry farming, swine farming, cattle farming and aquaculture as well. The use of *Yucca schidigera* dry extract in shrimp farms have reported excellent results in the reduction of the ammonia and nitrite levels, improving the water quality and consequently the farm productivity. The data presented clearly show that the use of saponin extract of the *Yucca schidigera* plant in pig, poultry, equine, pets, shrimps and other livestock feed lowers ammonia levels (Windisch *et al*., 2008). These levels are hazardous to animal health, and reduction of them dramatically improves animal performance. The evidence demonstrates that saponins enhance feed efficiency and weight gain in pigs, as well as feed efficiency, weight gain, and increased egg production in chickens, increase production of milk in dairy cows. Livestock clearly benefits when the extract from this plant is included in the feed. Because it is 100 % natural, the *Yucca schidigera* dry extract is environmentally safe and is the best answer to naturally lowering toxic ammonia levels in housing and improving the quality and potential output of animals (Inflamm, 2006).

The present study was conducted to evaluate the effect of dietary Yucca extract (KONFIRM, Czech Republic) on digestibility of nutrients and caecal parameters of growing rabbits.

MATERIAL AND METHODS

Animals

In our experiment, five rabbits per treatment (a total 15 males) at the age of 70 days with 2200 g ± 100 g of live body weight, belonging to commercial hybrid breed Hycole were used.

Housing and nutrition

The rabbits were housed individually in metabolic wire cages that allowed the faeces separation. A cycle of 16 h of light and 8 h of dark was used throughout the experiment. Temperature and humidity in the building were recorded continuously by a digital thermograph positioned at the same level as the cages. Heating and forced ventilation systems allowed the building air temperature to be maintained within 18 ± 4 C throughout the experiment. Relative humidity was about 70 ± 5 %. The rabbits were fed a commercial diet (pellets of 3.5 mm in diameter). The ingredients and chemical composition

Table 1: Ingredients and chemical composition of diet

Ingredients	in %	Chemical analysis (g. kg^{-1})	Experimental group		
			Control (C)	EG1 + Yucca 5g /100 kg	EG2+ Yucca 20g /100 kg
Lucerne meal	29	Dry matter	895.8	896.6	889.8
Dried beet pulp	14	Crude protein	155.3	153.7	155.6
Sunflower extr. meal	14	Crude fibre	165.4	164.1	164.1
Wheat middlings	16	Fat	36.5	37.3	37.5
		N free extract	458.3	464.5	455.5
Oats	13	Organic matter	815.5	819.6	812.7
Soybean	3.5	Ash	80.3	77	77.1
Molasses	2.1	Starch	153.7	153.2	153.2
Mineral &Vitamins*	2	ADF	208.1	206.2	206.2
MCP**	0.6	NDF	329.3	333.5	333.5
Malt sprout	5	Calcium	6.8	6.7	6.8
Rape oil	0.5	Phosphorus	5.8	5.9	5.7
NaCl	0.3	ME (MJ. kg^{-1})	10.73	10.76	10.78

*Provided per kg diet: Vit. A 12000 IU; Vit. D2 2500 IU; Vit. E 20 mg; Vit.B_1 1.5 mg; Vit. B_2 7.5 mg; Vit. B_6 4.5 mg; Vit.B_{12} 30 µg; Vit.K 3 mg; nicotic acid 45 mg; folic acid 0.8 mg; biotin 0.08 mg ; choline chloride 450 mg; premix minerals (per kg diet) Ca 6.85 g; P 6.2 g; Na 1.6 g; Mg 1.0 g; K 10.8 g; Fe 327.5 mg; Mn 80 mg; Zn 0.7 mg

**MCP– mono-calcium phosphate; ADF – acid detergent fibre; NDF – neutral detergent fibre; ME – metabolizable energy of this diet as presented in Table 1. The ME content was calculated using the equation of Wiseman *et al.* (1992). All animals were given access to the feed *ad libitum*. The adaptation period for this diet was 14 days. Drinking water was provided with nipple drinkers *ad libitum.*

Digestibility study

The faeces were collected individually during 4 consecutive days according to the European reference method for rabbit digestion trials (Perez *et al*., 1995). Sampling of faeces was done every 2 hours. Faeces were frozen daily and subsequently dried and ground for the analysis. Chemical analyses were conducted according to AOAC (1995) with the considerations mentioned by EGRAN (2001) for dry mater (DM), crude protein (CP), crude fibre (CF), crude fat, nitrogen free extract, ash and organic matter. Neutral detergent fibre (NDF) and acid detergent fibre (ADF) were analyzed sequentially (Van Soest *et al*., 1991) with a thermo stable amylase pre-treatment. Starch was determined by polarimetric method following the regulations of the Ministry of Agriculture of the Slovak Republic Nr. 1497/4/1997-100 (MP SR, 1998).

Parameters of caecum

The caecal samples from each of three slaughtered rabbits were collected for biochemical analysis; pH, VFA, ammonia-N and lactic acid were determined; pH was measured immediately after sampling using a digital pH meter; VFA concentration was determined using gas chromatography on a 1.8 m column with 10 % SP1200 and 1 % H_3PO_4 on Chromosorbe WAW 80/100 mesh with isokaprylic acid as an internal standard (GC Carlo Erba 8000 Top). Ammonia-N concentration was measured by the micro diffusion according to Conway (Voigt and Steger, 1967). Lactic acid levels were determined by gas chromatography.

Statistical analysis

The statistical analysis was performed for all monitored traits. A linear model and a one-way analysis of variance were used to analyze the data. Least square mean estimates with standard errors of the estimates were produced. Differences among least square means were estimated and tested using the Tukey-test. The statistical package SAS 9.1 (SAS, 2003) was used. P - values at P < 0.01 or 0.05 were considered as statistically significant.

RESULTS AND DISCUSSION

The digestibility of nutrients in rabbits is presented in Table 2. The rabbits in our experiment showed that in EG2 with 20g Yucca extract in 100 kg of diet lowered the coefficients of digestibility for crude fibre, nitrogen-free extract and organic matter compared to other evaluated breeds of rabbits, but the differences were not statistically significant. The digestibility of crude fibre and fat were higher in a population of rabbits that consumed diet with 5g yucca extract additive. There were no significant differences (P≥0.05) for starch digestibility between the control and both treated groups.

The chemical composition of feed gives an indication of the potential nutrient supply, but determination of digestibility provides an estimate of the nutrients available to the animal. Digestibility of nutrients in different rabbit genotypes was studied by several authors. Kustos and Hullár (1992) followed the heritability of digestibility in New Zealand White (NZW) rabbits. In their experiment the authors determined low (h2 = 0.19) heritability values for the coefficients of digestibility. Lebas (1973) in the NZW breed determined 4 % better coefficients of digestibility for dry matter and organic matter than in the Californian

Table 2: Coefficient of nutrient digestibility in %

Nutrients (n = 5)	Control (C)	EG1 + yucca 5g /100 kg	EG2+ yucca 20g /100 kg
	$\bar{x}$ ± SD	$\bar{x}$ ± SD	$\bar{x}$ ± SD
Crude protein	71.67±1.92	74.95±0.65[a]	72.94±1.57
Fat	82.34±3.16	88.94±1.60[ac]	84.95±0.43
Crude fibre	17.98±5.74	19.67±5.44	14.89±0.17
Nitrogen-Free Extract	67.60±3.06	65.59±2.64	63.69±0.46
Organic matter	57.46±2.44	57.19±2.61	54.58±0.34
Starch	95.47±1.11	95.01±0.68	94.89±1.40

Differences between values in line marked by different letters (a,b,c,) are significant on level P<0.05

Table 3: Qualitative parameters in caecum

Parameters (n = 5)	Control (C)	EG1 + yucca 5g /100 kg	EG2+ yucca 20g /100 kg
	$\overline{x}$ ± SD	$\overline{x}$ ± SD	$\overline{x}$ ± SD
pH	5.98±0.04	5.85±0.04	5.76±0.06
N-NH3 (mmol.l^{-1})	22.0±3.7	21.2±3.6	21.1±0.1
Acetate (mmol.100g^{-1})	8.203±1.288	8.087±0.215	8.499±0.611
Propionate (mmol.100g-^{1})	0.630 ±0.057	0.557±0.057	0.540±0.085
Butyrate (mmol.100g^{-1})	2.269±0.290^{bc}	2.685±0.111	2.752±0.293
Other VFA (mmol.100g^{-1})	0.367 ±0.045^{bc}	0.298±0.025	0.269±0.053
Lactic acid (g.100g^{-1})	0.021±0.003	0.020±0.003	0.022±0.014

Differences between values in line marked by different letters (a,b,c,) are significant on level P<0.05

rabbits, these coefficients of digestibility correspond to our results (P<0.05). The contribution of crude fibre is optimized up to the level of 14 -16 % in rabbit mixture. Crude fibre is digested by a microbial fermentation and the main place of this fermentation is caecum (Volek *et al.*, 2005). Rafay (1993) and Maertens and Lebas (1989) specified these values of digestibility of basic nutrients: crude protein - 75 %, crude fat – 65 % and crude fibre - 20-35 %. Coefficients of digestibility of crude protein and crude fibre in our experiment were slightly different than those published by Tůmová and Skřivanová *et al.* (2004), and Ondruška *et al.* (2011). These authors carried out a balance experiment on meat rabbits and their values of digestibility of present nutrients were 77.2 % vs. 72.6 % and 10.7 % vs. 15.7 %, respectively. Our values of digestibility of nutrients for crude protein were in the range of 71.67- 74.95 %, which was similar to the data of Battaglini and Grandi (1988). The values of crude fibre digestibility (14.89-19.67 %) and crude fat (82.34-88.94 %) were higher when compared to Bielański and Niedźwiadek (1993). Pascual *et al.* (2008) recorded significant differences (P < 0.05) of coefficients of digestibility for dry matter, organic matter and gross energy between two different groups of rabbit does selected for litter size and longevity. Al-Dobain (2010) followed the effect of the diet on digestibility of four rabbit breeds. The author observed that all digestibility coefficients were significantly (P < 0.01) affected by the interaction of dietary treatments and genetic groups. The rabbits were slaughtered before morning feeding for observation of fermentation process in the caecum. There were no significant pH differences between control and experimental groups. Concentration of observed VFA shows that most intensive process was in the caecum of rabbits in experimental groups (Table 3). All animals were found in good health conditions during the trial. These results are in agreement with those observed by many authors (Yeo and Kim, 1997; Colina *et al*., 2001; Duffy *et al*., 2001; Amber *et al.*, 2004). Hussain *et al.* (1996) observed that Yucca extract (YE) has ammonia-binding properties. It was hypothesized that by binding ammonia in the caecum, YE could influence caecal utilization of crude protein (CP) and dietary urea. Two experiments were undertaken using New Zealand White weanling rabbits (5–6 weeks of age). In both experiments, YE were mixed at 250 mg kg^{-1} of diet, and six individually fed rabbits were used per treatment. In Experiment 1, the four diets were: (1) high- protein (HP); (2) HP + YE (HPYE); (3) medium protein (MP); (4) MP + YE (MPYE). The two protein levels were 23 % and 19 %, respectively. Average daily gain (ADG) was higher (P < 0.01) in HPYE vs. HP whereas it was similar in MP vs. MPYE. There was no significant interaction between CP and YE. Feed intake was similar among treatments. Feed/gain in HPYE was better than in HP (P < 0.05). Caecal urea-N (CUN), caecal ammonia-N (CAN) and caecal pH did not differ significantly among the four treatments. Plasma urea-N (PUN) concentrations differed among treatments (P < 0.01). The PUN differed (P < 0.05) between HP and MP treatments. The interaction of CP and YE was significant (P < 0.01). The PAN was higher (P < 0.05) for HP than for the other treatments. Caecal propionate was lower (P < 0.05) for MP than for HP treatments. In Experiment 2, diets were: (1) low protein (LP); (2) LP + YE (LPYE); (3) LP + urea; (4) LPU + YE (LPUYE). The two CP treatments were 16.5 % CP and 16.5 % CP + 2 % urea. The ADG was the highest (P < 0.05) for the LPYE, and was lower (P < 0.05) for the LPU than for the LP treatments. CUN was similar among treatments, whereas CAN was the lowest (P < 0.05) in LPUYE. The PUN was higher (P < 0.05) in the LPU than in the LP treatments, and was higher for LPU than for LPUYE. There were no differences in PAN. Caecal acetate and propionate concentrations were higher in LPYE than in the other groups, indicating a favourable effect of YE on caecal fermentation. It may be concluded that YE modifies the utilization of dietary CP and urea in rabbits, by influencing caecal fermentation. This effect is probably mediated by ammonia binding (Hussain *et al*., 1996).

CONCLUSION

Obtained results demonstrate significant differences ($P < 0.05$) of coefficients of digestibility for dry matter and minimal, statistically non-significant differences (level $P > 0.05$) in digestibility of crude fibre, nitrogen free extract, starch and organic matter in the tested mixtures. The highest apparent protein and fat digestibility coefficient was observed for diets treated with 5g yucca extract per 100 kg rabbit feed mixture, which was significantly higher than that observed for the control diet. They positively influenced animal health as well as increased live weight.

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