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INCORPORATION OF COWPEA STOVER UNTREATED AND TREATED WITH *PLEUROTUS CITRINOPILEATUS* ON PERFORMANCE OF RABBIT GROWING

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Resumo: O objetivo do estudo foi avaliar o efeito da incorporação de palha de feijão-caupi (*Vigna unguiculata*) não tratada (US) ou tratada (TS) com *Pleurotus citrinopileatus* no desempenho, digestibilidade, custo da dieta nos parâmetros sanguíneos de coelhos em crescimento. O ensaio foi realizado com animais (80 coelhos de ambos os sexos) de 35 dias de idade que foram criados até ao abate (63 dias). Os animais foram distribuídos em cinco dietas experimentais com incorporação de 0g kg^{-1} (controle), 50g kg^{-1} e 100g kg^{-1} de US (US-5 e US-10, respetivamente) e 50g kg^{-1} e 100g kg^{-1} de TS (TS-5 e TS-10, respetivamente). Os resultados indicaram que a incorporação de palha de feijão-caupi não afetou o desempenho animal e a digestibilidade, e ainda permitiu uma redução máxima de 8,2% nos custos da ração. O tratamento da palha com *P. citrinopileatus* demonstrou potencial para inibir possíveis efeitos negativos da incorporação de USsobre o peso vivo final dos coelhos em crescimento. Adicionalmente, os animais submetidos à dieta com palha tratada apresentaram redução de 17,4% nos níveis de colesterol sanguíneo.

Keywords: biologic pre-treatment, legume co-product, white-rot fungi, *Vigna unguiculata*

Introduction

The disparity in the prices of raw materials used in the compound feed industry is a serious disadvantage in rabbit production systems since feed represents about 70% of the total costs. Thus, the search for alternative raw materials that allows a reduction of these costs and, at the same time, ensures the maintenance of growth performance of the animals is required. Due to their nutritional characteristics and abundance, co-products from the legume production, particularly stover and pods, are materials that can be incorporated into compound feeds for herbivores. Previously developed studies with cowpea (*Vigna unguiculata*) stover indicated that this feed presents high levels of crude protein (14%) and organic matter digestibility values averaging 40% (Andrade et al., 2017). This low digestibility is due to certain anti-nutritional factors, especially high lignin concentrations. The application of white-rot fungi through solid-state fermentation pre-treatments, promoting changes in lignin structure and facilitates access to structural polysaccharides that are potentially digestible (Ribeiro et al., 2012; Andrade et al., 2017), may be a viable treatment to increase the nutritional value of the stover. In this context, the objective of this study was to evaluate the incorporation of untreated and treated cowpea stover with *Pleurotus citrinopileatus* in compound feed and its effects on growth performance, digestibility and on blood parameters of rabbits.

Material and methods

Cowpea stover was obtained after harvesting of cowpea grains in the North of Portugal, and it was divided in two equal parts, one (untreated stover, US) was stored until the feed production, and the other part was treated (treated stover, TS) with *P. citrinopileatus* (UF21401 – UTAD). The cowpea stover (TS) was autoclaved (121ºC for 30 min), cooled and inoculated (32 g of spawn) in solid state fermentation with the fungus per 22 days, as previously described by Andrade et al. (2017). Five experimental diets were prepared containing 0g kg^{-1} (control) and 50g kg^{-1} or 100g

kg^{-1} of cowpea stover untreated or treated with *P. citrinopileatus*, (US5, US10, TS5 and TS10, respectively). The diets were formulated according to the recommendations of De Blas and Mateos (2010) for growing rabbits (Table 1). The incorporation of both untreated and treated cowpea stover in the diets was followed by an increase of wheat bran and a decrease in lucerne and beet pulp proportions. The level of crude protein and crude energy were similar in all diets.

The trial was carried out in the animal facility of UTAD, Vila Real, Portugal. A total of 80 New Zealand × Californian rabbits (16 per treatment) of both sexes with 35 days of age and similar live weight (1038 ± 147,7g) were reared until slaughter (63 days of age). Rabbits were handled according to the Portuguese legislation (Ports. no. 1005/92, 214/08, 635/09) on animal welfare. Live weight and feed consumed were registered during growing period daily and the weight gain, the daily feed intake and the feed conversion rate (ratio between the daily weight gain and the daily feed intake) were calculated. The apparent digestibility of nutrients of each experimental diet was also measured on 10 animals of both sexes per diet according to the European Standardized Method (55th to 58th day). In the same 10 animals, at 62 days of age, blood samples were collected (Daytona, Randox Laboratories Ltd. Crumlin, United Kingdon). All samples (feed and faeces) were dried at 60°C and grounded over a 1 mm screen. NDFom and lignin were analyzed according to Robertson & Van Soest, 1981. Dry matter, ash and crude protein were analyzed according to AOAC (1990). Data were analyzed with the GLM procedure of SAS, (2009) using one-way ANOVA, considering experimental diet the main effect. Additionally, orthogonal contrasts (US5+US10 vs. TS5+TS10) were carried out to compare the effects of the incorporation of untreated vs. treated cowpea stover.

Results and discussion

The incorporation of cowpea stover resulted in a cost reduction (€ ton of feed), that varied between 4.2 to 8.2%. The incorporation of cowpea stover did not

influence animal performance, digestibility and blood parameters when compared to the control diet (Table 1). Contrast analyses showed an increase (*P*=0.0391) of 4.7% in the final weight for TS fed animals compared to US (2323g vs. 2214g). These results suggest that the treatment of cowpea stover with *P. citrinopileatus* diminished the negative effects of the incorporation of untreated cowpea stover on rabbit performance. Similar results were observed by Ribeiro et al. (2012) when comparing the performance of growing rabbits fed on untreated or treated olives leaves with *Ganoderma resinaceum*.

Table 1 - Effect of the incorporation of untreated (US) and treated (TS) cowpea stover with *Pleurotus citrinopileatus* on performance, apparent digestibility and blood parameters

	Experimental diet[1]					SEM	*P*-value	
	Control	US-5	US-10	TS-5	TS-10		General	US vs. TS
Growth performance (n = 16/group)								
Initial body weightl (g)	1061	1022	995	1045	1058	37.5	0.7080	0.2496
Live weight at 63 days (g)	2365	2233	2196	2290	2356	52.5	0.1099	0.0391
Daily weight gain (g d^{-1})	46.6	43.3	42.9	44.4	46.3	1.45	0.2563	0.0983
Daily feed intake (g d^{-1})	155	148	153	151	163	4.9	0.2426	0.1881
Feed conversion rate	3.35	3.44	3.57	3.42	3.52	0.074	0.2238	0.0627
Apparent digestibility (n = 10 group)								
Dry matter (g kg^{-1})	567	566	566	569	556	11.2	0.9421	0.7918
Organic matter (g kg^{-1})	578	571	568	573	562	11.5	0.8973	0.8476
NDF[2] (g kg^{-1})	362	375	378	385	359	18.2	0.8281	0.7971
Crude protein (g kg^{-1})	709	690	689	685	661	11.0	0.0643	0.1044
Blood parameters (n = 10 group)								
Haematology								
Haemoglobin (g dL^{-1})	12.2	11.9	12.3	11.5	12.0	0.46	0.7124	0.4637
Haematocrit (%)	39.5	38.8	40.3	37.2	38.7	1.40	0.5174	0.2417
Lymphocytes (%)	57.1	46.7	55.4	65.4	58.2	6.36	0.3161	0.1037
Monocytes (%)	8.25	9.66	9.29	7.10	8.20	1.021	0.3583	0.0635
Eosinophils (%)	1.27	1.94	1.06	1.00	0.60	0.509	0.3896	0.0919
Serum biochemistry								
Triglycerides (mgdL^{-1})	94.5	98.0	101.9	100.2	97.8	9.89	0.9331	0.7385
Urea	27.6	30.9	29.1	30.3	25.7	2.54	0.4822	0.3960
Cholesterol (mg dL^{-1})	56.8	61.7	53.5	45.9	49.3	5.04	0.1522	0.0344
AST[3] (mg dL^{-1})	33.6	32.8	34.1	32.5	32.6	4.74	0.9977	0.8289
ALT[4] (mg dL^{-1})	42.9	39.2	58.3	41.5	42.2	6.46	0.0865	0.2413
Albumin (mg dL^{-1})	3.61	3.31	3.69	3.66	3.60	0.178	0.4359	0.4293
Total protein (mg dL^{-1})	5.61	5.88	5.74	5.53	6.05	0.259	0.5051	0.9353
Globulin (mg dL^{-1})	2.00	2.13	2.05	1.88	2.45	0.170	0.1200	0.6261

[1]Diets control, US5 and US10 containing 0g kg^{-1}, 50g kg^{-1} and 100g kg^{-1} of the untreated cowpea stover (US), respectively. Diets TS5 and TS10 containing 50g kg^{-1} and 100g kg^{-1} of the cowpea stover treated (TS) with *P. citrinopileatus*, respectively; [2]NDF, neutral detergent fibre; [3]AST, asparate aminotransferase; [4]ALT, alamine aminotransferase.[3] P≤ 0.05.

Animals fed diets containing treated cowpea stover presented 17.4% lower (P=0.0344) cholesterol levels when compared to those that received diet with untreated cowpea stover (47.6 vs. 57.6 mg dl^{-1}). Similar results were described in a review work by Patel et al. (2012). These authors identified a reduction in the arterial pressure and blood cholesterol level in diets containing 4-10% dried fruiting body of *Pleurotus* spp. when compared to normal diets of rabbits and rats.

Conclusion

The incorporation of cowpea stover did not affect the general parameters of animal performance and digestibility of the diets, allowing a reduction in the economic costs in the production of feed. The treatment with *Pleurotus. citrinopileatus* seems to enhance a better productive performance of rabbits.

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