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***Farias-Kovac C., Simbaña F., Reyes M., Ávila A.B., Carabaño R., Nicodemus N., García* J.**

EFFECT OF CELLOBIOSE SUPPLEMENTATION IN DRINKING WATER AND FEED RESTRICTION ON ENERGY AND NITROGEN RETENTION EFFICIENCY IN GROWING RABBITS

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EFFECT OF CELLOBIOSE SUPPLEMENTATION IN DRINKING WATER AND FEED RESTRICTION ON ENERGY AND NITROGEN RETENTION EFFICIENCY IN GROWING RABBITS

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ABSTRACT

The objective of this work was to evaluate the effect of cellobiose supplementation in water (CEL) and its potential synergy with feed restriction on nitrogen and energy retention efficiency. Four treatments in a factorial arrangement were used: 2 levels of CEL (0.0 and 7.5 g/L) × 2 feeding plans (*ad libitum* and restricted, from 32 to 47 d of age). A total of 102 32-d old rabbits weighing 683 ± 124 g were blocked by litter, randomly assigned to the four treatments and caged individually. The restricted group was fed with 50% of the feed eaten by the *ad libitum* group at weaning, and the daily feed supply increased linearly until 100% of intake of the libitum group at 47 d of age, and the experimental period finished at 60 d of age. Energy and body composition were determined at 32, 47 and 60 d of age using bioelectrical impedance technique. In the whole experimental period CEL did not affect digestible nitrogen and energy intake but tended to increase the nitrogen retained in the body (P = 0.072), resulting in an improvement of the body retention efficiency of digestible nitrogen (+5%. P= 0.010) and energy (P = 0.11). It was associated to a reduction of the urinary nitrogen losses (-6%. P = 0.037), and energy losses in urine and heat production (P = 0.11). Nevertheless, CEL had no influence on the nitrogen retention efficiency in the carcass, due to the trend to increase nitrogen losses in the skin and viscera (P = 0.065). In the whole fattening period, feed restriction had no effect on the body and carcass nitrogen and energy retention but improved the nitrogen and energy retention efficiency in the body and in the carcass (+7%. P ≤ 0.046). There was no interaction between CEL and feed restriction.

Keywords: Cellobiose, Feed restriction, Energy and nitrogen retention efficiency, Rabbit.

INTRODUCTION

Cellobiose supplementation in drinking water (CEL, 7-7.5 g/L) improved feed efficiency and mortality (this one only when combined with a low soluble fibre diet) and modified *in vivo* and *in vitro* fermentation (Ocasio-Vega et al., 2018a, 2019), with no influence on faecal digestibility of total dietary fibre (Farias-Kovac *et al.*, 2021a). Accordingly, it would be expected an improvement of the nitrogen and energy balance with CEL supplementation. It is well known the positive effects of feed restriction on the health status and feed efficiency, but also the nitrogen balance after weaning (Gidenne *et al.*, 2012 and 2017; Birolo *et al.*, 2016). The aim of this study is to evaluate the potential effects of CEL, as well as its possible synergy with the feed restriction on nitrogen an energy retention efficiency.

MATERIALS AND METHODS

Experimental design

Four treatments in a 2 x 2 factorial arrangement were used with two levels of (0, and 7.5 g/L. Savanna Ingredients GmbH, Elsdorf, Germany) along the whole fattening period, and two feeding plans (*ad libitum*, AL, and restricted, R). Restriction started with a 50% of the AL group and increased progressively until 100% at 47 d of age inspired in the feeding plan studied by Duperray and Guyonvarch (2009) and Birolo *et al*. (2016). From 47 to 51 d restricted rabbits were offered the same feed eaten by the AL group, and from 51 to 60 d they were fed completely *ad libitum*. A control diet was formulated to meet the nutrient requirements for growing rabbits with 21.1% crude protein and 19.0 MJ/kg gross energy (on DM basis) (Farias-Kovac *et al*., 2021a). A total of 102 weighing 683 ± 124 g were weaned at 32 d of age, blocked by litter, randomly assigned to the four treatments and individually caged. Due to the design of the farm, treatments were not balanced (NoCEL-AL=26 rabbits, NoCEL-R=25, CEL-AL=26, CEL-R=25). No antibiotic was supplied. Rabbits had *ad libitum* access to water. Faecal digestibility was determined (10/treatment) from 39 to 43 d of age (D1), and from 53 to 56 d of age (D2), and growth traits recorded until 60 d of age (see Farias-Kovac *et al*., 2021a). *In vivo* body and carcass chemical composition and energy content were estimated using the bioelectrical impedance analysis (BIA) technique (Saiz *et al*., 2013a,b and 2017). Measurements of resistance and reactance were done at 32, 47 and 60 d of age. Multiple regression equations according to Saiz *et al*. (2013a,b and 2017) were used to estimate protein and energy proportions both in the body and in the carcass. Nitrogen and energy retention efficiency were determined according to Delgado *et al*. (2018).

Statistical Analysis

Data of nitrogen and energy balances were analyzed as a completely randomized design considering CEL level, feed restriction and their interaction as the main sources of variation. Weaning weight was included as covariate. All data were presented as least-squares means.

Chemical Analyses

Crude protein (method 968.06) was determined according AOAC (2000), and gross energy by adiabatic bomb calorimeter (model 356, Parr Instrument Company, Moline, IL).

RESULTS AND DISCUSSION

In the whole experimental period CEL did not affect digestible nitrogen and energy intake but tended to increase the nitrogen retained in the body (P = 0.072), explained by its increase in the second phase of fattening (P = 0.003. Data not shown). It resulted in an improvement of the body retention efficiency of digestible nitrogen (+5%. P= 0.010) and energy (P = 0.11) in the whole fattening period. It was mainly associated to a reduction of the urine nitrogen losses (1.29 *vs.* 1.21 g/kg $BW^{0.75}$ d. P = 0.037), and energy losses in urine and heat production (P = 0.11. Data not shown). Nevertheless, CEL had no influence on the nitrogen retention efficiency in the carcass, due to the trend to increase nitrogen losses in the skin and viscera (P = 0.065. Data not shown). Anyway, CEL supplementation seems to exert more beneficial effects on growth performance than xylooligosaccharides supplementation (Farias-Kovac *et al*., 2020b; Farias-Kovac, 2021). During the restriction period, feed restriction impaired nitrogen (-14%) and energy retention (-16%) ($P \leq 0.003$) and improved the digestible nitrogen retention efficiency in the body and in the carcass (+8%. $P \leq 0.022$), but not the digestible energy ones. In the whole experimental period, feed restriction had no effect on the body and carcass nitrogen and energy retention but improved the digestible nitrogen and energy retention efficiency in the body and in the carcass (+7%. $P \leq 0.046$). These results are quite similar to those obtained previously (Farias-Kovac *et al*., 2021b), although in this case the positive effect of feed restriction on mortality did maintain it under an acceptable threshold. There was no interaction between CEL and feed restriction.

Table 1: Effect of cellobiose supplementation (CEL) and feeding plan (*Ad libitum vs.* Restricted - Rest.-) on energy and nitrogen retention efficiency.

	CEL –		**CEL +**		**SEM[1]**		**P-value[2]**	
	Ad libitum	**Rest.**	***Ad libitum***	**Rest.**	***Ad libitum***	**Rest.**	**CEL**	**Feeding plan**
N	**26**	**25**	**26**	**25**				
32 - 47 d of age (restriction period)								
Growth rate, g/d	60.4	48.6	56.0	49.1	4.04	1.28	0.526	0.003
Feed intake, g/d	128	91.5	117	89.7	7.31	1.32	0.246	<0.001
Metabolic weight, $BW^{0.75}$	1.12	1.05	1.11	1.05	0.01	0.01	0.426	<0.001
Digestible N intake, g/kg $BW^{0.75}$d	2.72	2.12	2.64	2.13	0.10	0.02	0.609	<0.001
N retained, g/kg $BW^{0.75}$ d, NR								
NR body	1.44	1.20	1.40	1.21	0.04	0.03	0.616	<0.001
NR carcass	0.910	0.774	0.853	0.762	0.04	0.03	0.359	0.003
Nitrogen efficiency								
NR body/DN_i	0.535	0.568	0.532	0.568	0.02	0.01	0.949	0.022
NR carcass/DN_i	0.337	0.363	0.321	0.363	0.01	0.02	0.566	0.019
DE intake, MJ/ kg $BW^{0.75}$d, DE_i	1.241	0.972	1.214	0.978	0.04	0.01	0.748	<0.001
Energy retained, kJ/kg $BW^{0.75}$ d								
ER body	430	341	396	331	21.4	10.0	0.203	<0.001
ER carcass	242	190	220	184	15.7	10.7	0.313	0.002
Energy efficiency								
ER body/DE_i	0.349	0.351	0.324	0.342	0.014	0.012	0.190	0.417
ER carcass /DE_i	0.196	0.195	0.178	0.193	0.010	0.011	0.371	0.540
32 - 60 d of age								
Growth rate, g/d	54.0	53.7	57.5	55.1	1.82	1.48	0.142	0.413
Feed intake, g/d	143	130	140	129	4.90	2.06	0.613	0.002
Metabolic weight, $BW^{0.75}$	1.33	1.33	1.36	1.34	0.01	0.01	0.145	0.235
Digestible N intake, g/kg $BW^{0.75}$d	2.50	2.25	2.42	2.24	0.05	0.02	0.261	<0.001
N retained, g/kg $BW^{0.75}$ d, NR								
NR body	1.09	1.08	1.14	1.10	0.02	0.02	0.072	0.198
NR carcass	0.738	0.726	0.743	0.730	0.019	0.016	0.796	0.480
Nitrogen efficiency								
NR body/DN_i	0.438	0.479	0.472	0.492	0.009	0.008	0.010	<0.001
NR carcass/DN_i	0.296	0.323	0.307	0.327	0.007	0.006	0.275	0.002
DE intake, MJ/ kg $BW^{0.75}$d, DE_i	1.187	1.076	1.159	1.071	0.02	0.01	0.355	<0.001
Energy retained, kJ/kg $BW^{0.75}$d, ER								
ER body	385	379	401	383	11.5	10.3	0.353	0.278
ER carcass	233	228	238	230	8.63	6.52	0.670	0.379
Energy efficiency								
ER body/DE_i	0.326	0.352	0.347	0.360	0.009	0.009	0.111	0.031
ER body/DE_i	0.198	0.212	0.205	0.216	0.007	0.006	0.344	0.046

[1] Due to variance heterogeneity, a SEM value was included for each mean of the ad libitum groups, and another one for the means of restricted groups. [2] No significant difference was found for the interaction CEL × Feeding (P ≥ 0.10).

CONCLUSIONS

CEL supplementation improved the nitrogen retention efficiency in the body, while gradual feed restriction improved the digestible nitrogen and energy retention efficiency with no effect on body nitrogen and energy retention. No synergism existed between CEL and feed restriction.

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REFERENCES

Birolo M., Trocino A., Zuffellato A., Xiccato G. 2016. Effect of feed restriction programs and slaughter age on digestive efficiency, growth performance and body composition of growing rabbits. *Anim. Feed Sci. Technol., 222, 194–203.*

Delgado R., Nicodemus N., Abad-Guamán R., Sastre J., Menoyo D., Carabaño R., García J. 2018. Effect of dietary soluble fibre and n-6/n-3 fatty acid ratio on growth performance and nitrogen and energy retention efficiency in growing rabbits. *Anim. Feed Sci. Technol., 239, 44-54.*

Duperray J., Guyonvarch A. 2009. Effet de différents plans de rationnement sur les performances des lapins en engraissement. Intéret d'un aliment concentré en énergie et proteines. *In Proc. 13 Journees de la Recherche Cunicole, pp. 59-62. November, Le Mans, France.*

Farias-Kovac C. 2021. Effect of dietary soluble and insoluble fibre level, oligosaccharides supplementation and feed restriction of rabbit performance. *PhD Thesis. Universidad Politécnica de Madrid. Spain.*

Farias-Kovac C., Simbaña F, Reyes M., Carabaño R, Nicodemus N, García J. 2021a. Effect of cellobiose supplementation in drinking water and feed restriction on apparent faecal digestibility and growth performance in rabbits. *In Proceedings of the 12th World Rabbit Congress, July, Nantes, France.*

Farias-Kovac C., Simbaña F, Reyes M., Carabaño R, Nicodemus N, García J. 2021b Effect of xylooligosaccharides supplementation in drinking water and feed restriction on fecal digestibility, growth traits and energy and nitrogen retention efficiency in growing rabbits. *In Proceedings of the 12th World Rabbit Congress, July, Nantes, France.*

Gidenne T., Combes S., Fortun-Lamothe L. 2012. Feed intake limitation strategies for the growing rabbit: Effect on feeding behaviour, welfare, performance, digestive physiology and health: A review. *Animal, 6, 1407-1419.*

Gidenne T., Fortun-Lamothe L., Bannelier C., Molette C., Gilbert H., Chemit M.L., Segura M., Benitez F., Richard F., Garreau H., Drouilhet L. 2017. Direct and correlated responses to selection in two lines of rabbits selected for feed efficiency under *ad libitum* and restricted feeding: III. Digestion and excretion of nitrogen and minerals. *J. Anim. Sci. 95, 1301-1312.*

Saiz A., García-Ruiz A.I., Martin E., Fernández A., Nicodemus N. 2013a. Aplicación de la técnica de Impedancia Bioeléctrica al estudio de la composición química de la canal de conejos de 35 a 63 días de edad. *In Proc. 38 Symposium de Cunicultura, pp. 162-165. 2013 May, Zamora, Spain.*

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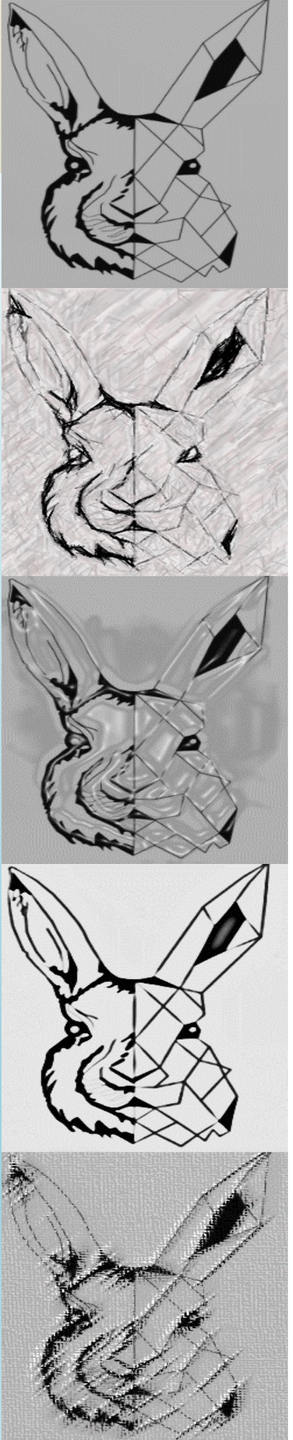
Saiz A., García-Ruiz A.I., Fuentes-Pila J., Nicodemus N. 2017. Application of bioelectrical impedance analysis to assess rabbit's body composition from 25 to 77 days of age. *J. Anim. Sci., 95, 2782-2793.*

Ocasio-Vega C., R. Delgado, R. Abad-Guamán, R. Carabaño, M.D. Carro, D. Menoyo, García J. 2018a. The effect of cellobiose on the health status of growing rabbits depends on the dietary level of soluble fiber. *J. Anim. Sci., 96, 1806-1817.*

Ocasio-Vega C., Abad-Guamán R., Delgado R., Carabaño R., Carro M.D., García J. 2018b. Effect of cellobiose supplementation and dietary soluble fibre content on *in vitro* caecal fermentation of carbohydrate-rich substrates in rabbits. *Arch. Anim. Nutr., 72, 221-238.*

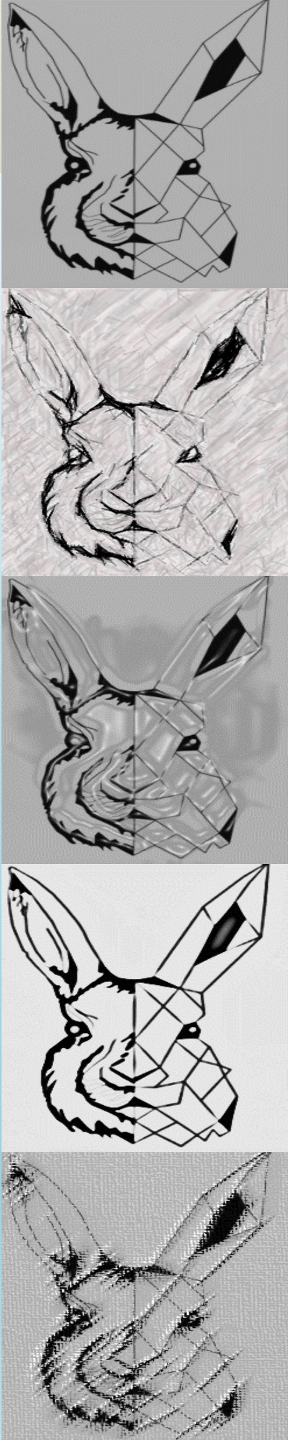
Ocasio-Vega C., Delgado R., Abad-Guamán R., Carabaño R., Carro M.D., García J. 2019. Effect of cellobiose supplementation on growth performance and health in rabbits. *Livest. Sci., 221, 163-171.*



Effect of cellobiose supplementation in drinking water and feed restriction on energy and nitrogen retention efficiency in growing rabbits.

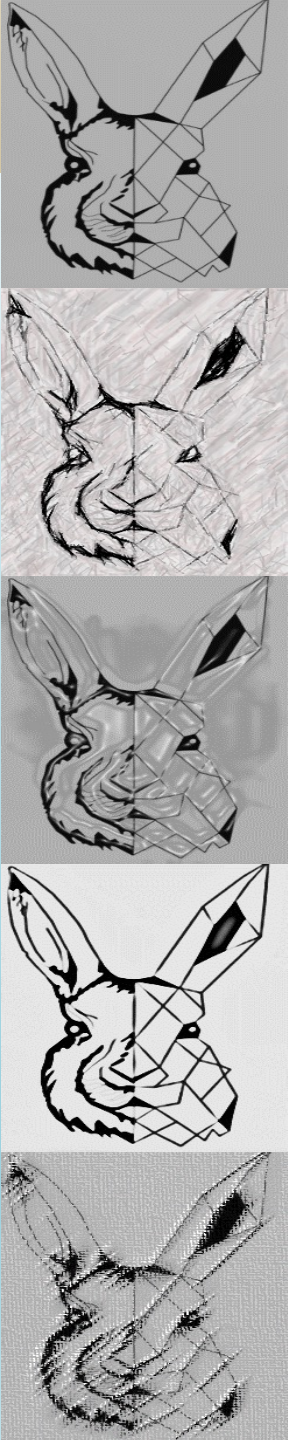
Carlos E. Farías Kovac

12th World Rabbit Science Congress.
3-5 November, 2021.
Nantes, France



Objective

To evaluate the potential effects of Cellobiose, as well as its possible synergy with the feed restriction on nitrogen an energy retention efficiency.



MATERIAL Y METHODS

Factorial
2 x 2

2 Cellobiose in drinking water (g/L)

0,0 (Ocasio-Vega, 2018) 7,5

Diet: 21,1% CP; 35,5% NDF; 9,1% SF;13,4% Starch

Progessive feed restriction period

F.A.D

32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60

Faecal apparent digestibility (F.A.D)

Bioelectrical impedance analysis technique

BIA
- Resistance values
- Reactance values
- Animal length
- Electrode distance

Prediction equations
- *Saiz et al., 2013a, 2013b, 2017*

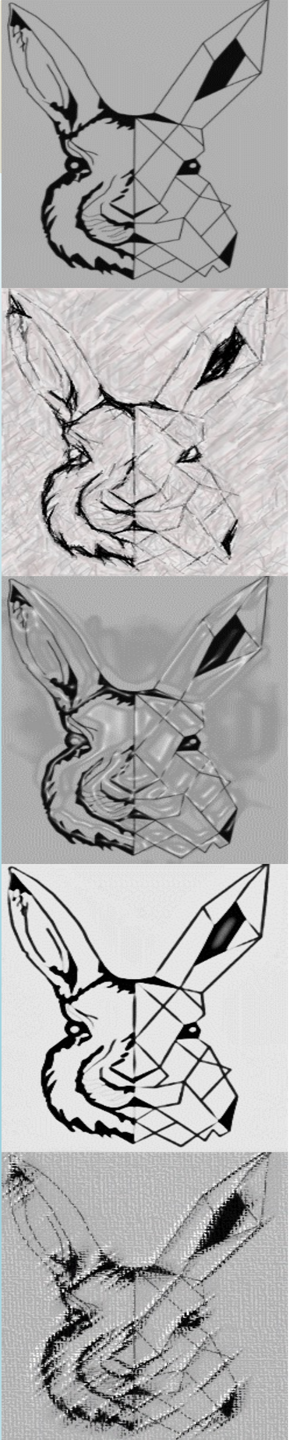
Chemical Composition
- **Body.**
- Carcass

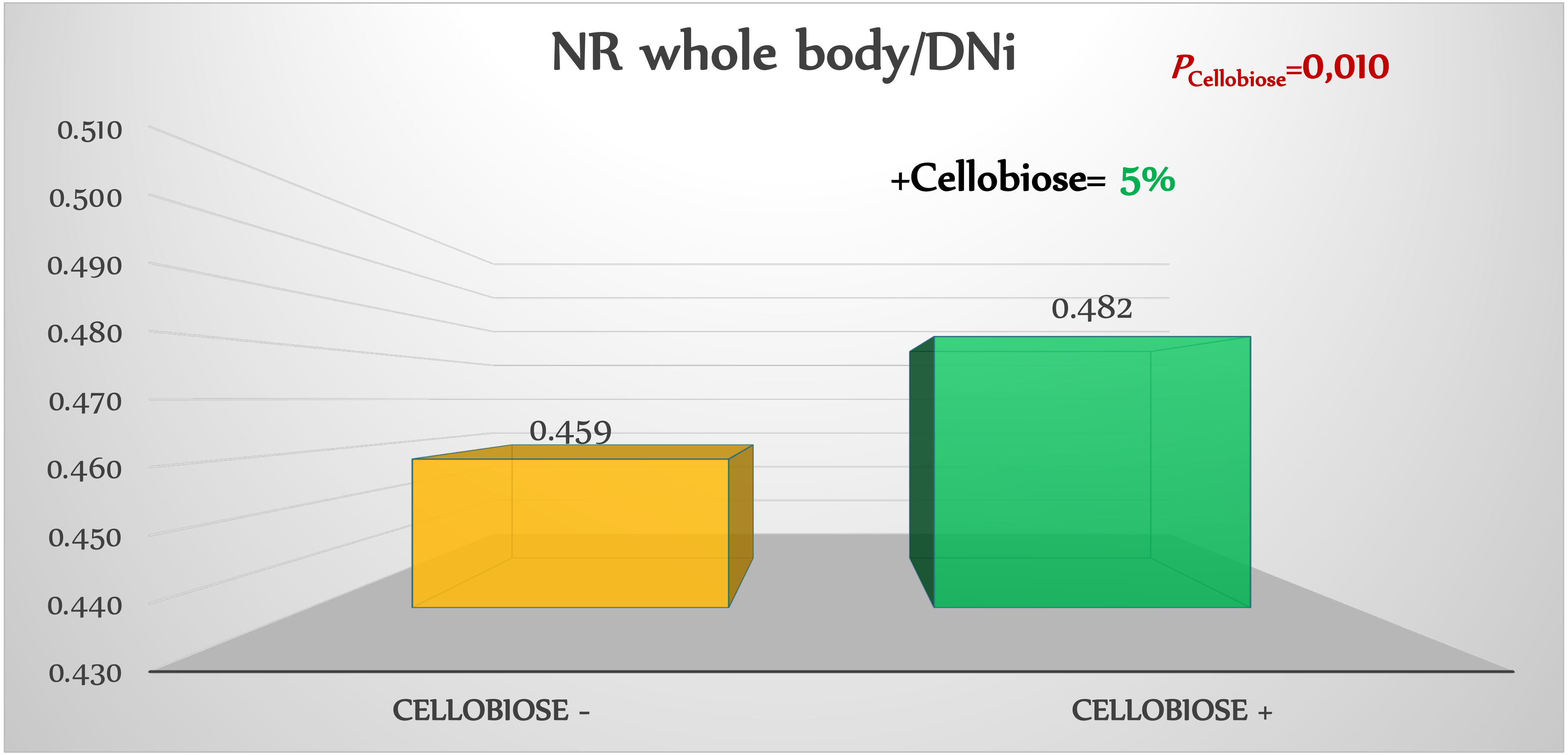
Faecal digitibility
- CPDC
- GEDC

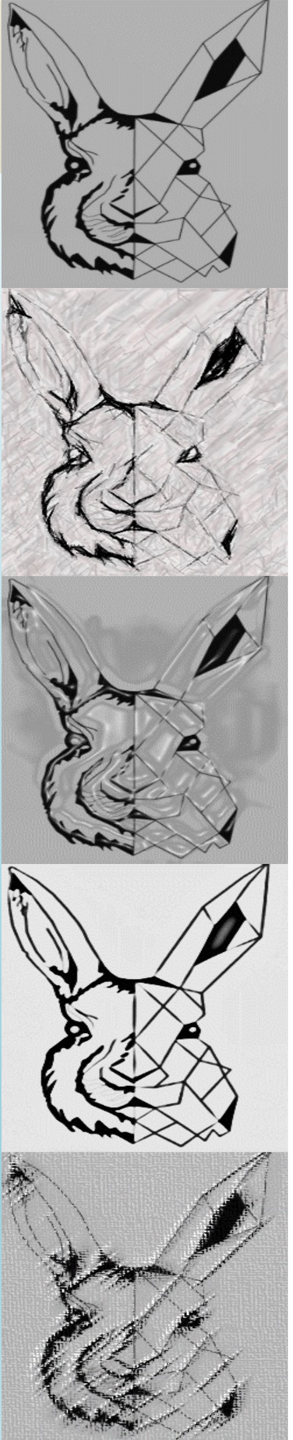
Nitrogen balance.
- DN. intake
- DN. retained Body y Carcass
- N losses (faeces, orine, skin y viscera)

Energy balance
- DE. intake
- DE. Retained. Body y Carcass
- Energy Losses (faeces, orine, skin y viscera)

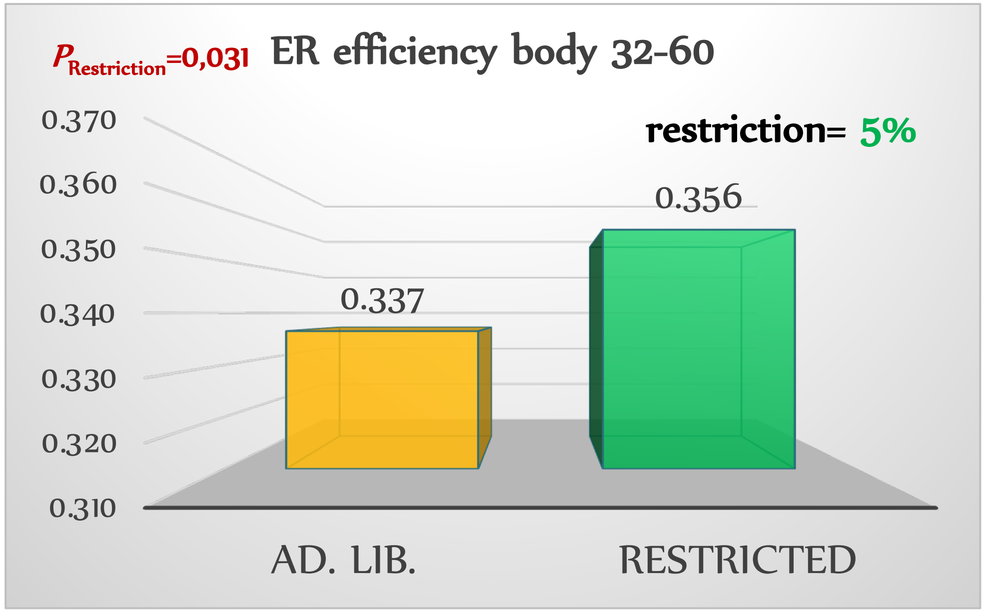
RESULTS

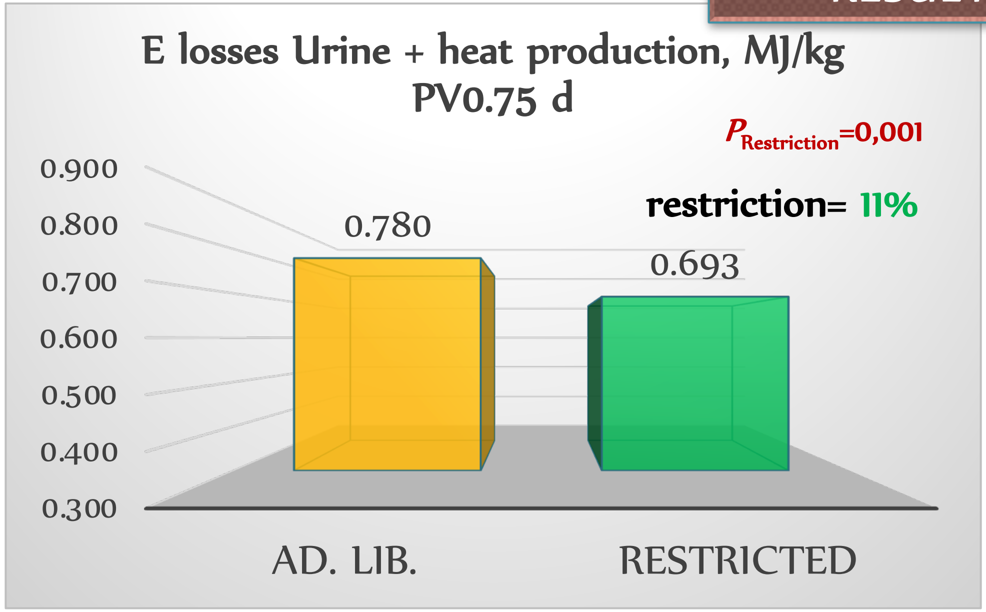



NR whole body/DNi
$P_{Cellobiose}$=0,010
+Cellobiose= 5%
0.510
0.500
0.490
0.480
0.470
0.460
0.450
0.440
0.430
0.459
0.482
CELLOBIOSE -
CELLOBIOSE +

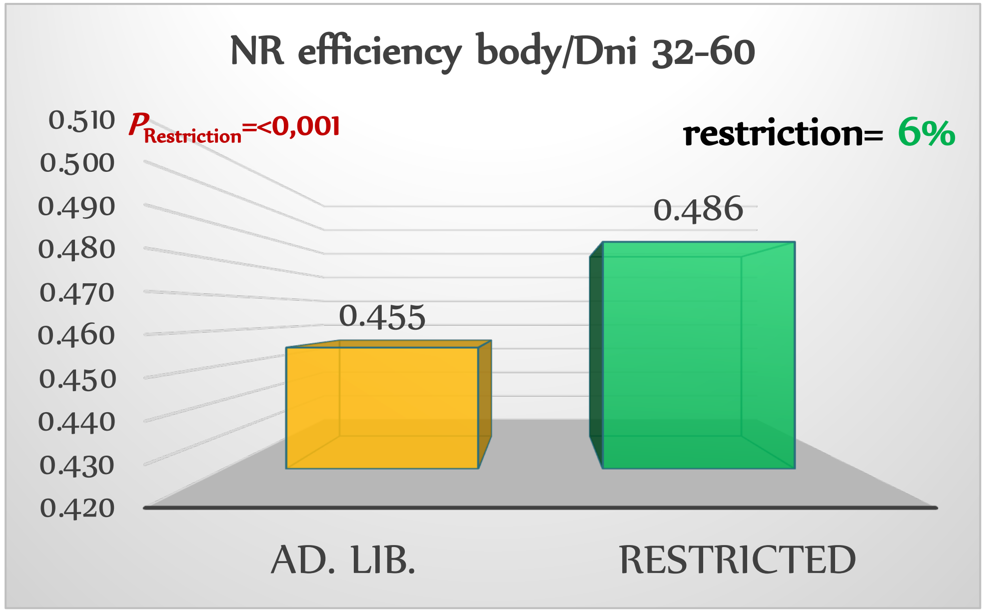


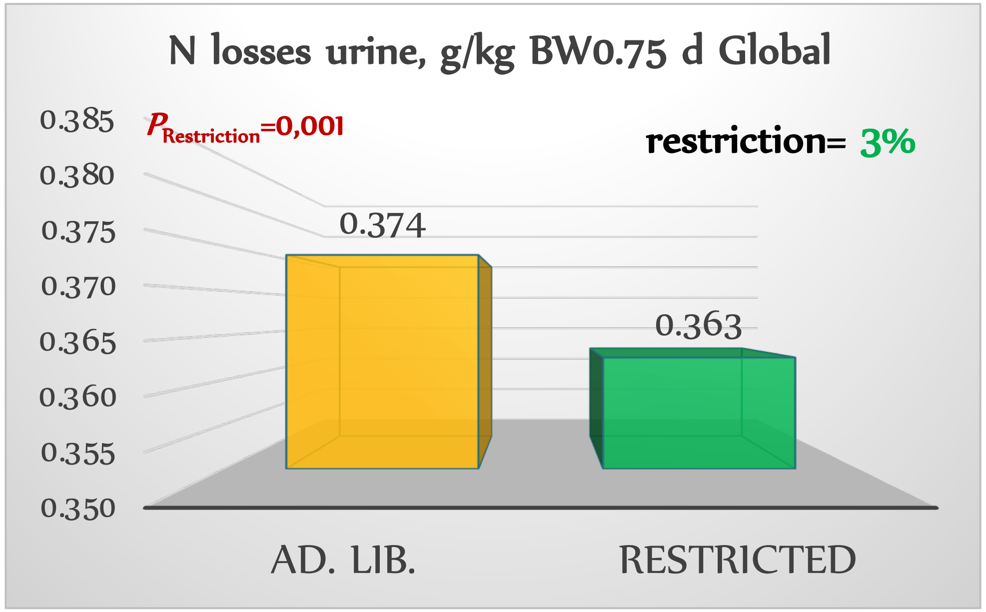
RESULTS

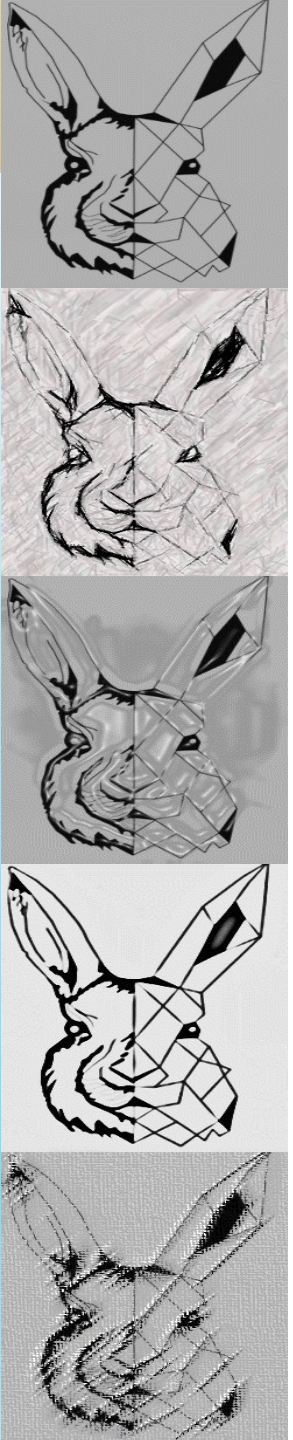




restriction







CONCLUSIONS

Cellobiose

⇣ N losses urine and ⇡ N sking and viscera

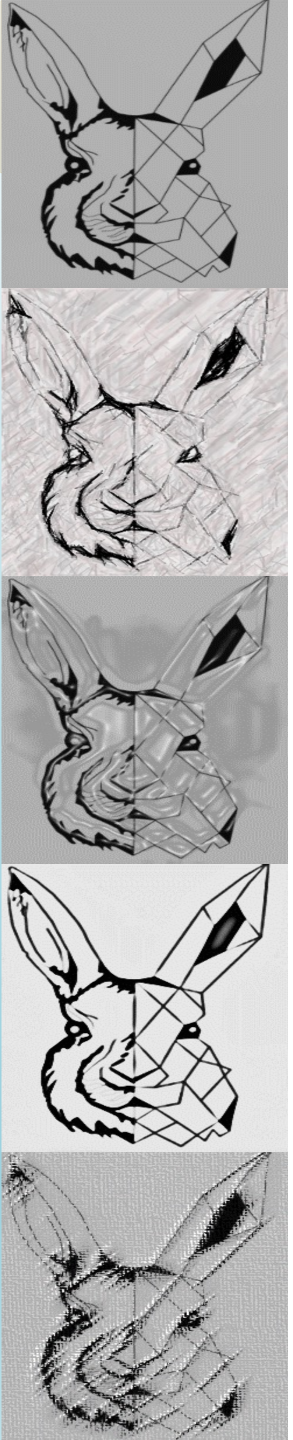
Feed restriction

⇡ N and E retention efficiency

⇣ Total N losses

Interation

No effect



Thank you.

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POLITÉCNICA

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