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PERFORMANCES AND DIGESTIBILITY OF A COMPLETE FEED WITH OR WITHOUT ALFALFA HAY IN GROWING RABBITS

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ABSTRACT

A growing trial was conducted with 120 rabbits divided in four groups and fed with a commercial diet with or without different physical forms of alfalfa hay as complementary food. Controls (**C**) were fed a commercial diet alone and the experimental groups the commercial diet+pelletted alfalfa hay (**C+AAp)** or the commercial diet+pelletted alfalfa-hay with vitamin-mineral premix **(C+AAp+)** or the commercial pellet+alfalfa-hay cut 8-10 cm long (**C+AAh)**. Individual live weights were recorded weekly. Cage feed intakes and health conditions were monitored daily. Histological samples of the gut were examined in 4 animals/diet after slaughtering (82d). Digestibility trial was performed in 9 rabbits per diet, during three experimental periods. Digestibility was evaluated for diet **C** and, diet **C+AAp** and diet **C+AAh**. The diet **C+AAp** was given in two different ratio complete feed/complementary feed: 2.8/1 and. 1/2.8. Ratio 2.8/1 reflected the free rabbit choice, the inverse ratio 1/2.8 was used to evaluate the effect of increasing alfalfa on diet utilization.
Results showed: mortality exclusively in **C** (6.7%); different morbility between **C** and **C+AAh** (20% vs 0%); similar live weight at slaughtering age; a reduction of the total feed intake in rabbits fed with the complementary food (about 30% and 15% during growing and fattening period, respectively); the best feed conversion in **C**. The cut-hay form of alfalfa showed to decrease the digestibility of the organic matter less than the pelleted forms (DCOM: 64.0% vs. 60.3 and 51.7% - P<.05).

INTRODUCTION

In these last years several studies have been conducted to define the requirements of quantity and quality of fibre and the effect of the level of ADF and Lignin/Cellulose ratio in diets for growing rabbits (GIDENNE et al. 1998; GIDENNE et al. 1998a; MAERTENS, 1992; MAERTENS, 1999). Some authors showed also that in rabbit feeding it is important not only the chemical quality but also the physical quality (particularly the size of the fibre particles), to reduce the incidence of enteritis (GIDENNE**,** 1992; LAMBERTINI et al. 1996).
The commercial feed is usually given pelleted after fine milling of the different foodstuffs, normally used by the commercial industry. Fine milling of raw materials overcomes mixing difficulties and ingredient separation so that very often the ingredients are grounded too fine. Dry matter digestibility is improved with diet containing finely grounded ingredients, but relatively coarse milling is required to encourage growth, efficiency and development of the digestive tract. The pellet form is only a method of presentation which is immediately dissolved after the intake and, for this reason, raw materials which has been grounded too fine may, sometimes, increase the retention time of the mixture in the caecum and colon and may increase the incidence of enteritis in growing animals (HANCOCK, 1999; LAMBERTINI et al. 1996; ZIGGERS, 1999). In addition, since fibre content of the diet decrease digestibility and the energy concentration of the diet may be a limiting factor for rabbit growth, feed producers tend to reduce the fibre content in the commercial feed with the aim of the growth-performance improving. For these reason it is not unusual to find rabbit breeders which use a rich in fibre complementary feed (often in form of hays or straws, cut 5-10 cm long) to

control the digestive morbidity. Since the use of cut-hay can produce problems in the management of the rabbitry it can be useful to verify the possibility of using pelleted-hay. Alfalfa is the most widespread hay included in rabbits diets. Increasing level of alfalfa, whose digestibility effects are well known, may allow a control of the sanitary condition in the rabbitry and might improve the nutritive characteristics of the diet (CAVANI et al., 1993; PEREZ, 1998; FERNANDEZ-CARMONA et al., 1998).
In the present experiment we wanted to evaluate and distinguish the possible "chemical" effects of alfalfa from the "physical" effect related to the form of its presentation on the productive performances, digestibility and health conditions of the rabbits.

MATERIAL AND METHODS

***Growth trial*:** The growing trial was conducted with 120 commercial hybrids. The rabbits were reared in cages, in a forced ventilated rabbitry, at the density of .5 sq.m per animal (2 rabbits per cage). The litters were divided at the weaning into four homogeneous groups and fed *ad libitum* with two commercial diets (growing period, 33-54 days, and fattening, 55-82 days). The complementary food was provided to the experimental groups as hay, pellet, and pellet containing also the mineral-vitamin premix (.01%). The composition and chemical analysis of feed given to the animals are shown in table 1. The experimental design performed the following diets:

- control, fed a complete feed alone (commercial pellet);
- experimental diet fed commercial pellet+alfalfa-hay milled then pelleted
- experimental diet fed commercial pellet+alfalfa-hay milled then pelleted with vitamin-mineral premix;
- experimental diet fed commercial pellet+alfalfa-hay cut 8-10 cm long.

Tab. 1 – Composition and chemical analysis of the complete feed and complementary food used in the trials (values into brackets on a.f.b., values without brackets on DM)

	Complete feed				**Complementary food**
	Growing rabbits		**Fattening rabbits**		
Components:	Dehydrated fourages, cereal grains, cereal by-products, oilseeds products and by-products, sugar-beet by-products, minerals, DL-Methionine.				Alfalfa-hay
Chemical composition	*declared*	*analyzed*	*declared*	*analyzed*	*analyzed*
Dry matter %	89.0	93.07	88,0	91.1	88.0
Crude protein %	(14.7) 16.5	17.7	(14.0) 16.0	17.8	16.1
Ether-extract %	(2.5) 2.80	4.06	(2.8) 3.2	3.38	3.5
Crude-fiber %	(14.2) 16.0	17.9	(12.8) 14.5	15.5	26.0
Ash %	(8.5) 9.5	7.96	(7.9) 9.0	7.9	14.27
N-free-Extr %	(49.1) 55.2	52.4	(50.4) 57.3	55.4	40.13
NDF %	-	35.5	-	31.0	43.8
ADF %	-	21.0	-	18.5	29.1
ADL %	-	6.3	-	6.13	8.67
Hemicellulose %	-	14.5	-	12.5	14.7
Vitamin and mineral premix per Kg	Vit. A, I.U. 15000; Vit. D3, I.U. 1500; Vit. E, mg 50; coline, mg 1000; Cu mg 30; Robenidine mg 66; Flavofosfolipol mg 2.		Vit. A, I.U. 10000; Vit. D3, I.U. 1000; Vit. E, mg 35; coline, mg 1000; Cu mg 30.		

Pellet feed were milled by a commercial rabbit feed producer (95% of the particles within the range 0.25-1 mm). Every feed was given independently, to allow rabbits selection of feeding. From weaning (33 d) to slaughtering age (82 d) each animal was weekly weighed and feed intake was daily measured per cage. During the experiment the health conditions of the animals were monitored daily, to check any kind of gastric-intestinal troubles (diarrhoea) and to measure the incidence of morbidity. The loss of soft faeces were controlled per cage.

***Gut analysis*:** After slaughter, 4 animals/diet were submitted to histology examination of the digestive tracts. The different tracts of the gut were measured and weighed. Several tissue samples were taken for microscopically examination in duodenal, caecal, colonic and rectal tracts of the gut, including caecum appendix and ileo-caeco-colon junction. Samples were fixed in 10% buffered formaline and embebbed in paraffin. The measures of ten villi (height) were performed for each intestinal tract and the mean length was evaluated for each rabbit. The thickness of caecum and ileo-caeco-colon junction was measured.

***Digestibility trial*:** digestibility was performed on 9 rabbits per diet, divided in three experimental periods. The digestibility was evaluated in animals fed "complete feed alone", "complete feed+alfalfa pelleted" and "complete feed+alfalfa hay". Pelleted alfalfa was given in two different ratio to complete feed: 1/2.8 and 2.8/1. The ratio complete feed/complementary feed 2.8/1 reflected the free rabbit choice and the inverse ratio 1/2.8 was used to evaluate the effect of increasing alfalfa on diet utilization. Total excreta and urine were collected individually for 4 days after 7 days adaptation period, following the standard procedure (PEREZ et al. 1995). The digestibility of the complementary feed alone was obtained by the comparison of the digestibility of the total intake and the digestibility of the complete feed alone measured in each period. Feed and the faeces were analysed according to AOAC (1990), the fibre fractions were analysed according to VAN SOEST et al. (1991). ANOVA was applied to productive performance data and digestibility coefficients (SAS, 1995).

RESULTS AND DISCUSSION

During the experiment only two rabbits died in the control group (6,7%), while no mortality was observed in the experimental groups. Different morbility were observed between the control group and the experimental group which fed the hay cut (χ^2= 6.81, p<.05). The experimental groups, which fed the pelleted alfalfa, positioned themselves between the two extreme incidences observed and did not statistically differred (table 2). Animals fed only complete diet showed an usual loss of soft faeces. It is necessary to notice that, also with a lignine to fibre ratio equal to .4, according to the recommended level for preventing digestive disorders (GIDENNE et al., 1998a), the animals fed complete feed alone presented a higher level of morbidity than that one observed in the animals supplemented with the cut-hay. This fact alone seems to confirm the importance of the physical form of the ingested fibre.

Tab.2 - Observed mortality and morbidity (*Means with different letter significantly differ per P≤ 05)*

		Complete feed (control)	**Complete feed with complementary food**		
			Alfalfa-Pellet		**Alfalfa-Hay Cut 8-10 cm long**
			Without premix	**With premix**	
Mortality	%	6.7	0	0	0
Morbidity	%	20a	6.7ab	11ab	0

The productive performance of growing (33-54d), fattening (55-82d) and total periods are reported in table 3. The growth performance did not differ between diets and the live weights at slaughtering age were similar. During the growing period however, the weight gain was significantly higher in the control group than in the experimental groups (P<.01), but the growing speed became significantly lower (p<.05%) during the fattening period. Feed intake and conversion efficiency were significantly influenced by the addition of alfalfa, as complementary food.

Tab. 3- Productive performance (estimated mean±s.e.)		**Complete feed (control)**	**Complete feed with complementary food**		
			Alfalfa-Pellet		**Alfalfa-Hay Cut 8-10 cm long**
			Without premix	**With premix**	
Weaning Live weight	g	740 ± 17	732 ± 15	741± 15	737 ±12
Weight gain	**(33-54 d)** g/d	45.4**A**± 1,03	40.7**B**± 1.20	40.0**B**± 1.05	39.3**B**± 1.38
	(54-82 d) "	35.9**b**± .82	39.3**a**± .77	38.1**a**± .73	38.3**a**± .79
	(33-82 d) "	40.0± .71	39.9± .57	38.9± .53	38.7± .61
Slaughter live weight	g	2699±47	2685±30	2648± 31	2635± 31
Cages	no.	15	15	15	15
Feed intake (33-54d)					
Complete feed	g/d	110.5**A**±2.16	71.9**B**±.80	72.2**B**±.60	71.9**B**±.76
complementary feed	"	-	38.9±2.13	39.9±1.73	40.0±3.74
Total	"	110.5±2.16	110.8±2.65	112.1±2.21	111.9±4.39
(54-82 d)					
Complete feed	g/d	158.2**A**±4.90	140.5**B** ±2.42	140.1**B**±2.85	137.9**B**±2.47
complementary feed	"	-	28.0±3.31	26.1±2.,59	32.2±1.76
Total	"	158.2**b** ±4.90	168.5**a**±3.64	166.2**ab**±3.87	170.1**a**±4.11
(33-82 d)					
Complete feed	g/d	137.0**A**±3.24	111.1**B**±1.53	111.0**B**±1.73	109.6**B**±1.52
complementary feed	"		32.7±2.09	32.0±1.74	35.5±2.38
Total	"	137.0**b**±3.23	143.8**a**±2.49	143.0**a**±2.69	145.1**a**±3.79
Feed Conversion Efficiency					
(33-54 d)		2.44**C**±.024	2.75**B**±.057	2.82**AB**±.056	2.86**A**±.045
(54-82 d)		4.44±.081	4.30±.064	4.37±.090	4.46±.101
(33-82 d)		3.44**C**±.043	3.61**B**±.048	3.68**AB**±.061	3.74**A**±.046

Note: Means with different letter significantly differ (capital letters P≤.01; cursive letters P≤05).

During the growing and the fattening periods the rabbits, fed with the complementary feed reduced the intake of the complete feed of about 30% and 15% respectively (growing, g/d/rabbit: 110.5 vs. 71.9, 72.2, 71.9 - P<.01; fattening, g/d/rabbit: 158.0 vs. 140.5, 140.1, 137.9- P<.01). However the total daily intake was significantly higher in the rabbits fed with the complementary feed also. The consumption of the complementary food did not show any significant difference between the experimental groups but the average intake of alfalfa cut-hay was higher than the alfalfa pellets and from growing to fattening the animals reduced the consumption of the complementary feed. The control group showed the best conversion efficiency so that the introduction of a complementary feed, every-physical-presentation, always worsened the transformation efficiency.

The results observed in the performace test were confirmed by the digestibility test. The presence of alfalfa significantly worsened the digestibility coefficients of utilization (Table 4). Regarding the experimental diets, alfalfa as complementary feed in the cut-hay form worsened the digestibility of the organic matter less than in the pellet form (DCOM: 64.0 vs.

60.3, 51.7 - P<.05). This observed-trend is in contrast with the effect of feed pelleting observed in every other species which does not perform caecotrophy. The production of soft faeces is increased by high level of fibre (GIDENNE, 1998) and better digestibilities, probably due to a better production and utilisation of protein contained in soft faeces, may be related to a better development of the digestive tracts induced by the complementary food given as cut-hay.

Tab.4 – Digestibility Coefficients of Utilization (%) - averages±standard error		**Dry matter**	**Organic Matter**	**Protein**	**Ether extract**	**N free Extract**	**Crude Fiber**	**NDF**	**ADF**
Complete feed alone	avg	64.8**a**	65.8**a**	74.2**a**	82.5**a**	72.9**a**	12.6	23.4	16.5
	s.e.	*±1.79*	*±1.76*	*±1.57*	*±1.22*	*±1.56*	*±1.83*	*±1.61*	*±1.77*
Complete feed									
+ Alfalfa pellet	avg	54.4**d**	51.7**d**	69.3**b**	66.3**c**	55.8**c**	16.8	23.7	21.5
ratio: 1/2.8	*s.e.*	*±1.27*	*±1.35*	*±1.02*	*±1.13*	*±1.35*	*±1.37*	*±1.73*	*±1.78*
+ Alfalfa pellet	avg	60.4**c**	60.3**c**	71.9**ab**	77.0**b**	67.3**b**	13.9	22.1	18.2
ratio: 2.8/1	*s.e.*	*±1.25*	*±1.25*	*±1.04*	*±1.19*	*±1.06*	*±1.24*	*±1.54*	*±1.80*
+ Alfalfa cut-Hay	avg	63.5**ab**	64.0**ab**	73.6**a**	78.7**b**	70.9**ab**	12.9	24.9	17.4
ad libitum	*s.e.*	*±1.26*	*±1.24*	*±0.98*	*±1.23*	*±1.03*	*±1.3*	*±1.84*	*±1.91*
Complementary food alone									
Alfalfa Pellet	avg	50.3	46.2	67.2	60.0	49.2	18.1	23.5	20.1
ratio: 1/2.8	*s.e.*	*±1.75*	*±1.84*	*±1.45*	*±1.51*	*±1.77*	*±3.16*	*±3.03*	*±2.62*
Alfalfa Pellet	avg	44.6	41.3	61.2	57.5	47.6	12.4	19.7	17.5
ratio: 2.8/1	*s.e.*	*±5.36*	*±5.39*	*±4.9*	*±4.26*	*±5.31*	*±3.5*	*±4.3*	*±3.22*
Alfalfa cut-Hay	avg	58.5	56.5	73.8	57.3	62.6	10.3	27.6	19.5
ad libitum	*s.e.*	*±6.48*	*±6.82*	*±6.17*	*±4.06*	*±6.66*	*±3.18*	*±4.1*	*±3.11*

Note: Means with different letter significantly differ (P≤.05

The different tested relationships between complete-feed and alfalfa showed that, when alfalfa becomes the principal component of the daily intake, the digestibility of organic matter (protein and lipid) decreases (p<.05) and the digestibility coefficient of fibre is higher than in each other diet, even if the minimum statistical difference is not reached.
The digestibility of alfalfa did not differ in relationship to the presentation form or the intake ratio complete feed/complementary food, even if better digestibility coefficients are calculated when alfalfa is used in the form of cut-hay.

Tab. 5 - Histologic examination and morphological parameters of gut			**Complete feed (control)**	**Complete feed+complementary food**		
				Alfalfa-Pellet		**Alfalfa-Hay Cut 8-10 cm long**
				Without premix	**With premix**	
Colon	**villi-height**	μ	400±22.7	586±61.7	381.3±76.3	587±141
Caecum	**wall-thickness**	μ	2072±62.1	2234±462	1502±314	2535±144
Duodenum	**villi-heigh**	μ	460±62.8	851±117	932.5±145	750.5±140
J. Ileo-caeco-colon	**wall-thickness**	μ	3897±363	4468±562	3502.3±634	2805.7±75.0
Gut	**lenght**	cm	454±7.2	520±31.0	534.7±10.8	485.3±15.1
	weight	g	141±10.1	168±12.1	136±5.3	147.3±12.9

The histologic examination of the different intestinal tracts revealed some differences about the height of the duodenal villi, the thickness of the caecal mucosa wall and ileocecocolonic junction. The samples for histologic examination were not sufficient to demonstrate statistical

differences, on account of their specific high variability, but can give some useful suggestion about the influence of the diets on the physiological characteristics of the digestive apparatus. The rabbits fed alfalfa pellet with and without premix showed the greatest sizes of duodenum villi. This is probably due to a greatest and quick availability of nutritive substances, particularly protein, easily absorbed by the first portion of the small intestine. The hay determined a higher thickness of the caecal mucosa, due to the high activity of the gut associated limphoid tissue (G.A.L.T.). The higher thickness of caecal mucosa may be probably due to the cellular proliferation while the higher thickness colon may depend on the increased number and the circumference of the crypts as observed in other species (EDWARDS, 1992; MCCULLOGH, 1998).

REFERENCES

A.O.A.C., 1990. Officials Methods of Analysis of the Association of Official *Analytical Chemists. 15th Ed. Association of Official Analytical Chemists, Washington, DC.*

CAVANI C., MINELLI G., URRAI G.F., 1993. Digeribilità in vivo e valore nutritivo dell'erba medica disidratata nel coniglio in accrescimento. *Proc. X° Congresso Nazionale ASPA, Bologna, Italy,* 543-548.

EDWARDS C.A., WILSON R.G., HANLON L., EASTWOOD M.A., 1992. Effect of the dietary fibre content of lifelong diet on colonic cellular proliferation in the rat. *Gut*, 33, 8, 1076-1079.

FERNANDEZ-CARMONA J., BERNAT F., CERVERA C., PASCUAL J.J., 1998. High lucerne diets for growing rabbits. *World Rabbit Science*, 6, 237-242.

GIDENNE T., PEREZ J.M., 1994. Apports de lignines et alimentation du lapin en croissance. I. Conséquences sur la digestion et le transit. *Ann. Zootech.*, 43, 313-322.

GIDENNE T., PINHEIRO V., FALCAO E CUNHA L., 1998. Conséquences d'une déficience en fibres alimentaires sur la digestion et le transit: premiers résultats chez le lapin adulte. *7èmes Journ. Rech. Cunicole Fr., Lyon.* 147-150

GIDENNE T., MADEC O., ARVEUX P., 1998a. Effects de la nature de la lignocellulose sur la digestion et les performances zootechniques du lapin en croissance. *7èmes Journ. Rech. Cunicole Fr., Lyon.* 151-154.

HANDCOCK J.D., 1999. Uniform particle size not so important after all. *Feedtech* 3(5): 17-19.

LAMBERTINI L., CAVANI C., ZUCCHI P., RICCI BITTI F., BENASSI M.C., 1996. Influence of different particles size of feed on performances of growing rabbits. *Atti S.I.S. Vet., L,* 593-594.

MAERTENS L., 1992. Rabbit nutrition and feeding: a review of some recent developments. *J.Applied Rabbit Res.*, 15, 889-913.

MAERTENS L., 1999. Towards reduced feeding costs, dietary safety and minimal mineral excretion in rabbits: a review. *World Rabbit Sci.*, 7 (2), 65-74.

McCULLOGH J.S., RATCLIFFE B., MANDIR N., CARR K.E., Goodlad R.A., 1998. Dietary fibre and intestinal microflora: effect on intestinal morphometry and crypt branching. *Gut,* 42,6, 799-806.

PEREZ J.M., LEBAS F., GIDENNE T., MAERTENS L., XICCATO G., PARIGI BINI R., DALLE ZOTTE A., COSSU M.E., CARAZZOLO A., VILLAMIDE M.J., CARABANO R., FRAGA M.J., RAMOS M.A., CERVERA C., BLAS E., FERNANDEZ J., FALCAO E CUNHA L., BENGALA FREIRE J., 1995. European reference method for in vivo determination of diet digestibility in rabbits. *World Rabbit Sci.*, 3, 41-43.

PEREZ J.M., 1998. Valeur nutritive de la luzerne déshydratée au sein d'un régime complexe pour le lapin: influence du taux d'incorporation et de la méthode d'estimation. . *7èmes Journ. Rech. Cunicole.* 133-136.

VAN SOEST P.J., ROBERTSON J.B., LEWIS B. A., 1991. Methods for dietary fiber, neutral detergent fiber, and non starch polysaccharides in relation to animal nutrition. *J. Dairy Sci.*, 74, 3583-3597.

SAS (1995) JMP©. Cary NC: SAS Institute Inc. ISBN: 1555446795.

ZIGGERS D., 1999. The importance of particle size in layer feed. *Feedtech* 3(3): 14-16