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EFFECT OF NUTRITIVE LEVEL AND OF AGE ON FEED DIGESTIBILITY AND NITROGEN BALANCE IN RABBIT

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INTRODUCTION

The digestibility and the nutritive value of rabbit diets are influenced by several factors, the most important being composition of feed, nutritive level, age, weight, sex and individual variability.

The effect of the nutritive level on feed digestibility was investigated by some authors, who indicated a decrease of digestibility with the increase of the nutritive level (Lebas, 1979; Ledin, 1984).

The effect of age and of weight on digestibility of nutrients and especially of fibre fractions is not well known, even though some researchers have noticed a reduction in digestive utilization with age (Lebas, 1973; Maertens and De Groote, 1983). As for nitrogen metabolism, the comparison among various studies on rabbits at different age and weights indicates that nitrogen retention is definitively affected by these factors, with a decrease during the growth (Spreadbury, 1978; Chiericato et al., 1983; Greppi et al., 1984).

The objective of this work was to investigate the influence of the nutritive level and of age on diet digestibility and on nitrogen balance in rabbits, by two feeding and metabolism experiments.

MATERIAL AND METHODS

Experiment 1.

Twenty-four male rabbits (Provisal hybrid), 3067.5 ± 245.9 g live weight, 100 days old, were kept in individual metabolism cages for 30 days. During the first 10 days, the rabbits were fed "ad lib." with a commercial pelleted diet, in order to measure voluntary intake, then they were divided into 3 groups of 8, fed "ad lib." (high level), 65% of "ad lib." (intermediate level) and 45% of "ad lib." (low level), respectively. After a 10 day preliminary period, a 10 day digestibility trial was carried out.

Experiment 2.

Twelve male rabbits (Hyla hybrid), 768.2 ± 80.7 g live weight, 42 days old, were raised for 6 weeks in individual metabolism cages. The animals were fed "ad lib." with a commercial pelleted diet. Samples of urine and faeces of each week of trial were obtained.

Analitical and statistical methods.

The feed and faeces of both experiments were analysed to determine nutrient content (A.O.A.C., 1970). Fibre fractions of diet and faeces in the 2nd experiment were analysed using the Goering and Van Soest (1970) method. NDF analysis was conducted by preliminary treatment with amilase. Nitrogen concentration in urine, collected during the 2nd trial, was determined by the Kjeldahl method (A.O.A.C., 1970).

Apparent digestibility coefficients of nutrients and of fibre fractions were calculated by "ingesta-excreta" balance and nitrogen retention was determined as: ingested N - (faecal N + urinary N).

The statistical analysis of the results was carried out by the "least squares analysis", according to linear models (Nie et al., 1975). First and second order components of variance were also estimated in relation to the nutritive level and age.

RESULTS AND DISCUSSION

The composition of the two diets is reported in table 1 and the results of the experiments are reported in tables 2 and 3.

The nutritive level (experiment 1) significantly affected the digestibility of nutrients: dry matter digestibility increased from 65.77% at the "ad lib." level, to 67.90% at the intermediate level, to 70.64% at the low level. The most important effect was observed for crude protein digestibility, which increased from 64.75% to 69.98% to 75.91% with the reduction of feed intake. A linear increase of the digestibility was observed also for ash and N-free extract, while the ether extract utilization was not influenced. The crude fibre was better utilized only at the lowest nutritive level (25.76% and 25.50% vs 30.80%, $P < 0.05$)..

According to our results, Lebas (1979) found a significant increase in the digestibility of dry matter, crude protein and energy on pregnant does subjected to restricted feeding. Also Ledin (1984) observed a better digestive utilization of nutrients in growing rabbits fed with restricted diets.

In the 2nd experiment, no significant trend of variation was observed with age on dry matter, organic matter and crude protein digestibility. A significant difference was observed only between the first and the second weeks of trial (7th and 8th weeks of age), in coincidence with a rapid increase of daily dry matter intake (77.22 vs 112.53 g/d). The digestibility of ether extract showed a significant linear increase, rising from 71.7%, in the 7th week of age, to 79.4%, in the 12th ($P < 0.01$), whereas crude fibre and ash were digested in a percentage decreasing with the age, varying from 16.8% to 14.4% ($P < 0.05$) and from 52.9% to 46.9% ($P < 0,01$), respectively.

The digestive utilization of fibre fractions was scarcely influenced by the age, with mean values rather low (NDF 22% to 23%; hemicellulose 33% to 34%; ADF 15% to 16%; cellulose 21% to 23%).

A scarce effect of age on the digestibility of dry matter, organic matter and crude protein was found also by Gacek (1976), Auxilia and Masoero (1980), Partridge (1980) and Parigi-Bini et al. (1987), whereas Lebas (1973) and Maertens and De Groote (1982) observed decreasing digestibility coefficients. These last authors, as well as Gacek (1976) and Parigi-Bini et al. (1987), found that ether extract digestibility

increases with age, while ash digestibility decreases. As far as fibre is concerned, most of the studies are in accordance with ours, showing no change or little decrease of crude fibre and of fibre fraction digestibility with age (Gacek, 1976; Partridge, 1980; Maertens and De Groote, 1982).

The effect of age on nitrogen balance is presented in table 3, where it can be noted that most items were affected by the week of control. In particular the intake, the faecal excretion and the digestibility of nitrogen, referred to the metabolic weight (MW), showed a non linear trend, with maximum levels occurring in the 8th or 9th week of age, when the highest daily weight gain was reached. On the contrary, the urinary nitrogen had a linear increase with age, from 0.61 to 0.97 g/d kg MW. This determined at first an increase of nitrogen retention (from 1.07 g/d kg MW, in the 1st week of trial, to 1.26 g/d, in the 2nd one), then a decrease up to the last week (0.70 g/d kg MW).

Finally the nitrogen retention, referred to ingested and to digested nitrogen, was significantly affected by age, with a linear decrease of the ratios from 44.0% to 28.7% and from 63.4% to 41.8%, respectively.

The retention of nitrogen observed in our experiment is in accordance with the values found on growing rabbits by Spreadbury (1978), Chiericato et al. (1983) and Parigi-Bini et al. (1987), whereas Greppi et al. (1984) observed a nitrogen retention much lower in adult rabbits, confirming the negative trend with age.

CONCLUSION

Our experiments showed significant effects of nutritive level and of age on nutrient digestibility and nitrogen balance in the rabbit.

In the 1st experiment, carried out on 100 day-old male rabbits, digestibility increased with the reduction of nutritive level, from 100% to 45% of "ad lib.". The effect of the restriction of feeding is particularly important for protein digestibility and, when the restriction is very strong (e.g. 45% of "ad lib."), also for fibre digestibility.

The 2nd trial with growing male rabbits showed little effect of age on nutrient digestibility, except for ether extract, crude fibre and ash. Greater effect was found on nitrogen retention during growth, with a rapid decrease after the 10th week of age.

These results suggest that digestibility trials on rabbits fed at

different nutritive levels are not comparable, while they can be performed at any moment of the growing period, from weaning to slaughtering. On the contrary, the nitrogen balance varies with age.

These results indicate that the choice of the nutritive level and of the period of metabolism trials must be carefully evaluated, according to the specific goals of the experiments.

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Table 1: Composition of experimental diets

		Diet 1	Diet 2
Dry matter	%	90.1	91.2
Crude protein	% d.m.	17.1	18.2
Ether extract	"	4.0	3.2
Crude fibre	"	15.1	17.1
Ash	"	9.0	10.5
N-free extract	"	54.8	51.0
NDF	"		36.6
Hemicellulose	"		13.9
ADF	"		22.7
ADL	"		5.3
Cellulose	"		15.9
Acid insoluble ash	"		1.5

Formulation of diet 1 (experiment 1): dehydrated lucerne meal 25%, wheat middlings 23%, barley meal 20%, lucerne hay meal 10%, soybean meal 8%, oats meal 7%, maize meal 4%, limestone 1%, calcium diphosphate 1%, salt 0,4%, vitamin-trace element supplement 0.6%.

Formulation of diet 2 (experiment 2): dehydrated lucerne meal 40%, barley meal 21%, wheat middlings 20%, soybean meal 8%, sunflower meal 6%, cane molasses 2%, calcium diphosphate 1%, limestone 0.8%, vitamin-trace element supplement 0.67%, salt 0.45%, DL-methionine 0.08%.

Table 2: Effect of nutritive level on performance, feed intake and apparent digestibility (1st experiment)

		Nutritive level (1)			Probability		
		High	Medium	Low	Main effect	Components linear	quadratic
Animals	n.	8	8	8			
Average liveweight	kg	3.34	3.15	2.87	**	**	N.S.
Daily weight gain	g/d	18.1	11.9	4.4	**	**	N.S.
Dry matter intake	g/d	156.1	102.9	71.6	**	**	*
Digestibility coefficients:							
- dry matter	%	65.77	67.90	70.64	**	**	N.S.
- organic matter	"	66.62	68.81	71.68	**	**	N.S.
- crude protein	"	64.75	69.98	75.91	**	**	N.S.
- ether extract	"	84.11	84.97	85.23	N.S.	N.S.	N.S.
- crude fibre	"	25.76	25.50	30.80	*	*	N.S.
- ash	"	57.16	58.60	60.11	*	*	N.S.
- N-free exctract	"	76.84	78.47	80.36	*	*	N.S.

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(1) - Nutritive level: High = "ad lib."; Medium = 65% of "ad lib."; Low = 45% of "ad lib."
**: P<0.01; *: P<0.05; N.S.: not significant

Table 3: Effect of age on performance, feed intake, apparent digestibility and N balance (2nd experiment)

		Age						Probability		
		7th week	8th week	9th week	10th week	11th week	12th week	Main effect	Components	
									linear	quadratic
Average liveweight	kg	0.89	1.17	1.47	1.76	2.02	2.25	**	**	**
Daily weight gain	g/d	35.88	42.29	44.46	38.74	33.73	33.20	**	*	**
Dry matter intake	g/d	77.22	112.53	133.12	138.79	145.88	153.37	**	**	**
Digestibility coefficients:										
- dry matter	%	59.39	57.55	58.06	58.62	58.72	58.65	*	N.S.	N.S.
- organic matter	"	60.10	58.52	59.19	59.80	60.10	60.03	*	N.S.	N.S.
- crude protein	"	69.34	67.18	67.19	68.57	68.60	68.57	*	N.S.	N.S.
- ether extract	"	71.71	74.67	73.93	76.75	78.73	79.36	**	**	N.S.
- crude fibre	"	16.82	15.31	16.00	15.17	14.52	14.38	N.S.	*	N.S.
- ash	"	52.93	49.29	48.41	48.62	46.98	46.91	**	**	*
- N-free extract	"	70.67	68.91	69.79	70.56	71.18	70.93	**	*	N.S.
- cell content	"	80.06	77.96	78.80	79.84	79.23	79.20	**	N.S.	N.S.
- NDF	"	23.61	22.24	22.18	21.93	23.26	23.07	N.S.	N.S.	N.S.
- hemicellulose	"	34.67	33.63	32.52	34.40	35.91	34.67	N.S.	N.S.	N.S.
- ADF	"	16.81	15.31	15.80	14.27	15.50	15.96	N.S.	N.S.	N.S.
- cellulose	"	23.16	21.52	22.59	21.50	22.37	23.31	N.S.	N.S.	N.S.
Nitrogen balance:										
- ingested N	$g/kg^{0.75}$	2.43	2.92	2.91	2.65	2.52	2.44	**	*	**
- fecal N	"	0.75	0.96	.95	0.83	0.79	0.77	**	N.S.	**
- urinary N	"	0.61	0.70	0.81	0.87	0.92	0.97	**	**	N.S.
- digested N	"	1.68	1.96	1.96	1.81	1.72	1.67	**	*	**
- retained N	"	1.07	1.26	1.15	0.94	0.80	0.70	**	**	**
- retained N/ingested N	%	43.96	43.30	39.67	35.52	31.92	28.70	**	**	N.S.
- retained N/digested N	%	63.36	64.31	58.72	51.75	46.51	41.84	**	**	N.S.

**: $P < 0.01$; *: $P < 0.05$; N.S.: not significant

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SUMMARY

Two digestibility and metabolism trials were carried out in order to evaluate the influence of nutritive level and of age on digestibility and nitrogen balance in the rabbit.

In experiment 1, 24 male rabbits (100 days old, 3068 g live weight) were kept in metabolism cages and divided into 3 groups fed "ad lib.", 65% of "ad lib." and 45% of "ad lib.", respectively. The digestibility of the diet increased significantly with the reduction of the nutritive level (DM 65.77% to 67.90% to 70.64%; CP 64.75% to 69.98% to 75.91%). The CF digestibility was influenced positively only at the lowest nutritive level, while EE was not affected by treatment.

In experiment 2, 12 male rabbits (42 days old, 768 g liveweight) were raised for 6 weeks in individual metabolism cages and fed "ad lib.". Digestibility of DM, OM and CP did not change during the trial, whereas EE digestibility significantly increased from 71.6% at the start to 79.4% at the end of the trial ($P< 0.01$) and CF digestibility decreased from 16.8% to 14.4% ($P< 0.01$). Fibre fraction utilization was not affected by age. Ingestion, excretion and retention of N varied significantly during the experiment, with the maximum levels at the 8th and 9th weeks of age. Retained N/digested N ratio showed a linear reduction ($P<0.01$) varying from 63.4% to 41.8%.

EFFETTO DEL LIVELLO NUTRITIVO E DELL'ETA' SULLA DIGERIBILITA' E SUL BILANCIO AZOTATO NEL CONIGLIO

RIASSUNTO

Furono condotte due esperimenti con lo scopo di valutare l'effetto del livello nutritivo e dell'età sulla digeribilità e sulla ritenzione azotata nei conigli.

Nella prima prova furono utilizzati 24 conigli ibridi maschi (età 100 d, peso vivo medio 3068 g), divisi in 3 gruppi alimentati a diverso livello nutritivo: "ad libitum", 65% "ad lib." e 45% "ad lib.". La digeribilità della dieta aumentò significativamente con la riduzione del livello nutritivo (s.s. da 65,77% a 69,90% a 70,64%; p.g. da 64,75% a 69,98% a 75,91%). La digeribilità della fibra aumentò solo al livello di ingestione più basso, mentre quella dell'estratto etereo non fu influenzata.

Nella seconda prova, 12 conigli ibridi maschi (età 42 d, peso vivo medio 768 g) furono allevati per 6 settimane per valutare l'evoluzione della digeribilità del mangime e del bilancio azotato. La digeribilità della s.s., della s.o. e della p.g. non ha mostrato un trend significativo nel corso delle 6 settimane, mentre sono stati osservati un aumento lineare della digeribilità dell'e.e. (71,6% nella 7ª settimana di età, 79.4% nella 12ª; $P<0,01$) e una diminuzione della digeribilità della fibra (16,8% nella 7ª, 14,4% nella 12ª settimana; $P< 0,05$). L'utilizzazione digestiva delle frazioni fibrose non è stata influenzata dall'età. Si è evidenziato un significativo effetto dell'età sull'ingestione, escrezione e ritenzione dell' azoto. Il coefficiente di ritenzione azotata ha mostrato una riduzione lineare ($P<0,01$) con l'età, variando da 63,4% a 41,8%.