Proceedings 5th World Rabbit Congress, 25-30 July 1992, Corvallis – USA, 1263-1269.

EFFECTS OF AGE AND DIETARY PROTEIN AND ENERGY LEVELS ON DRY MATTER INTAKE, DIGESTIBILITY AND NUTRITIVE VALUE OF FEEDS IN NEW ZEALAND WHITE RABBITS

S.V. Deshmukh[1,2] and N.N. Pathak[2]

[1] Indian Veterinary Research Institute
Izatnagar (U.P.) 243122 India

[2] College of Veterinary and Animal Sciences
M.A.U. Parbhani (M.S.) 431 40 India

Abstract

Diets supplying three protein levels (13, 16 and 20% CP) and two energy levels (56-58 and 60-62% TDN) were fed ad-libitum to young and adult New Zealand White rabbits to observe the effects of dietary protein and energy levels on DM intake, digestibility of nutrients and nutritive value of feeds. A significant ($P<0.01$) effect of dietary protein and energy levels on DM intake was observed in young rabbits but not in adult rabbits. The protein: energy interaction was significant for DM intake, both in young and adult rabbits. Improvement was observed in digestibility of nutrients, resulting in improved nutritive value of feeds for adult rabbits as compared to young rabbits. Improved nutritive value of the feeds was shown to be regulated not only by age but also by feed energy density.

Introduction

In developing countries, rabbit farming is encouraged to minimize the gap between demand and supply of animal proteins (F.A.O., 1987). Rabbits, as a relatively new meat source, have attracted attention in India (Jain, 1987), and there is great potential for establishment and propagation of rabbit farming for meat production in this country. Nutrition is an important factor in animal production. However, in India, scientific information regarding rabbit nutrition is scanty compared to that regarding other farm animals. The present investigation was, therefore, undertaken with New Zealand White rabbits to study the effects of age and dietary protein and energy levels on dry matter intake, digestibility and nutritive value of feeds.

Materials and Methods

From the same lot, 66 male purebred New Zealand White (NZW) rabbits were weaned at 5 weeks of age and divided into six groups of 11 each on similar body weight basis. These groups were alloted to six diets supplying three protein levels, 13% (low), 16%

(medium) and 20% (high), and two energy (total digestible nutrients) levels, 56-57% (low) and 60-62% (high). These diets were mixed in mash form.

The rabbits were housed individually in metallic cages with arrangements for separate feeding, watering and feces collection. The feeding trial was divided into two phases. During phase 1 diets were fed ad-libitum to 11 young rabbits per treatment until they reached a 1 kg body weight, at about 12 weeks of age. During Phase 2, the diets prepared a second time were fed ad-libitum to 6 adult rabbits in each treatment between 1 and 1.5 kg body weight, i.e. between 12 to 18 weeks of age.

Two digestion trials were conducted, at the end of Phase 1 and 2, on four rabbits for each dietary treatment. Dry matter (DM) intake was recorded daily. The digestibility coefficients and nutritive values of different diets were calculated from digestion trial data. Representative samples of feed offered, residues and feces were analyzed for proximate principles as per ADAC (1980). Fiber was analyzed by the method of Goering and van Soest (1970). Analysis of variance two way classification was done as per Steel and Torrie (1981).

Results and Discussion

Phase 1: (Young rabbits 5 to 12 weeks of age). Percent and chemical composition of the experimental diets along with their nutritive value are presented in Table 1. When average daily dry matter (DM) intake along with DM intake percent of body weight and per kg $W^{0.75}$ were compared at different protein levels (Table 2), it was observed that daily DM intake was significantly ($P<0.01$) higher as protein content increased, being highest at high protein (HP) followed by medium protein (MP) and low protein (LP) levels. Mean DM intake per 100 units of body weight and per kg $W^{0.75}$ was significantly ($P<0.05$) higher at the HP level only but comparable at the MP and LP levels.

Comparison of two energy levels (Table 2) revealed that, irrespective of mode of expression, DM intake was significantly ($P<0.05$) lower at the high energy (HE) level than at the low energy (LE) level. This confirmed the findings of Butcher et al. (1981 and 1983) for Californian rabbits. Such observations were attributed by Fekete and Gippert (1985) to the ability of rabbits to change their feed intake, depending on energy concentration of the diet, to maintain daily energy intake as far as possible within the limits of the gastrointestinal tract.

A highly significant ($P<0.01$) protein:energy interaction was observed for daily DM intake which was also significant ($P<0.05$) for DM intake as percent of body weight and highly significant ($P<0.01$) for DM intake per kg $W^{0.75}$.

Observations on effect of dietary protein and energy levels on digestibility of nutrients (Table 2) indicated no significant effect of protein levels on digestibility coefficients of DM, crude protein (CP), neutral detergent fiber (NDF) or nitrogen free extract (NFE), but a

Table 1. Percent composition, chemical composition and nutritive value of experimental diets during Phase 1.

Items	Experimental Diets					
	1	2	3	4	5	6
Wheat, crushed	62	52	44	15	10	7
Wheat bran	-	-	-	55	50	38
Groundnut cake (deoiled)	3	15	25	-	12	25
Fish meal	5	5	5	5	5	5
Wheat straw	22	20	18	12	10	12
Molasses	5	5	5	10	10	10
Mineral mixture	2	2	2	2	2	2
Salt	1	1	1	1	1	1
Vitamin mixture*	+	+	+	+	+	+
Chemical composition (% DM)						
CP	13.28	16.85	19.87	13.87	16.64	20.72
EE	2.82	2.95	2.67	2.10	2.38	2.07
CF	10.52	9.94	9.08	12.68	10.77	10.97
Ash	11.59	13.04	12.10	14.59	13.90	14.53
NFE	61.78	57.22	56.28	56.76	56.31	51.71
ADF	20.56	20.90	19.45	29.45	28.72	29.21
NDF	38.16	37.32	36.82	39.81	37.39	38.81
Nutritive value (% DM)						
DCP	8.55	11.33	12.80	8.84	10.72	14.34
± S.E.	0.48	0.49	0.44	0.15	0.32	0.53
TDN	60.08	62.84	62.62	56.29	57.26	56.40
± S.E.	1.43	1.48	0.84	1.21	0.56	0.68

* Rovimix vitamin supplement was added at the rate of 10 g per 100 kg of the diet. It contained 40,000 IU vitamin A, 20 mg vitamin B_2 and 5000 IU vitamin D_3 per kg.

significant difference was observed in digestibility of ether extract (EE), crude fiber (CF) and acid detergent fiber (ADF). EE digestibility was highest in the HP group, although not statistically different from the MP group. The LP group was significantly ($P<0.05$) lowest. Reduction in digestibility of nutrients in the low protein ration compared to the high protein ration was in agreement with a report of Sanchez et al. (1985). However, these workers reported reduction in digestibility of only DM, ADF and CP.

Between the two energy levels, the HE group showed significantly ($P<0.01$) higher digestibility (Table 2) of DM, EE and NFE than the LE group. A reverse trend was observed for the digestibility of fiber (CF and ADF) which was significantly ($P<0.01$) higher in the LE group than in the HE group. This might have been due to extensive breakdown of fiber by microbes in the cecum, a means of extracting maximum possible energy from low energy diets. However, such a significant effect on digestibility of nutrients was not observed by Butcher et al. (1981) with different energy levels.

Phase 2 (Adult rabbits 12 to 18 weeks of age). Chemical composition and nutritive value of the experimental diets are presented in Table 3. During digestion trial 2, it was observed (Table 4) that the HP group had significantly ($P<0.01$) higher DM intake than the MP and LP groups. There was no significant effect of dietary energy levels on DM intake. However, protein:energy interaction was significant.

Though the absolute DM intakes during phase 1 and 2 were more or less similar (Tables 2 and 4), relative DM intake was less during phase 2 than in phase 1, indicating higher DM intake in young rabbits as compared to adults. This might have been due to a higher DM requirement per unit of body weight during youth when the metabolic rate is higher due to fast growth.

Data in Table 4 indicate that dietary protein levels did not show any significant effect on digestibility of nutrients as was observed in young rabbits during phase 1. But the digestibility coefficients of nutrients were significantly ($P<.01$) higher in the HE group than in the LE group and significant ($P<0.05$) protein:energy interaction was observed only for EE digestibility.

There was improvement in digestibility of DM during digestion trial 2 compared to digestion trial 1. The same trend was also observed for all other nutrients except NFE. Such improvement in digestibility of nutrients may be attributed to the improved digestive ability of adult rabbits compared to young ones. Similar findings have been reported by Evans and Jebelian (1982). This improved digestibility of nutrients was reflected in increased DCP and TDN levels (Tables 1 and 3) for the high energy rations only and not for the low energy rations, thus indicating that the better utilization of nutrients by adults was governed by energy concentration of the diets in addition to age of the animals.

Table 2. Effect of dietary protein and energy levels on dry matter intake and digestibility of nutrients during digestion trial 1 (Phase 1).

	Protein Levels			Energy Levels		Statistical Significance			
Particulars	LP	MP	HP	HE	LE	SE of of Means	Protein Levels	Energy Levels	P:E Inter-Action
No. of rabbits	8	8	8	12	12	24	24	24	24
DM intake									
Body weight (kg)	0.927	1.068	1.040	1.070	0.953	0.03	NS	*	NS
Metabolic body size, kg $W^{0.75}$	0.943	1.049	1.028	1.050	0.963	0.02	NS	*	NS
DM intake (g)	52.20^{c}	60.34^{b}	71.06^{a}	56.52	65.88	2.62	**	**	**
DM intake, % body weight	5.66^{b}	5.81^{b}	6.93^{a}	5.35	6.92	0.30	*	**	*
DM intake, kg $W^{0.75}$ (g)	55.46^{b}	58.61^{b}	66.67^{a}	54.23	68.27	2.81	*	**	**
Digestibility coefficients (%)									
DM	61.39	63.48	62.46	64.08	60.81	0.59	NS	**	NS
CP	64.09	65.85	67.13	65.57	65.81	0.98	NS	NS	NS
EE	73.15^{b}	78.61^{a}	79.53^{a}	81.34	72.85	1.34	*	**	NS
CF	32.30^{a}	27.55^{ab}	23.03^{b}	23.42	31.77	1.64	*	**	NS
NFE	70.31	72.93	72.01	74.46	69.05	0.86	NS	**	NS
ADF	31.06^{ab}	35.32^{a}	26.83^{b}	19.12	43.01	3.28	*	**	**
NDF	37.08	39.39	38.73	39.20	37.60	0.86	NS	NS	NS

Values bearing the same superscript do not vary significantly. * Significant ($P<0.05$), **Significant ($P<0.01$), NS = Nonsignificant ($P>0.05$), LP = low protein, MP = medium protein, HP = high protein, HE = high energy, LE = low energy, P:E = protein:energy.

From the results obtained in this study, it is indicated that DM intake per unit of body weight is higher in young than in adult rabbits. Digestibility of nutrients is affected by age, being lower in young compared to adult rabbits, resulting in better utilization of nutrients and subsequently improved DCP and TDN values of feeds for adult rabbits, provided energy density of the feed is optimum or higher.

Table 3. Chemical composition and nutritive value (% DM) of experimental diets during Phase 2.

Items	Experimental Diets					
	1	2	3	4	5	6
CP	13.60	16.07	19.98	13.17	16.50	20.32
EE	2.80	2.17	2.02	2.78	2.34	2.80
CF	14.01	14.53	13.42	14.16	14.19	15.50
Ash	12.77	13.79	12.78	11.24	11.14	11.64
NFE	56.82	53.44	51.80	58.65	55.83	49.74
ADF	28.45	25.21	25.15	23.04	23.39	28.26
NDF	39.08	38.80	40.13	41.03	38.14	37.81
Nutritive value						
DCP ± S.E.	10.41 ± 0.52	13.03 ± 0.15	15.37 ± 0.53	8.14 ± 0.28	10.23 ± 0.86	14.55 ± 0.33
TDN ± S.E.	68.36 ± 4.09	68.60 ± 1.51	63.89 ± 3.41	56.13 ± 1.43	56.38 ± 0.60	58.96 ± 1.45

References

ADAC. 1980. Official methods of analysis (13th 3d.). Association of Official Analytical Chemists, Washington, D.C.

Butcher, C., M.J. Bryant, D.H. Machin, E. Owen and J.E. Owen. 1981. The effect of metabolizable energy concentration on performance and digestibility in growing rabbits. Tropical Anim. Prod. 6:93-100.

Butcher, C., M.J. Bryant, E. Owen, I. Leach and D.H. Machin. 1983. The effect of slaughter weight upon growth and carcass characteristics of rabbits fed diets of different dietary metabolizable energy concentrations. Anim. Prod. 37:275-285.

Evans, E. and V. Jebelian. 1982. Effects on age upon nutrient digestibility by fryer rabbits. J. Appl. Rabbit Res. 5:8-9.

F.A.O. 1987. Rabbit production. The 12th session of the F.A.O. Regional Animal Production and Health Commission for Asia and the Pacific (APHCA) held in Islamabad, Pakistan, from 5th to 10th Oct., 1987.

Fekete, S. and T. Gippert. 1985. Effect of crude fiber on protein utilization by rabbits. J. Appl. Rabbit Res: 8:31-38.

Goering, H.K. and P.J. Van Soest. 1970. Forage Fiber Analysis. USDA Agriculture Handbook no. 379, USA Dept. of Agric., Washington, D.C.

Table 4. Effect of dietary protein and energy levels on dry matter intake and digestibility of nutrients during digestion trial 2 (Phase 2).

Particulars Interaction	Protein Levels			Energy Levels		Statistical Significance			
	LP	MP	HP	HE	LE	SE of of Means	Protein Levels	Energy Levels	P:E
No. of rabbits	8	8	8	12	12	24	24	24	24
DM intake									
Body weight	1.507	1.667	1.685	1.570	1.669	0.04	NS	NS	NS
Metabolic body size, kg $W^{0.75}$	1.359	1.466	1.477	1.401	1.467	0.02	NS	NS	
NS									
DM intake (g) per day	54.11[b]	57.01[b]	65.97[a]	58.96	59.10	1.51	**	NS	*
DM intake, % body weight	3.60[b]	3.43[b]	3.95[a]	3.76	3.56	0.09	*	NS	*
DM intake, kg $W^{0.75}$ (g)	39.88[b]	38.91[b]	44.86[a]	42.08	40.34	0.94	**	NS	**
Digestibility coefficients (%)									
DM	65.26	66.65	64.38	71.91	58.95	1.78	NS	**	NS
CP	69.26	71.60	74.34	76.23	65.23	1.91	NS	**	NS
EE	83.80	82.67	81.78	85.40	80.09	1.17	NS	**	*
CF	48.01	48.21	45.75	52.87	41.78	2.34	NS	*	NS
NFE	71.50	72.97	69.68	77.94	64.82	1.70	NS	**	NS
ADF	43.37	42.00	40.30	47.96	35.81	2.59	NS	**	NS
NDF	46.04	44.78	44.15	55.23	34.75	2.80	NS	**	NS

Values bearing the same superscript do not vary significantly. * Significant ($P<0.05$), **Significant ($P<0.01$), NS = Nonsignificant ($P>0.05$), LP = low protein, MP = medium protein, HP = high protein, HE = high energy, LE = low energy, P:E = protein:energy.

Jain, S.C. 1987. Multifocal approach on research and development with special reference to transport and distribution of meat and poultry products. In: Advances in Meat Research (Khot, J.B., A.T. Sherikar, B.M. Jayarao and S.R. Pillai, ed.) pp. 9-14. Red and Blue Cross Publishers, Bombay, India.

Sanchez, W.K., P.R. Cheeke and N.M. Patton. 1985. Effect of dietary crude protein level on the reproductive performance and growth of New Zealand White Rabbits. J. Anim. Sci. 60:1029-1039.

Steel, R.G.D., and J.H. Torrie. 1981. Principles and Procedures of Statistics, a Biometrical Approach, 2nd ed. McGraw Hill.