Proceedings 5th World Rabbit Congress, 25-30 July 1992, Corvallis – USA, 1633-1639.

THE EVALUATION OF NUTRITIVE VALUES OF THE FEEDSTUFFS AND DIETS FOR ANGORA RABBITS-- 1. THE DETERMINATION OF THE CONTENTS OF DIGESTIBLE ENERGY AND DIGESTED CRUDE PROTEIN IN FEEDSTUFFS

Liu S.M., L. Zhang*, C. Chang, D.H. Pen and Z. Xu

Lanzhou Institute of Animal Science of Chinese Academy of Agricultural Sciences, Lanzhou, 730050, P.R.China

Y.Z. Wang, Q. Chen, W.J. Cao and D.Z. Yuan

Institute of Feed and Food of Jiangsu Academy of Agricultural Sciences, Nanjing, 210014, P.R.China

Abstract

145 digestive experiments with total faeces collection were conducted for three years with adult Angora rabbits to determine the nutritive values of feedstuffs. The digestibilities , gross energy, crude protein and other nutrient contents of the feeds , including 15 species of energy feeds, 15 protein feeds, 10 fresh feeds and 28 roughages, were measured and then the contents of digestible energy and digested crude protein were calculated. Another 50 diets were formulated with more than 10 species of the tested feeds and their contents of digestible energy and digested crude protein were tested to examine the verity of the nutritive values of these feeds. The differences between the tested contents and the calculated ones were 0.57% ± 2.6% averagely for digestible energy and 3.4% ± 4.6% averagely for digested crude protein.

Key words: Angora rabbit, Feed, Digestible energy, Digested crude protein.

Introduction

Digestible energy content (DE) and digested crude protein content (DCP) are two important terms which are used to express the nutritive values of feeds for rabbits. Unfortunately the data available are much less, especially in China. In recent years, rabbit industry has been developed rapidly and more and more rabbit raisers have recognized advantages of balanced diets. However, because of the lack of the data from rabbits, the data of nutritive values measured with pigs often have to be accepted for this purpose. The recent studies indicated that there was a difference between rabbits and pigs in digestion of nutrients, especially in digestion on cell wall components (Cheeke et al., 1987; Lebas, 1988). Therefor, it is necessary to determine the nutritive values of feeds for rabbits. This study was conducted from 1987 through 1989 with the aim to measure the DE and DCP contents of feeds by digestive experiments.

*: To whom correspondence should addressed.

Proceedings 5th World Rabbit Congress, 25-30 July 1992, Corvallis – USA, 1633-1639.

Materials and Methods

Digestive method with total faeces collection was accepted in this study. The feedstuffs, except 5 species of fresh grasses, were mixed with the basic diets and fed to the rabbits. Generally, the substitute proportions of the feeds under tested for the basic diets varied from 20-40%. Five species of fresh grasses, namely alfalfa, sainfoin, wild vetch, ryegrass and cicer milkvetch, were tested alone without basic diets.

The experiments were carried out with male Angora rabbits. Six individual rabbits in each group were used for each tested feed. Rabbits were housed individually in metabolic cages and allowed to access to the tested diets and water freely.

The testing time for each feed lasted 12 days with 7 days of pre-experiment and 5 days of faeces collection. During these 5 days, all faeces excreted by the rabbits were collected, the corresponding feed intake was recorded, the feed and pelleted diets were sampled for measurement of nutrient contents and gross energy. Nitrogen was measured with Kjeldahl method, and gross energy was measured with adiabatic bomb calorimeter. the apparent nutrient digestibilities of the diets were calculated and then the digestibility of the tested feed was calculated with the following formula:

$$DF(\%) = [DR(\%) - DD(\%) \times (1-R)] + R$$

where,

DF = the digestibility of the tested feed,
DD = the digestibility of the tested diet,
DB = the digestibility of the basic diet,
R = the substitute proportion in terms of energy proportion or crude protein proportion for the basic diet.

Results and Discussion

1. The main components, DE, DCP and digestibilities of the feeds are listed in Table 1.

Table 1 showed that there was a remarkable effect of feed species on their nutritive values. The DE of protein feeds and energy feeds varied from 1789 to 5222 kcal/kg and from 2346 to 3645 kcal/kg respectively , and were significantly higher than that of the roughages. This stemed from the differences among their components as the protein feeds and energy feeds were lower in crude fibre, higher in gross energy and energy digestibility.

Among the protein feeds, silkworm chrysalis meal and fish meal from animal source had the highest energy digestibilities and so did the soybean and black soybean from plant source. The reason for this was that these feeds had high contents of fat and protein , which are associated with high gross energy concentrations and high energy digestibility. Pea had a similar quality with horsebean. Among the protein feeds, the nutritive values of linseed cake was poorest with quite low digestibilities of protein and energy. This was in agreement with the report from Langlands and his co-workers (1976). They explained that there was 3 to 10% of viscose in the outer wall of linseed and some carbohydrates which can disperse into the water and absorbs a lot amount of water. The enlarged chyme by such a reaction had

Table 2 The DE (kcal/kg) of some feeds from different sources

	This study	NRC (1977)	Rougeot (1984)	Sandford (1986)	Klaus (1985)	Maertents (1988)
Animal	Angora rabbits		Angora rabbits			
Corn	3461	3790	/	3564	3551	3070
Wheat	3160	3680	3025	3124	3467	3080
Barley	3362	3330	3083	3212	3238	2950
Oat	3000	2950	2911	2992	2900	2580
Wheat bran	2849	2610	/	2067	2500	2440

the similar affection of lubricant and was difficult for monostomach animals to digest. In our experiments, 20% of linseed cake meal was once mixed with the basic diet and fed to 6 male rabbits. About 10 days later, all the 6 animals suffered from diarrhoea to different extent and the digestibilities decreased sharply. Thes facts indicated that it should be very cautious to use linseed in rabbit diets.

The DE of some protein feeds reported by other researchers were: 3140 (Maertents, 1988), 3420 (Klaus, 1985) and 3700 kcal/kg (Ding et al., 1988) for soybean cake, 4356 (Klaus, 1988) and 4360 kcal/kg (Maertents, 1988) for soybean, being close to our results, 3235-3434 kcal/kg for soybean cake and 4225 kcal/kg for soybean. The DE of rapeseed cake, horse bean and pea were reported as 2950, 2800 and 2800 kcal/kg respectively, which were lower than our results, 3186, 3234 and 3304 kcal/kg.

Corn was the easiest to be digested by rabbits among the energy feeds, and the digestibilities of energy and protein were almost highest. The quality of potato residue and beet residue was poor with very low digestibilities. The DE of some basic feeds measured by other workers were listed in Table 2. A comparison of these data showed that the differences were small except for wheat bran. The variation of DE in wheat bran might be caused by different processing procedures.

Five fresh feeds, alfalfa, sainfoin, wild vetch, ryegrass and cicer milkvetch, were tested without adding any basic diets. The results showed that both DE and DCP were quite low and likewise energy digestibility was lower than protein. The DE of the fresh feeds varied from 1473 kcal/kg for wild vetch to 3973 kcal/kg for cabbage. On the base of dry matter, most of them were lower than 2200 kcal/kg, which was convinced by our experiments to be the margin for energy deficit (Liu et al., 1989). Furthermore, fresh feeds were comparatively larger in volume and this in turn affected the intake of rabbits. So it was impossible to feed rabbits just with fresh feeds alone for providing adequate amounts of nutrients and reaching high production level. This fact has been confirmed by the experiment of Yono et al. (1986). They reported that some concentrates should be added into the diets which only consisted of tropical fresh feeds for supplement of nutrients. Otherwise, the rabbits would lose their weight.

The energy digestibilities of carrot, potato and sweet potato were quite high, being as high as 3500 kcal/kg on the base of dry matter. But the protein digestibilities were quite low. The reason was unclear.

Generally the quality of the roughages was poor because of high contents of fibre and the poor ability of rabbits to digest fibre. According to Cheeke's work (1987), the fibre digestibility of rabbits to alfalfa was only 14%, lower than 22% by pigs. The digestibility measured by Sakaguchi (1987) was 10.4% when diet contained 12.6% of crude fibre. In the present study, the fibre digestibility of the rabbits at 3 month of age was averagely 7.5% on the diet containing 14.65% of crude fibre, and 17.20% by pregnant does on the diets containing 19.93% of crude fibre. The results indicated that the utilization efficiency of the roughages was actually not satisfied although many roughages could be used for rabbits.

Alfalfa was the most common feed in rabbit production. Its DE was 1785 kcal/kg when cut during budding period and containing 25% crude protein and 30% crude fibre. The DE of alfalfa decreased sharply to 1586 kcal/kg when harvested during the late full-blooming stage, which showed that the growth stage of forage had a significant effect on its nutritive values. The same results were observed from spring vetch and smooth brome, which indicated that the forages could be used more efficiently by rabbits if they were harvested in proper time.

2. Examination of verity of the nutritive values of the feeds

For examine of the verity of the nutritive values of the tested feeds, another 50 diets were formulated with the feeds whose DE and DCP had been measured. These feeds included soybean cake, fish meal, rapeseed cake, linseed cake, barley, corn, wheat bran, oat, alfalfa meal in different quality and so on. The DE and DCP of the diets were measured in digestive experiments. The tested values were compared with those calculated according to the diet formulas and the DE and DCP of each feed. The relative differences between the two values were listed in Table 3.

The Table 3 showed that a rather slight difference occurred in DE contents , all lower than 10%, and 95% of the difference were within 5%. The difference of DCP was a little large with the tested values higher than the calculated ones, and 10% of the difference exceeded 10%. These results illustrated that the degree of verity of diet method (the tested feed + basic diet) was high enough to evaluate DE in feeds since DE reflects the interaction of all organic matters in feed with the animals. The degree of verity was not fully satisfactory when the diet method was used to evaluate the digestibility of one of feed components such as protein. In such a case, some factors including the ingredients and nutritional levels should be carefully controlled.

Table 3 The comparison of the tested nutritive values of 50 diets with the calculated values

	Average differences*	≤ ± 5%	≤ ± 10%	> ± 10%
DE	0.58 ± 2.6	92	8	0
DCP	3.40 ± 4.6	44	52	4

* Relative difference = 100(tested value - calculated value)/tested value

Proceedings 5th World Rabbit Congress, 25-30 July 1992, Corvallis – USA, 1633-1639.

Table 1 The compositions, nutritive values and digestibility of feeds for Angora rabbits

Feedstuffs and sample description		DM	CP	CF	GE	DE	DCP	Digestibility(%)	
-		%	%	%	kcal/kg	kcal/kg	%	GE	CP
Protein feeds									
Soybean cake,	solvent	86.10	43.45	4.52	4247	3434	32.63	80.85	75.10
	hot extract	85.75	42.30	3.64	4270	3235	31.47	75.76	74.40
	hot extract & solvent	90.62	46.06	5.97	4320	3273	34.27	75.76	74.4
Rapeseed cake,	hot extract	91.02	35.96	10.96	4227	3186	31.03	75.36	68.29
	hot extract & solvent	90.30	30.13	10.44	4410	3323	26.00	75.36	68.29
Linseed cake,	hot extract	89.58	33.85	9.36	4402	2610	18.61	59.29	54.96
Hemp cake,	hot extract	81.99	29.19	23.87	3813	2635	22.00	69.11	75.37
Perilla cake,	hot extract	93.10	35.29	16.16	4483	3021	27.75	57.43	78.63
Cottonseed cake,	hot extract & solvent	86.50	29.91	20.67	4400	2414	17.99	54.84	60.15
	hot extract & solvent	88.75	29.21	18.26	4020	1789	17.79	44.56	60.89
Peanut cake,	hot extract & solvent	86.76	39.55	11.07	3920	2432	24.13	62.11	61.00
Bean curd,	air dry	97.19	27.45	13.55	4656	3900	19.28	83.77	70.25
Soybean		91.69	35.53	4.90	5126	4225	24.66	82.43	69.39
Black bean		91.63	31.13	5.76	5011	4064	20.16	81.10	64.76
Pea		91.37	20.48	4.86	4006	3304	17.96	82.50	87.70
Horse bean		88.94	24.02	7.79	3946	3234	17.20	81.95	71.62
Fish meal		91.74	58.54	0.00	4487	3774	49.54	84.12	84.63
Silkworm chrysalis meal		75.36	45.29	5.34	6000	5522	37.73	92.00	83.30
Blood meal		89.73	86.42	1.80	4920	0	61.06	0.00	70.60
Energy feeds									
Corn		89.49	8.95	3.21	4011	3461	7.60	86.28	84.95
Wheat		90.40	14.63	2.28	3710	3085	12.78	83.15	87.36
Barley		90.15	10.19	4.31	3946	3362	6.83	85.20	67.00
Oats		92.42	8.81	9.99	4170	3000	3.99	71.94	45.34
Highland barley		89.41	11.60	3.20	4021	3645	6.07	90.63	52.35
Millet		88.36	10.59	4.90	3907	3560	8.36	92.37	78.98
Proso		89.39	9.54	10.44	3805	2702	6.21	64.13	65.13
Wheat		88.25	14.81	2.64	3930	2467	8.18	62.77	55.21
Paddy		88.62	7.66	11.44	3710	2784	6.41	74.93	83.74
Unpolished rice		86.56	8.13	0.87	3760	3615	3.87	96.18	83.16
Cruised rice		89.16	7.87	1.66	3830	2948	5.29	77.02	67.22

Table 1 (continuous)

Energy feeds								
Wheat bran		89.50	15.62	9.24	4051	2849	9.95	70.34	63.71
Potato residue		89.13	4.34	6.48	3396	2752	2.30	87.75	53.03
Beet residue		91.87	9.69	10.33	3927	2895	4.55	73.72	46.93
Rice bran cake		88.52	18.69	9.26	3890	2346	10.35	60.28	55.39
Fresh feeds								
Alfalfa,	full flowering	26.57	4.42	8.7	1141	463	2.83	40.62	64.13
Sainfoin(aftermath),	full flowering	27.32	4.87	7.23	1181	608	2.70	51.47	55.03
Wild vetch,	pudding	27.35	4.26	8.57	1236	403	1.78	32.67	41.89
Ryegrass	joining	22.80	4.07	4.70	953	450	2.76	47.26	67.70
Cicer milkvetch,	full flowering	24.22	5.03	12.26	993	649	3.86	65.35	76.74
Cabbage		5.24	1.09	0.57	219	209	1.01	95.72	93.07
Broom cypress		14.25	2.85	2.81	530	278	2.21	52.51	77.41
Carrot		8.73	0.68	0.82	355	351	0.38	98.79	55.88
Irish potato		39.03	2.31	0.52	1594	1390	1.12	87.18	48.78
Sweet potato		29.86	1.12	1.24	1212	1112	0.14	91.71	12.76
Roughages								
Alfalfa, hay meal,	full flowering	89.10	11.49	36.86	4247	1186	6.65	27.94	57.85
	full flowering	90.82	11.76	41.46	3900	1098	7.86	28.73	66.83
	full flowering	91.43	11.48	30.49	3862	1390	6.35	35.99	59.66
	budding	91.00	20.32	25.00	3970	1785	13.38	44.96	65.86
	air dry	88.37	9.53	35.74	3550	992	5.51	27.94	57.85
Sainfoin, hay meal,	podding	90.19	11.78	26.25	3870	1849	4.65	47.77	39.49
Red clover, hay meal,	podding	91.31	9.49	28.26	3816	2236	6.22	58.59	65.54
Alsike clover, hay meal		93.50	10.64	25.96	3698	858	6.18	23.21	58.12
Cicer milkvetch, hay meal,	maturing	92.38	10.84	34.00	3775	491	6.51	12.99	60.11
Crown vetch, hay meal		88.30	5.22	44.15	3927	1033	2.54	26.31	48.65
Spring vetch, hay meal		93.26	8.15	42.99	3743	388	3.95	10.38	48.45
	full flowering	94.09	18.98	12.09	3961	1740	11.34	43.02	59.76
Sweet clover, hay meal,	full flowering	92.14	18.49	29.67	3995	1588	12.22	61.64	61.44
Shadawang, hay meal,	full flowering	90.85	16.05	22.74	3914	1635	8.81	41.78	54.92
Russian wildrye, hay meal		90.27	12.25	29.04	3769	1107	9.56	29.38	78.02
Meadow fescue, hay meal,	growing	90.12	11.70	18.73	3412	1973	7.36	57.81	62.91
Birdsfoot trefoil, hay meal,	growing	92.28	10.03	18.87	3937	2348	7.17	59.63	71.56
Orchardgrass, hay meal		93.32	9.29	26.68	3928	1643	8.08	41.82	66.94

Table 1 (continuous)

Roughages								
Fish potato vineay meal, growing	88.74	19.72	13.55	3152	2126	15.61	67.44	79.14
Corn stover	66.72	6.50	18.77	2759	1951	5.26	70.70	80.97
Smooth brome , straw	90.61	10.48	28.48	3832	1007	4.03	26.29	38.44
hay meal, seed-setting	90.98	5.17	13.61	3900	1814	3.24	46.51	62.39
Oat straw	92.24	5.51	22.49	3960	1869	2.64	47.20	47.97
Pumpkin powder, maturing	96.51	7.78	32.94	3876	3066	4.43	79.11	56.91
Sunflower disc	88.49	6.73	16.22	3392	2226	3.53	65.63	52.48
Millet bran	91.74	4.24	39.64	4029	968	1.26	24.03	29.63
Proso bran	90.26	6.42	46.97	4019	894	3.87	22.24	60.35
Green grass meal	88.50	7.46	29.35	3640	1682	4.17	46.24	55.29
Field sowthistle	86.02	17.69	11.64	3720	2403	8.67	64.62	48.98
Silkworm cecrement, sun dry	86.55	8.24	14.65	3500	1432	4.45	40.95	54.02
	84.84	16.96	13.59	3490	1758	13.29	50.30	78.37
Chinese Scholartree leave meal	90.79	12.36	17.81	3538	963	4.24	27.23	34.34
Soybean straw	87.66	4.59	40.07	3890	1979	2.50	50.82	54.55
Apple tree leaves	88.01	8.36	12.81	3761	1151	/	30.61	-2.67

References

1. Cheeke, PR; Patton NM; Lukefahr SD; and McNitt JI; 1987, Rabbit Production, IPP, Danville, Illinois, p.115.
2. Ding XM; Wu L; Hang LY; Can GX; Zhou XY; and Lu ZN; 1988, Studies on the estimation of digestible energy content of diets for wool rabbits, Chinese J. Anim. Sci., 1:4-7.
3. Klaus JL; 1985, A Compendium of Rabbit Production, Eschborn, pp.227-232.
4. Lebas F; 1988, Rabbits, Livestock Production Science, 19:289-290.
5. Liu SM; Zhang L; Chang C; Wei CM; and Pen DH; 1989, Feed intake of Angora rabbits, Chinese J. Rabbit Farming, 5:18-22.
6. Maertents L; Moermans R; and Groote De; 1988, Prediction of the apparent digestible energy (ADE) content of commercial pelleted feed for rabbits, J.Appl. Rabbit Res., 11(2):60-67.
7. NRC, 1977, Nutrient Requirements of Rabbits, 2nd edition, Washington DC, p.17.
8. Rougeot J; and Thebault RG; 1984, Le lepin angora, Mainsons-Alfort, p.128.
9. Sandford FC; 1986, The domestic Rabbit, 4th edition, London, p.107.
10. Yono CR; Cheeke PR; Patton NM; and Supriyati K; 1986, Evaluation of tropical forages and by-products feeds for rabbit production -- 1. Nutrient digestibility and effect of heat treatment, J.Appl. Rabbit Res., 9(2):56-66.