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DIGESTIBILITY AND DIGESTIBLE ENERGY CONTENT OF A NUMBER OF FEEDSTUFFS FOR RABBITS

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Introduction

Data about the digestibility and the energy content of feedstuffs for rabbits are to be found only sporadically in the literature. Van Schoubroeck and Cloet (1968), on the basis of published data, drew up tables of the energy content and the digestibility coefficients of feedstuffs examined up to that time. However, certain feedstuffs utilised at present to a large extent in rabbit feeds (e.g. alfalfa meal, grass meal, corn glutenfeed, beet pulp,citrus pulp and other by-products, were not included in that study. They also found, for certain raw materials (e.g. barley, maize), very greatly diverging digestibility coefficients between one author and another. The main causes for this are ascribed to the changed feeding methods and to the experimental methodology. Formely, one or more roughages were provided as basic feed, whether or not supplemented by high energy feedstuffs. The transition to an exclusively pelleted, compound diet makes a new- and different evaluation of the feedstuffs necessary.

Since that report, little information has become available about the digestibility of feedstuffs (Gacek, 1974; Martinez & Fernandez, 1980; Lebas & Cheriet, 1981). For the formulation of rabbit feeds, use is still made to a large extent of data obtained with animals of other kinds (pig, cattle). Nevertheless, various studies have clearly indicated that the ration digestibility of the rabbit differs considerably from that of ruminants and monogastric animals (Nehring et al.,1963; Ingalls et al., 1964), but also from animals which, in the field of anatomy and physiology of the digestive tract, bear a likeness to the rabbit, namely the horse and the guinea-pig (Slade & Hintz, 1969; Schurg et al., 1977; Wolter et al., 1980).

Because of the close relationship between the digestible (metabolisable) energy content of the feed and the feed intake (Lebas, 1975; Bombeke et al., 1978; Spreadbury & Davidson, 1978), the digestible energy content and the digestibility coefficients of ingredients are indispensable data to formulate rabbit diets and to interpret nutrition experiments.

The purpose of this study was to determine the digestibility of a number of feedstuffs for rabbits.

Materials and Methods

With the exception of the first digestibility trial (Maertens & De Groote, 1981), the experimental methodology applied was the following :

1. Animals

For each diet, six-eight weeks old broiler rabbits were housed in digestibility cages. At that age, the digestibility coefficients appear to stabilise (Lebas, 1973). After some trials, account was no longer taken of the sex or the breed (Maertens & De Groote, 1982). However, every litter was homogeneously distributed over the different test diets. The least possible variation of the weights of the animals, too, was pursued.

2. Diets

For each of the digestibility trials, a balanced basal diet was formulated. Account was taken of the composition of the test feedstuff, in order to avoid that, after substitution of a part of the basal diet, the experimental ration would deviate too far from current practice.

With the exception of alfalfa meal, the substitution percentage amounted to 30 % or 40 % (Table 1). The diets were fed ad libitum to the animals in the form of 2.5x5mm pellets.

3. Procedure of the digestibility trials

In order to permit the animals to adapt to the test diets, as well as to the cages, a preliminary period of at least one week was observed. The rabbits were housed and sampled individually during two weeks (method of Lebas & Colin, 1976 : 2x4 days). The feces were taken daily quantitatively from each cage and collected per period of four days, after which they were dried at 70°C for eight hours. After conditioning at a relative humidity, corresponding with that in the laboratory, the feces from each rabbit of both periods were pooled, freed from any hairs, weighed and ground in an analysis mill (screen diameter : 1mm).

At the end of each period, the food intake was accurately determined. Any possible spilt feed pellets were removed from the feces daily, in order to prevent contamination of the excreta.

4. Analyses and calculations

Feedstuffs, diets and faecal samples were analysed for their content of absolutely dry matter (3h at 103°C), mineral ash (5h at 550°C), crude protein (Kjeldahl method), ether extract (Soxlet method), crude fiber ("Fibertec") and gross energy (adiabatic bomb calorimeter "Ika").

The apparent digestible energy content (ADE) and the apparent digestibility coefficients (ADC) of the Weende fractions of the diets were calculated according to the classical practice. For the calculation of the digestibility of the test feedstuffs, use was made of the Kellner method. It was assumed that there were no interactions between the incorporated feedstuff and the basal diet.

Results and Discussion

The chemical analysis of the tested feedstuffs are shown on Table 2. The ADC and the ADE are given in Table 3.

The digestibility of the crude protein of the protein-rich feedstuffs lies between 75 and 80 %, with the exception of the coconut meal (only 57,7 %) and whole soybeans. In comparison with soybean meal, the protein digestibility of whole soybeans was 9 % higher, but also the ADC of the other fractions were clearly higher. In this case it may certainly be questioned if there is still additivity between the basal diet and the incorporated feedstuff.

The digestibility of the ether extract of feedstuffs rich in fat is very high. This confirms the results of other studies (Arrington et al., 1974; Nehring et al., 1963). The latter, in their comparative studies with cattle, sheep, pigs and rats, found the highest average digestibility of the fat fraction with rabbits. This is in contrast with the other nutrients, where the rabbit always showed the lowest digestibility, compared with the animals of the above mentioned species. The possibility to enrich rabbit diets with high fat containing ingredients or with additional fats must certainly still be thoroughly examined. Especially because of the high (indigestible) crude fibre requirements (Lebas, 1975b; Spreadbury & Davidson, 1978), rabbit diets are generally low in ADE-content and, in consequence, they have a relatively unfavourable feed conversion.

The ADC of the ether extract of feedstuffs containing less than 2 % fat is also presented. With such low percentage present and a replacement level of 30-40 %, it is impossible to determine reliable ADC of the fat fraction with only six repetitions. Account must also be taken of the variability of the ADC, which is assumed to be high with rabbits, compared to other animals (Proto, 1964; Lebas & Colin, 1976). Restricted feeding by no means reduces the variability with growing rabbits (Fekete & Gippert, 1981; Duchenne, 1980).

The crude fibre of most feedstuffs, rich in crude fibre, is very badly digested (<15 %); consequently they fulfil extremely well their role of suppliers of indigestible crude fibre. Some feedstuffs appear to be exceptions thereto : beet pulp has been mentioned already by several researchers (Martinez & Fernandez, 1980; Lebas & Cheriet, 1981). However, also the crude fibre from corn glutenfeed, coconut meal, soybeans and, to a lesser extent, from cassava meal cannot be regarded directly as indigestible fibre. The composition of the crude fibre complex varies considerably from one feedstuff to another, although other methods of analysis (Van Soest) do not appear to be able to estimate the digestibility on the basis of the composition (Fekete & Gippert, 1981).

The ADE content of grapeseed meal and oat hulls is barely 700 kcal/kg d.m. Because of the presence of some readily digestible fat (4.8 %), the ADE content of flax chaff is about 300 kcal higher. These feedstuffs, rich in fibre, can consequently only be of value for rabbits, in order to satisfy their need for crude fibre, but account must be taken of the fact that they will reduce considerably the ADE content of the diet. Soya hulls, on the other hand, with an almost equal crude fibre content (32 %), with low digestibility, reduces the energy content to a much lesser degree.

The examined alfalfa meal had an ADE content of 1820 kcal/kg d.m. The energy content of beet pulp was comparable with those of oats and wheat shorts. Cassava meal and milo appear to be good suppliers of energy for rabbits too.

The difference between rapeseed meal and soya meal was over 400 kcal/kg d.m. to the advantage of the latter. The difference between the two varieties of rapeseed was about 150 kcal/kg d.m. The chemical composition between the two varieties differs clearly (crude protein : +6 % for "Erglu"; NFE : +6.5 % for "Jet Neuf"), but this cannot obviously fully explain the difference in ADE content in favour of the French variety. From this it appears that an increased glucosinolate content does not negatively influence the ADE content of rapeseed meal, which explains why rapeseed meal with high- (Lebas & Colin, 1977) as well as with low (Throckmorton et al., 1980) glucosinolate contents have been successfully used with growing rabbits.

The ADE values determined by us appear in most cases to be lower than those at present indicated in literature (Table 4). The differences can only be ascribed in part to the variability of the feedstuffs. Consequently, the experimental methodology adopted must likewise be considered responsible in part for the extreme values, which deviated by almost 50 % for certain feedstuffs (alfalfa meal, sunflower meal). The ADE value for alfalfa meal (1832 kcal/kg d.m.) mentioned in Table 4 (Duchenne, 1980) was obtained by furnishing alfalfa meal as the only feed. The same author obtained, by applying the Kellner substitution method (20 % starch by 20 % alfalfa meal), a much higher value (2616 kcal/kg d.m.). By extrapolation, from the calculated regression at 30 % and 50 % replacement, to 100 %, he finally again found a much lower value (1674 kcal/kg d.m.). This clearly illustrates the need for standardising methodology.

As regards the accuracy of the ADE content of the feedstuffs, the standard deviation was, on an average, 103 kcal/kg d.m. or 3.0 %. Here, too, account must be taken of the fact that when the ADE content of the raw material is calculated according to the difference principle, the error increases two- to threefold, depending upon the percentage of substitution. As long as that percentage is sufficiently high, it is possible to determine a satisfactory accurate ADE value, using six animals.

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Summary

In a series of digestibility trials with broiler rabbits, the apparent digestibility coefficients (ADC) and the apparent digestible energy content (ADE) of seventeen feedstuffs have been determined.

With the exception of alfalfa meal, the replacement level of the feedstuffs in the basal diet amounted to 30 % or 40 %. The composition of those feedstuffs as well as their ADE content, varied considerably (e.g. oat hulls : ADE = 680 kcal/kg d.m.; full-fat soybeans : ADE = 5085 kcal/kg d.m.).

The ADC of the protein fraction were between 75 % and 80 % for protein rich feedstuffs, with the exception of the coconut meal (57.7 %) and full-fat soybeans (88 %). The digestibility of the ether extract of feedstuffs rich in fat was very high.

In contrast with most of the feedstuffs, the crude fibre of beet pulp, corn glutenfeed, coconut meal, soybeans and, to a lesser extent, of cassava meal cannot be regarded as indigestible fibre.

The obtained values are compared and discussed in relation to methodology and other data form the literature.

Résumé

Les coefficients d'utilisation digestive apparente (CUDa) et la teneur en énergie digestible apparente (EDa) de 17 matières premières ont été déterminés au cours d'une série d'essais de digestibilité sur lapins de boucherie. A l'exception de la farine de luzerne, le pourcentage de remplacement de la ration de base par les matières premières étaient à raison de 30 % ou 40 %.

Aussi bien la composition que la teneur en EDa de ces matières premières différaient considérablement (p.e. : écorces d'avoine, EDa = 680 kcal/kg m.s.; graines de soja, EDa = 5085 kcal/kg m.s.).

Les CUDa de la matière azotée des matières premières riches en protéines, étaient entre 75 % et 80 %, sauf pour le tourteau de coprah (57,7 %) et les graines de soja (88 %). Par opposition à la plupart des matières premières, le fibre brute de pulpe de betteraves, tourteau de coprah, aliment de gluten de mais, graines de soja et dans une moindre mesure, de la farine de manioc ne peut pas être considéré comme lest.

Table 1. Replacement level of the feedstuffs in the basal diets

Feedstuff	Replacement level (%)
Alfalfa meal	20-40-60-99
Grapeseed meal	40
Flax chaff	40
Corn glutenfeed	40
Beet pulp	40
Oats	30
Wheat shorts	40
Soybean meal	30
Sunflower meal	40
Rapeseed meal, Jet Neuf (10mg VOT/g*)	40
Rapeseed meal, Erglu (1mg VOT/g*)	40
Coconut meal	40
Oat hulls	30
Soya hulls	30
Soybeans (full-fat)	30
Cassava meal	30
Milo	30

* VOT = (±) - 5 - vinyl - 2 - oxazolidinethione

Table 2. Chemical composition of the feedstuffs (% of d.m.) (analytical results)

Feedstuff	Dry matter DM	Crude protein CP	Ether extract EE	Crude fibre CF	Nitrogen free extr. NFE	Ash	Gross Energy kcal/kg
Grapeseed meal	85.96	11.85	0.41	51.05	32.86	3.83	5049
Oat hulls	87.26	2.38	0.72	37.88	54.52	4.50	4500
Flax chaff	90.20	7.00	4.81	42.97	34.78	10.44	4589
Soya hulls	90.24	14.92	3.70	35.63	40.30	5.45	4396
Alfalfa meal	91.55	16.03	3.05	28.56	40.77	11.59	4323
Beet pulp	89.94	8.57	0.74	15.55	63.14	12.00	3810
Oats	87.08	13.77	4.67	7.64	70.80	3.12	4600
Wheat shorts	86.32	18.28	4.65	8.97	62.36	5.75	4603
Corn glutenfeed	89.69	21.54	3.81	8.99	58.32	7.34	4500
Cassava meal	89.59	4.15	1.52	6.02	79.33	8.98	3967
Milo	87.45	11.03	3.92	2.34	80.85	1.85	4473
Coconut meal	91.45	20.60	11.84	14.01	47.01	6.53	4787
Rapeseed meal (Jet Neuf)	90.24	36.82	1.51	12.57	41.27	7.83	4591
Rapeseed meal (Erglu)	86.76	42.75	1.74	13.16	34.82	7.53	4728
Soybean meal	88.35	48.90	1.53	8.52	33.66	7.38	4661
Sunflower meal	89.33	33.38	1.10	27.62	30.67	7.23	4632
Soybeans (full-fat)	86.59	38.88	21.09	11.59	22.99	5.44	5592

Table 3. The apparent digestibility coefficients (ADC) and the apparent digestible energy content (ADE) of the feedstuffs

Feedstuff	ADC (%)							ADE(kcal/kg d.m.)	
	DM	OM	CP	EE	CF	NFE	GE	X	± s
Grapeseed meal	14.9	14.1	45.1	(125.5)	12.0	15.3	14.6	738	94
Oat hulls	14.9	15.0	24.5	92.9	11.7	15.2	15.2	683	142
Flax chaff	23.8	23.1	47.8	75.1	7.1	27.6	22.7	1042	104
Soya hulls	43.1	42.9	54.4	93.4	6.0	65.0	44.3	1946	115
Alfalfa meal	46.4	44.8	64.0	50.3	14.7	60.0	42.1	1820	89
Beet pulp	73.6	77.7	44.7	66.3	59.9	90.0	77.1	2939	89
Oats	65.6	67.5	72.6	80.4	(-6.2)	74.6	64.6	2970	141
Wheat shorts	63.5	64.2	75.3	84.3	18.4	64.5	63.4	2919	107
Corn glutenfeed	68.3	69.4	79.8	85.1	43.9	66.6	68.5	3085	56
Cassava meal	89.9	91.0	66.3	43.2	31.2	97.8	86.6	3433	59
Milo	76.4	76.5	54.6	95.9	(-25.7)	81.4	77.8	3480	66
Coconut meal	64.5	64.8	57.7	93.7	59.4	62.4	66.4	3182	196
Rapeseed meal (Jet Neuf)	66.4	68.6	76.3	95.8	8.7	78.5	68.6	3148	71
Rapeseed meal (Erglu)	59.8	62.1	77.3	71.0	11.2	63.0	63.3	2992	103
Soybean meal	74.3	73.9	79.4	61.6	(-1.7)	89.6	76.2	3550	95
Sunflower meal	49.0	49.8	75.5	84.1	4.6	62.0	51.7	2397	82
Soybeans (full-fat)	90.4	91.2	88.0	93.8	71.0	95.7	90.0	5035	129

Table 4. Comparison of the obtained digestible energy values with literature data

Feedstuff	This report	Jentsch e.a. 1963	Slade en Hintz, 1969	Martinez & Fernandez, 1980	Lebas & Cheriet, 1980	Cheeke e.a. 1982	Duchenne, 1980
Beet pulp	2939 (100)			3400 (116)	3330 (113)	3460* (118)	
Oats	2970 (100)	3092 (104)				3315* (112)	
Alfalfa meal	1820 (100)		2298 (126)	2400 (132)		2640* (145)	1832 (101)
Milo	3480 (100)					3740* (108)	
Sunflower meal	2397 (100)			3100 (129)			
Soybeans full-fat	5035 (100)	4437 (88)					
Soybean meal	3350 (100	3178 (90)					

* converted to d.m. basis (d.m. content of 89 %)