THE EFFECT OF METABOLIZABLE ENERGY CONCENTRATION ON PERFORMANCE AND DIGESTIBILITY IN GROWING RABBITS

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Growing rabbits in a simulated tropical environment were used in a growth trial and a balance trial. Experiment 1 involved 24, six week old, weaned male Californian (C) and New Zealand White (NZW) rabbits (weight, 1.11 kg) pair-fed diets formulated (using ruminant metabolizable energy values) to contain an M/D of 8, 10, or 12 ME MJ/kg DM. Crude protein was 160g/kg DM and ground wheat straw was the main fibre source. Diets were pelleted and fed ad libitum until slaughter at 2.2 kg live weight. Average daily weight gains were 24.41, 32.03 and 31.00 (SED = 1.24g) for 8, 10 and 12 M/D dicta respectively and breeds did not differ. Total DM consumption wee greater (PC 0.05) on the 8 MID diet. Carcass fat content differed with diet (P<0.01); rabbits on the 8 M/D diet had lower fee. In Experiment 2, the diets were fed individually and ad libitum to 12 male, 14 week old C rabbits (mean weight 2.16 kg) in metabolism crates. Total faeces were collected over 6 days. Digestibilities of crude fibre (0.07 + 0.05) and crude protein (0.77 + 0.04) did not differ between diets. Neutral detergent fibre digestibilities were different (P<0.05) 0.19, 0.32 and 0.44 (SED = 0.04) for 8, 10 and 12 M/D diets respectively. Metabolizable energy (digestible energy less urinary energy) contents (MJ/kg DM) were 6.80, 9.39 and 12.44 (SED - 0.33) The results indicate that despite low digestion of fibre, rabbit. will grow on a law energy intake. Ruminant metabolizable energy values, especially for fibrous foods, are likely to overestimate their values for rabbits.

Key words: Rabbit production, metabolizable energy, digestibility, rabbit growth, , feed intake

Despite its many apparent advantages there is little information on the meat rabbit. It is small, prolific and will eat both concentrates and roughages. Its small carcass can be eaten in one meal, presenting no conservation problems. These attributes are specially relevant to developing countries in tropical areas, providing its feed requirements would not compete for products used in human diets. Digestion of fibrous foods seems poor (Spreadbury 1975), but effects on growth and consumption are less clear.

The objective of this experiment was to assess growth, food consumption and carcass quality of growing rabbits kept under simulated tropical conditions and fed diets of different energy concentrations. A subsequent experiment assessed metabolizable energy.

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Materials and Methods

A growth trial (Experiment 1) and a balance trial (Experiment 2) were performed with growing rabbits kept in wire cages and housed in a simulated tropical environment, ie 25°C ambient temperature with a 12 hour day length. Humidity was not controlled and varied between 40 and 80 RH.

Experiment 1: Prior to weaning, rabbits were fed a standard ration, SG 1V (Short and Gammage 1959). After one week's adaptation, 24 six week-old, male, Californian and New Zealand White rabbits were pair-fed one of three diets (Table 1) in a 2 x 3 factorial design with 4 replicates. Rabbit pairs were of similar weights and were allocated to treatments at random.

Table 1:
Composition of pelleted diets (g per kg dry matter)

	Estimated metabolizable energy MJ/kg DM[1]		
	8	10	12
Ground wheat straw	609	368	128
Extracted soya bean meal	276	226	175
Ground barley	41	330	620
Molasses	50	50	50
Dicalcium phosphate	11	9	7
Limestone	10	12	14
Salt	0.7	1.5	2.3
Lysine	1.1	1.8	2.5
Methionine	1.1	0.8	0.5

[1] Based on values for ruminants (MAFF 1975)

Diets were computer formulated to provide 3 energy concentrations while keeping protein, lysine, methionine and vitamin/mineral fractions constant. Energy concentrations (MJ/kg DM)* were based on ruminant metabolizable energy (ME) values (MAFF 1975) at (1) 8 M/D, (2) 10 M/D and (3) 12 M/D. Ground wheat straw was the main fibre source.

The straw component was hammer-milled through a 2 mm screen. A particle size analysis (Tetlow 1974) showed a modulus of fineness of 2.20 and a modulus of uniformity of 0:5:5. Diets were steam-pelleted giving pellets approximately 6 mm in diameter, 9 mm in length. Coccidiostats or other medicants were not administered.

**Editors note*: In the metabolizable energy (ME) system of ration formulation, energy concentration (MJ/kg DM) of a ration is denotes by M/D.

Table 2:
Chemical analysis of diets (g per kg dry matter)

	Estimated metabolizable[1] energy MJ/kg DM		
	8	10	12
Dry matter	859	871	870
Crude fibre	225	163	76
Neutral detergent fibre	586	491	369
Acid detergent fibre	299	218	101
Crude protein	172	160	157
Ether extract	12	11	10
Ash	59	61	60

[1] Based on values for ruminants (MAFF 1975)

Diets were analysed (Table 2) by standard procedures (Association of Official Agricultural Chemists 1970; Goering and Van Soest 1970).

Food and water were available at all times, food consumption and liveweight were recorded twice weekly (Table 3). At 2.2 kg liveweight, rabbits were fasted for 6 hours before slaughter by neck dislocation. Gut contents, offal components and hot carcass weights were recorded (Table 4). After freeze-drying and mincing through a 3/8" (9 mm) screen followed by a 3/16" (4.5 mm) screen, carcasses and internal offal were chemically analysed. (Association of Official Agricultural Chemists 1970).

Experiment 2: 12 male, Californian rabbits of 13-15 weeks were individually fed 3 diets with 4 replicates per diet. Diets were fed ad libitum from before weaning at 5 weeks of age. Water was available at all times. Introduction into the balance cages was 14 days prior to collection, in 2 periods of 6 days with 6 rabbits in each Rabbits were weighed before and after collection periods. Refusals, urine and faeces were weighed daily. Food and refusal samples were oven-dried and urine and faeces freeze dried before being ground through a 0.8 mm screen for chemical analysis by standard procedures (Nijkamp 1969; Association of Official Agricultural Chemists 1970; Goering and Van Soest 1970).

Table 3:
Mean growth and food consumption values (Experiment 1)

	Estimated metabolizable energy of diet (MJ/kg DM)						SED between means	Significances[3]	
	8		10		12			Diet	Breed
Breed	NZW[1]	C	NZW	C	NZW	C			
No. of rabbits completing trial	3	4	3	4	4	4			
Initial weight (kg)	1.042	1.086	1.051	1.136	1.120	1.222	0.084[4]	NS	NS
Age at 2kg (days)	90	88	74	76	79	74	4.85[4]	P <0.05	NS
Mean daily[2] weight gain (g)	25.16	23.85	32.40	31.75	29.81	32.2	1.748[4]	P <0.05	NS
Total food[2] intake during trial (kg DM)	8.05	7.98	3.12	3.05	3.40	3.30	3.61[5]	P <0.05	NS
Mean food conversion ratio[2] (kg food DM/kg gain)	7.59	8.03	3.09	3.35	3.73	3.84			

[1] NZW = New Zealand White, C = Californian
[2] Data from start of experiment to first weight after reaching 2 kg
[3] No significant Diet x Breed interactions occurred
[4] SED between means with 4 replicates
[5] SED between means with 2 replicates

Results and Discussion

There were no obvious health problems caused by the warm environment. Rectal temperatures were normal.

Experiment 1 (Growth trial): 22 rabbits completed the trial.

Age at 2 kg was similar for both breeds. Diet had a statistically significant (P< 0.05) effect with rabbits on the 8 M/D diet reaching slaughter weight at a greater age than those on the other two diets (Table 3). Rabbits on the 8 M/D diet also consumed significantly (P <0.05) more total dry matter than those on the other two treatments (Table 3). From these two findings it is reasonable to conclude that the food conversion ratio is substantially poorer on the 8 M/D compared with the other two diets.

Diet has a statistically significant (P <O.Q1) effect on weight of gut contents (Table 4). A significant interaction (P< 0.001) occurred due to the gut contents being much larger for the NZW's than the C's on the 8 M/D diet , therefore overall breed and

Table 4:
Killing out % and weight of various organs at slaughter (Experiment 1)

	Estimated metabolizable energy of diet (MJ/kg DM)						SED between treatment means (4 replicates)	Significances		
	8		10		12			Diet	Breed	Diet x Breed
Breed	NZW	C	NZW	C	NZW	C				
No of rabbits completing trial	3	4	3	4	4	4				
Slaughter weight (kg)	2.107	2.079	2.046	2.064	2.083	2.082	0.030	NS	NS	NS
Killing out %	57.30	60.02	58.87	58.35	58.92	60.25	0.013	NS	NS	NS
External offal weight (g)	451	441	444	423	493	460	30.16	NS	NS	NS
Empty gut weight (g)	146	130	118	131	115	124	5.56	P <0.01	NS	P< 0.01
Weight of gut contents (g)	218	135	147	187	120	129	15.95	P<0.01	NS	P< 0.001
Pluck and miscellaneous organs' weight (g) [2]	114	138	110	102	112	107	23.7	NS	NS	NS
Liver weight	51.3	41.0	45.3	53.8	56.5	62.2	0.037	P<0.01	NS	P< 0.05

[1] Killing out % calculated as: $\frac{\text{Carcass weight}}{\text{slaughter weight} - \text{gut content's weight}} \times 100\%$

[2] Pluck + miscellaneous organs include heart, lungs, trachea, oesophagus, reproductive organs, blood, spleen

diet differences are not particularly meaningful. Empty gut weights differed between the 8 M/D diet and the other diets (P< 0.001) but again must be regarded cautiously due to a significant (P<0.01) diet/breed interaction.

Liver weights differed (P < 0.01) according to diet but there was a diet/breed interaction (P < 0.05).

Carcass fat percentage (Table 5) differed significantly according to diet (P< 0.001). Differences occurred between all diets at least at the 5% level of significance,

No statistical differences in internal offal composition were detected (Table 5).

Table 5:

Carcass and offal analysis of rabbits in Experiment 1

	Estimated metabolizable energy of diets (MJ/kg DM)						s^*	Significance		
	8		10		12			Diet	Breed	Diet x Breed
Breed	NZW[1]	C	NZW	C	NZW	C				
a) Carcass Analysis										
Mean carcass weight (kg)	1.083(3)[2]	1.178(3)	1.150(3)	1.084(4)	1.157(4)	1.183(2)	0.041	NS	NS	NS
Moisture[3]	711.1(3)	693.9(3)	674.5(3)	686.2(4)	682.3(4)	644.5(2)	2.16	$P<0.05$	NS	NS
Fat[3]	39.5(3)	43.3(3)	88.0(3)	78.7(4)	126.4(4)	124.4(2)	1.81	$P<0.001$	NS	NS
Protein[3]	179.0(3)	168.3(4)	171.2(3)	167.1(4)	180.5(4)	128.7(1)	2.00	NS	NS	NS
Ash[3]	38.2(3)	37.2(3)	38.8(3)	36.6(4)	38.9(3)	35.8(2)	0.812	NS	NS	NS
							0.2500	NS	NS	
Ash (acid soluble)[3]	3.4(3)	3.6(3)	4.6(3)	3.8(4)	3.7(4)	0.12(1)	0.2500	NS	NS	NS
b) Offal analysis							SED between means with 2 replicates			
No of replicates analysed	2	2	1	2	2	2				
Mean weight (kg)	0.036	0.254	0.270	0.274	0.297	0.304	22.13	NS	NS	NS
Moisture[3]	771.7	744.0	732.0	763.8	736.6	701.2	2.31	NS	NS	NS
Fat[3]	46.2	82.5	78.9	74.8	89.6	84.5	3.91	NS	NS	NS

[1] NZW = New Zealand White, C = Californian

[2] Figures in brackets indicate the number of replicates involved

* Because of the uneven replication in this table $\sqrt{s^2}$ has been given. To obtain the appropriate standard error for each treatment s should be divided by $\sqrt{n}$

[3] Values given as g/kg fresh matter

Experiment 2 (Balance trial) : Results of balance trial (Experiment 2) are shown in Table 6 . Agreement between rabbits within diets was good with the exception of crude fibre and acid detergent fibre digestibility coefficients. Digestibility coefficients for dry matter and gross energy were significantly different (P< 0.001) between diets, digestibility declined as fibre level increased and energy concentration decreased.

There was no difference in crude fibre digestiblities between diets. Digestibility ranged from -2.08% to 17.76% with 75% of values from 4% to 11%.

Neutral detergent fibre (NDF) digestibility declined as energy concentration decreased with differences at least at the 5% level of significance between all 3 diets.

Hemicellulose digestibility coefficients differed between all diets ($P < 0.01$).

Due to some small urine loss, two metabolizable energy (MJ/kg DM) figures are given (Table 6), calculated as follows:

$$1.\ ME = \frac{\text{gross energy intake} - \text{faecal energy} - \text{urinary energy}}{\text{dry matter intake}}$$

This is likely to slightly overestimate ME available to the rabbit (due to above mentioned urine loss).

Table 6:
Results of balance trial

	Estimated metabolizable energy of diet (MJ/kg DM)			SED (between means)	Significance between diets
	8	10	12		
Number of replicates	4	4	4		
Initial weight of rabbit (kg)	1.515	2.465	2.485	0.640	$P < 0.01$
Daily weight gain	21.0	20.2	19.9	4.043	NS
Intakes:					
Dry matter (kg)	0.873	0.786	0.539	0.063	NS
Gross energy (MJ)	16.32	14.81	10.25	1.304	$P < 0.01$
Digestibility (%)					
Dry matter	38.2	54.8	71.9	2.00	$P < 0.001$
Gross energy	38.6	55.9	71.8	2.71	$P < 0.001$
Crude fibre	7.3	8.4	.4.1	3.17	NS
Neutral detergent fibre	18.9	32.3	44.3	3.87	$P < 0.05$
Acid detergent fibre	9.4	17.2	0.50	3.67	$P < 0.05$
Hemicellulose	31.6	47.6	64.3	3.87	$P < 0.01$
Crude protein	75.6	75.8	80.6	19.9	NS
Digestible energy of diets (DE) (MJ/kg DM)	7.23	10.37	13.12	0.354	$P < 0.01$
Calculated metabolizable energy of diets (MJ/kg DM):					
DE minus urinary energy	6.80	9.39	12.44	0.331	$P < 0.01$
DE[1] x 0.81	5.50	7.61	10.08	0.227	$P < 0.01$

1 DE = digestible energy

2. ME = 0.81 DE, likely to underestimate ME available as caecal methane loss is less than rumen loss (Eriksonn 1952).

By using ME values for the complete diets obtained in this trial and ME values for the; concentrate components of the diets from the literature, the ME available to the rabbit from the wheat straw can he estimated. Using ruminant concentrate values (MAFF 1975), the straw ME (MJ/kg DM) values estimated for the rabbit were 2.20, 1.45 and 0.43 for diets 8 M/D, 10 M/D and 12 M/D respectively, while using poultry values (MAFF 1974) straw values for the rabbit were 2.98, 2.64 and 2.39 ME MJ/kg DM respectively. Using rabbit values calculated by Vanschoubroek and Cloet (1968) from digestibility coefficients, straw values were 2.88, 2.38 and 2.34 ME MJ/kg DM. Figures show that some fibre is digested by the rabbit. The balance trial indicated that the NDF fraction, in particular is partly digested.

Thus, although fattening rabbits fed a 61% wheat straw diet did not maintain daily ME intakes at a similar level to those on the other two diets, they did grow at a slow rate, consuming approximately 2.5 times as much total dry matter. To be economically viable, without allowing for increased labour and housing costs, the 8 M/D diet would have to be 40% of the cost of the other two rations.

In conclusion this trial supports earlier findings (Watson and Horton 1935; Spreadbury 1975) that rabbits cannot digest fibre to the same extent as ruminants. However, in their ability to digest some crude fibre and consume :large amounts of fibrous food, they are superior to poultry. These findings apply to pelleted diets. In a tropical situation pelleting is expensive or unavailable. With similar diets fed in unprocessed forms, palatability, selection and wastage will affect growth and efficiency. Therefore this is an important area for research.

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