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The Rate of Growth of Rats Maintained on Different Diets

by

T. W. WIKRAMANAYAKE AND G. D. HOOVER
Department of Physiology, University of Ceylon

The growth rate of black and white (hooded) rats which had been inbred in this department for over four years was found to be below the accepted standard of 2 to 3 g. per day. Their reproductive performance was also poor. Experiments were therefore designed to compare their growth on the stock diet used at that time with their growth on diets used in other laboratories. Albino rats of the Wistar strain imported from the Nutritional Laboratories, Coonoor, India, were also fed these diets and their growth compared with that of the hooded strain.

Experimental and Results

In all the experiments rats of approximately the same age and weight were kept in individual cages, given food and water ad libitum and their weights recorded twice weekly.

Experiment I

Four different diets were used. Two of them contained a cooked rice-legume mixture and the others bread and milk.

Diet A was the one used as a stock colony diet, consisting of a mixture of 80 parts of "home-pounded" rice and 20 parts of mixed legumes, to which was added dried full-cream milk (about 1 g. per rat per day) and fresh vegetables. The legumes used were green gram (Phaseolus aureus) and lentil (lens esculenta). The rice-legume mixture was cooked before feeding and mixed with a small amount of rice polishings. Boiled beef (about 2 g. per rat) was added twice weekly.

Diet B was the same rice-legume mixture as in Diet A but no milk or beef was added.

Diet C consisted of bread soaked in fresh cow's milk, along with fresh green vegetables.

In Diet D fresh milk of Diet C was replaced by dried full-cream milk which was mixed with a little water and rolled into pellets. The other constituents were the same as in Diet C.

The rats chosen were weanlings, about 3 weeks old and of the hooded strain. They were divided at random into the 8 groups, a, b, d, e, f, g, h and i. Group c consisted of older animals of the same strain which was fed for a longer period of time.

The results are given in Table I.

TABLE I

The rates of growth of hooded rats fed on rice-legume and bread-milk diets.

Diet	Number of rats in each group	Number of days of expt.	Mean initial weight	Mean final weight	Regression coefficient
			g.	g.	g./day
A	(*a*) 5 males	47	21	104	1.93
	(*b*) 4 females	47	19	94	1.75
	(*c*) 3 males	62	41	166	2.25
B	(*d*) 4 males	47	20	87	1.36
	(*e*) 4 females	48	16	83	1.20
C	(*f*) 5 males	47	19	173	3.48
	(*g*) 4 females	48	19	130	2.48
D	(*h*) 2 males	58	20	149	2.28
	(*i*) 2 females	58	20	116	1.93

Experiment II

Three diets were used, all composed of dry, uncooked ingredients.

Diet E consisted of cubes based on the formula for diet 41 (Bruce and Parkes, 1949) supplied by Messrs. Joseph Rank Ltd., London, and recommended for rats, mice and monkeys (Cassidy, 1957), and contained wholemeal flour, Sussex-ground oats, white-fish meal, dried yeast, dried skimmed milk, stabilised vitamins A and D, and trace-element supplement.

Diet F also consisted of cubes made from wheatmeal, coconut meal, lucerne meal, milk powder, wheat germ, dried activated yeast, bone flour, molasses, salt and stabilised Vitamins A and D_2 powder, supplied by W. D. Thompson & Co., Ltd., New South Wales, Australia. The exact composition of this diet is not available.

Diet G consisted of crushed maize and a dry powder, made up as follows :—

Maize meal	100 lbs.
Coconut poonac	20 lbs.
Dried meat	20 lbs.
Fish meal	15 lbs.
Rice bran	15 lbs.
Skimmed milk powder	20 lbs.
Mineral mixture	6 lbs.
Baker's yeast	6 lbs.

Albino rats were divided into three groups and maintained on these diets for 10 weeks. Diet F was also fed to hooded rats to enable a comparison of the rates of growth of the two strains.

The results are given in Table II.

TABLE II

Rates of growth of rats fed on dry uncooked diets.

Diet		Number of rats in each group	Number of days of expt.	Mean initial weight	Mean final weight	Regression coefficient
				g.	g.	g./day
E	(*a*)	4 males (albino)	71	35	246	3.08
	(*b*)	2 females (albino)	71	36	156	1.63
F	(*c*)	4 males (albino)	71	38	259	3.20
	(*d*)	4 males (hooded)	73	34	167	1.78
	(*e*)	2 females (albino)	71	37	163	1.73
	(*f*)	2 females (hooded)	73	29	128	1.29
G	(*g*)	4 males (albino)	71	41	203	2.33
	(*h*)	2 females (albino)	71	38	136	1.36

Experiment III

In a study of the effect of dietary lipid on liver lipids, comparable groups of rats, both albino and hooded, were fed purified diets. The basic diet consisted of casein (2.8 parts by weight), potato starch (2.5 parts), butter (0.5 parts) and 2 parts of the vitamin-mineral-roughage mixture used in previous experiments (Munro and Wikramanayake, 1954). This was mixed with either glucose (Diet H), lard (Diet I) or coconut oil (Diet J), 3 g. glucose, 1.17 g. lard or 1.34 ml. coconut oil being added to every 7.8 g. of the basic diet. In Diet H, proteins supplied 26% of the calories, carbohydrates 57% and fat 17%. In Diets I and J 31% of the calories were derived from carbohydrate and 42% from fat.

The animals were weighed twice weekly and the results are given in Table III.

Statistical analysis :

The significance of the differences between the rates of growth on the different diets was assessed by a comparison of the regression coefficients (Fisher, 1944). In no instance did the regression lines deviate significantly from linearity (calculation by means χ^2 tests).

Discussion

The results in Table I show that a more satisfactory growth was produced by the mixed Diet A than by a strict vegetarian diet such as Diet B. The difference between the regression coefficients for growth of sub-groups (*a*) and (*d*) and between sub-groups (*b*) and (*e*) are highly significant ($P < 0.01$). Baptist (1956) reports a growth rate of 1.9 g. per day on a

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TABLE III

Rates of growth of rats on purified diets.

Diet		Number of rats in each group	Number of days of expt.	Mean initial weight	Mean final weight	Regression coefficient
				g.	g.	g./day
H	(*a*)	4 males (albino)	36	51	178	3.45
	(*b*)	2 males (hooded)	36	51	167	3.15
	(*c*)	2 females (albino)	36	52	132	2.13
	(*d*)	2 females (hooded)	36	45	117	1.92
I	(*e*)	4 males (albino)	36	53	196	3.93
	(*f*)	2 males (hooded)	36	54	193	3.91
	(*g*)	2 females (albino)	36	51	148	2.57
	(*h*)	2 females (hooded)	36	47	148	2.08
J	(*i*)	4 males (albino)	36	53	199	3.93
	(*j*)	2 males (hooded)	36	53	186	3.75
	(*k*)	2 females (albino)	36	48	143	2.53
	(*l*)	2 females (hooded)	36	46	130	2.26

diet very similar to Diet A and of 2.1 g. per day on one containing no meat or milk or other animal protein but a higher proportion of legumes. However, the numbers of rats in the two groups differ considerably and, in the absence of statistical analysis of results, this difference in growth rate cannot be taken as significant. Diet C produced a significantly higher regression coefficient for growth than either Diet A or Diet B ($P < 0.01$). When the milk was given in the form of pellets (as in Diet D) the rate of growth was less satisfactory, though comparable with that produced by Diet A. Soaking the bread in milk probably ensures a higher proportion of the milk being ingested.

Table II compares the growth rates of rats maintained on a dry powdered mixture containing uncooked maize as the main ingredient with those of rats fed a pelleted diet. Groups (*a*) and (*c*) grew at a faster rate than group (*g*) ($P < 0.01$) and so did groups (*b*) and (*e*) when compared with group (*h*) ($P < 0.05$), showing that a powdered diet is less satisfactory than the pelleted ones. Comparison of the regression coefficients of groups (*a*) and (*c*) and of groups (*b*) and (*e*) showed that the two forms of the pelleted diets produced rates of growth which were not significantly different ($P > 0.5$).

The results in Table III clearly indicate that very high rates of growth could be obtained when the diet contains all the requirements in adequate amounts. These rates compare well with that of 28 g. per week obtained in temperate climates (Brown and Sturtevant, 1949). When a greater proportion of the calorie intake was derived from fat growth was faster than when carbohydrate was the major source of energy, even though the same increase in nitrogen retention is brought about by the addition of isocaloric amounts of carbohydrate and fat to an adequate diet (Munro and Wikramanayake, 1954). The food in Experiment III was available ad libitum and it is very probable that a greater amount of the diets I and J were consumed than of diet H due to greater palatability. The greater influence of fat on growth, however, was found with males only, the growth rate of females of both the albino and the hooded strains showing no significant differences when

maintained on Diets H, I and J. As the content of essential fatty acids in lard is high while that of coconut oil is negligible (Deuel, 1951) and as the amount in 0.5 g. of butter present in these diets would be insufficient to supply the optimal requirement of about 100 mg. per day for a growing rat (Cuthbertson, 1957), Diet I would be expected to produce a more rapid rate of growth than Diet J. However, a comparison of all the groups fed on these diets (Table III) show that the rates were similar, whether the fat consumed was lard or coconut oil. The duration of the experiment (36 days) was probably insufficient to show the effect of a deficiency of the unsaturated fatty acids.

A comparison of the rates of growth of the albino and hooded strains is found in Tables II and III. On a pelleted diet (Table II) the male albinos grew faster than the males of the hooded strain ($P < 0.01$) and a similar result was obtained with the females ($P < 0.02$). On the diets used in Experiment III, however, there was no significant difference between the rates of growth of samples from the two strains.

The diets used in Experiment I suffer from the disadvantage that they are wasteful as well as unhygienic, tending quickly to become stale when kept at our room temperature (28°—30°C), and being easily fouled by the animal. The powdered diet used in Experiment II is easily scattered and wasted and is also easily fouled in the cage. Further, the animals tend to pick out the larger grains, the rest of the powder falling more easily to the bottom of the cage from between their paws. The pellets, on the other hand, contain similar ingredients as the powdered mixture but these are well mixed and compressed into a hard mass to ensure that they are consumed in the desired proportion. They can be fed from a hygienic wire basket thus eliminating wastage as much as possible. Lane-Petter (1957) points out that the interaction of individual components in the mixture might be deleterious to the healthy growth of the animal, and suggests that at least a portion of the diet should be of unprocessed food where the composition of the diet is more likely to approximate the sum of the compositions of the ingredients. But interaction is also likely between components of a powdered mixture packed and stored at room temperature. The observation that the composition of a pellet might not always be the same, depending as it does on the variation in the quality of the cereal, fish meal etc., used by the manufacturers (Cassidy, 1957) would be applicable to a powdered, unprocessed diet as well.

The percentage of fibre in the pellets is high, ranging from 6 to 10% and the consumption of food diminishes with increase in indigestible matter in the diet. Further, the amount of nitrogen retained is proportional to the ratio of digestible energy to the digestible nitrogen (Sibbald et al., 1957). The pellets would therefore be less suitable for optimal growth than a bread and milk diet, and this is confirmed by results in Tables I and II.

For use as a stock diet the pelleted food is the most convenient and one that produces a satisfactory rate of growth. Diet G costs less than the pellets (Rs. 50/- to Rs. 55/- per cwt. as compared with Rs. 65/- to Rs. 70/- per cwt.) but the wastage is greater. The bread and milk diet produces a more rapid rate of growth and costs as much as the pellets but is unhygienic and inconvenient for feeding a large number of rats in one cage. For obtaining rapid growth in a few rats or of rats maintained in individual cages a bread and milk diet is the most satisfactory.

Summary

1. The rates of growth of rats, both of the black and white (hooded) and Wistar strains, maintained on various diets have been measured with a view to choosing a suitable stock diet.

2. A pelleted diet such as Diet 41 (Bruce and Parkes, 1949) is the most satisfactory for use as a stock colony diet from the point of view of growth, cost and cleanliness.

3. A cooked rice diet supplemented with legumes, beef and milk produces more rapid growth than one containing cooked rice and legumes but no animal protein.

4. Fat produces a more rapid rate of growth than an isocaloric amount of glucose when added to an adequate purified diet, when the food is made available ad libitum.

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