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## THE NUTRITION OF LABORATORY ANIMALS

*Chairman* : DR S. K. KON, *National Institute for Research in Dairying, Shinfield, near Reading*

### Modern ways of feeding laboratory animals

By W. LANE-PETTER, *Laboratory Animals Bureau of the Medical Research Council, Holly Hill, Hampstead, London, N.W.3*

There is a trend in the feeding habits of biologists—that is, in the way they feed their animals, not themselves—going back some 20 or 30 years. It starts with the homely methods of pet-keeping: for mice, bread soaked in milk with a handful of oats and an occasional lettuce or dandelion leaf; through the preparation of sticky mashes of various kinds, with or without supplements; the offering of dry powdered mixtures in little dishes or ingenious non-spill feeders; to the ideal of a compound cubed or pelleted diet, fed if possible without supplements from a hygienic wire basket, together with water from a bottle.

The sticky mashes have been beloved especially of commercial breeders. They are less laborious than a varied diet and demand no special food utensils in the cage, but they are wasteful and unhygienic. Powders have to be mixed on the spot at frequent intervals and are easily fouled in the cage, more easily scattered and wasted. They are also open to the objection that the animal can pick out what it likes and leave the rest; a drawback that is easy to exaggerate.

#### *Cubed diets*

The advantages of cubed and pelleted compound diets have been indicated by many workers, notably by Parkes (1945–6). Their convenience is great: under the right conditions their wastefulness is minimal: and the results of feeding them are often excellent. But that so many different cubed diets exist, and that with no one of them is there general agreement as to its completeness for the species for which it is prescribed, suggest that we are still some way from the goal of a perfect cubed diet, and perhaps even that the goal is an illusion.

Laboratory animals kept in hygienic cages are completely dependent on the food they are given for their sustenance; they are utterly unable to correct deficiencies by foraging. In this they differ fundamentally from farm animals and from human beings. (Intensively kept poultry and pigs are not really an exception to this rule, for it is unusual to breed from such stock.) If our knowledge of their nutritional requirements, or of the composition of the food as offered to them, is incomplete—and it is—we should regard ourselves as lucky if we can maintain them in health and productivity at all, not as unlucky when something goes wrong. We should

not be surprised if a diet suitable for rats proves a failure for mice and we must expect differences in the needs of different strains of the same species. If we impose the extra physiological strain of heavy productivity on our animals, which is what many breeders aim at, we must look out for signs of deficiency: we are not likely to be disappointed.

#### *Variability of diets*

The ingredients of different compound diets show remarkable variations. Diet 41 (Bruce, 1950), which, like all British laboratory animal diets, is made to a published formula, contains but six items. Rockland rat and mouse diet (Lane-Petter & Dyer, 1952), made like most American commercial diets to a secret formula, contains four times the number of ingredients in undisclosed amounts. There is undoubtedly safety in numbers because, as Plouvier (1953) has pointed out, with no one item bulking too large the final analysis is less at the mercy of one aberrant ingredient.

Cereals, which form the greater part of diets of laboratory animals, vary in their composition as between varieties, sources and seasons, and their variations will be reflected in the actual analysis of the compound diet. For example, diet 41 has a theoretical content of digestible protein based on mean values of 13.7% but if the known ranges of protein in the ingredients are taken into the calculation, the protein content of the diet could be anywhere between 12.9 and 19.4% (Table 1).

Table 1. *Possible range of protein in diet 41 (Bruce, 1950)*

Ingredient	Percentage in diet	Protein content	
		Minimum (%)	Maximum (%)
Wholemeal flour	46	3.2	6.2
Sussex-ground oats	40	3.6	6.8
Fish meal	8	4.88 (mean value)	4.88
Dried yeast	1	0.36	0.41
Dried skim milk	3	0.9	1.1
Total		12.94	19.39

The same is equally true of all other compound diets and not only in respect of protein: it may apply with more serious results to other components, including vitamins.

Moreover, the interaction of individual components in the compound cannot be overlooked; for example, the action of phytase in one ingredient on phytic acid in another. This may be a beneficial interaction, but others may not; for example, the oxidation of vitamin E by oxidizing agents with which it is brought into intimate contact. It cannot, therefore, be assumed that the composition of the compound diet is the sum of the compositions of its ingredients. Theoretical analyses are misleading; even periodic batch analyses would be very little better. To give a diet a formula and a name or number is to suggest, inevitably, a degree of standardization that is illusory. One batch may appear to resemble another, or may appear not to

change with keeping; but the appearance will often be deceptive. Thanks to the widespread use of compound diets with well-known names, we are perhaps further away than ever from standardizing one of the most important factors in the animal's environment, one we had thought to have successfully nailed.

*A biological approach to animal feeding*

It would be most convenient if we could treat an animal colony as an automatic machine. At one end we put in a hundredweight of diet X; at the other we draw out a hundred uniform animals. If this diet were complete in the fullest sense of the word, and there were no other (non-dietary) disturbing factors, this could theoretically happen. If the diet is not completely adequate in every nutritional requirement, even if it is uniformly incomplete, the slot machine ideal is unattainable, for a uniformly unsatisfactory environment will not produce uniform animals. When the environmental factor—diet—is both unsatisfactory and not uniform, the result is worse still. If this seems too gloomy a picture for the acceptance of those who have been breeding animals on the same compound diet for many generations, it is undeniable that no single compound diet has achieved anything approaching universal acceptance. After so many years' experience of their use, it might have been expected that one or two would have dominated the field, but this has not happened, in spite of the approval of so many workers for the undoubted convenience of this method of feeding.

Perhaps the convenience of the laboratory worker has received more consideration than the biological needs of the animal. Rats and mice and guinea-pigs and rabbits eat these confections, *faute de mieux*, but do they like them? Rats and mice are hardy animals, able to eat most things, equipped, like all animals, with an innate ability to distinguish between what is food and what is not. In nature this innate ability of animals to feed themselves, to make a choice within the limits of their circumstances, is essential to their survival. But the animal's innate ability to recognize what is good for it is not a perfect mechanism and it cannot apply to cubes or pellets or to anything else remote from what could occur in nature. The animal is not able to 'sense' protein, or phosphorus, or vitamin E, or whatever it is a little short of. Given a wide choice of ingredients in a form not far removed from that in which they might occur in nature—for example, whole grains, or pieces of meat or greenstuff—a healthy animal will pick out what it needs or likes, rejecting the rest. The observant keeper then continues to offer it what it chooses to eat and omits the rejected items. A deficient animal may have the ability to choose something that will quickly correct its deficiency: it may equally well suffer from a generally deranged appetite, which will lead it to eat anything and everything, a sort of blunderbuss autotherapy. Cannibalism, cage-chewing and sawdust-eating are sometimes manifestations of this kind.

*An alternative to cubed diets*

Cubes have not fulfilled all their early promise of success, and the multiplicity of formulas in current use makes one doubt if they ever will succeed completely.

Nor do they eliminate wastage. As much as 20% of a bag of cubes may be rendered unusable from powdering in the bag itself; a half-eaten cube may be drawn through the bars of the basket into the cage and abandoned, while the animal gets to work on a new one. The fragments get mixed up with the bedding or fall through the wire bottom of the cage, out of reach. All these may be faults in fabrication of the cube or of the baskets, but they are common faults, pointing to an inherent weakness in the system. Lastly, there is the question of palatability or acceptability. Why are the fragments pulled through the wires, abandoned and not eaten? Why do young guinea-pigs (especially) pick up pellets from the hopper and promptly drop them in the cages to seek, in vain, for something more to their taste?

All rodents will readily consume whole grains, and cereals must form a high proportion of their diet. The extra protein, from fish meal, skim milk and the like, can as easily be compounded in granules of similar size as in any other form, and be given alongside, in the same hopper. There is no difficulty about providing a suitable hopper for such a mixed diet; indeed, such hoppers have been in use in some laboratories for years.

This new approach to food presentation has many advantages, namely: (1) the quality of ingredients can be easily supervised in the laboratory; (2) the formula can be varied at will under laboratory conditions, so that (3) pilot experiments on different diets can be easily conducted, in which (4) the animal's ability to pick and choose to some extent can be observed and may assist in the devising of a really satisfactory formula; (5) the composition of the whole diet is more likely to approximate the sum of the compositions of its ingredients, for there will be less chance of interaction between ingredients; (6) acceptability or palatability is likely to be no less than in cubes, it might be greater.

### *Summary*

The modern habit of feeding cubed or pelleted compound diets, with or without supplements, is convenient but has certain disadvantages, which may be inherent in the system. The impression of standardization in named diets is unreliable, nor can it be assumed that the composition of a compound diet is equal to the sum of the compositions of its ingredients.

Further advance in the feeding of laboratory animals should pay more attention to the biological needs of the animal; this may mean including at least a proportion of unprocessed food, such as cereal grains, in the diet.

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