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SECTION D

ENVIRONMENT AND ANIMAL LIFE

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Albino rats are being extensively used in nutrition research and in India, a fairly large volume of work has been done using the rat as the experimental animal. Experience in India and elsewhere has shown that even under famine conditions, when rice gets scarce, the rice eater would not easily change over to any other grain. Hence the importance of nutritional studies with poor rice diets. The overall picture of rice diets, especially the purely vegetarian ones is that they are nutritionally poor and lead to different deficiency diseases. McCay (1912) and McCarrison (1932) did some pioneering work which pinpointed the low nutritive value of rice diet in general. Systematic rat-growth experiments designed to bring out the multi-deficient character of poor rice diet started with the classical experiments of Aykroyd and Krishnan (1937). Over the past two decades, a number of investigators have studied the effect of various supplements at different levels on the overall growth-promoting value of a poor rice diet (Moorjani and Subrahmanyan 1953).

The basal diet used by Aykroyd and Krishnan (1937) was evolved after extensive diet surveys. It consisted of raw polished rice, pulses, vegetables and negligible quantities of vegetable oil, cocoanut and meat. This composition was later modified by the Vanaspati Research Advisory Committee (1952) by including a little skimmed milk powder and common salt and increasing the proportion of oil. It has been pointed out by various workers that neither of these compositions contains some of the food components commonly consumed by the rice-eater like tamarind and chili (Krishnamurthi *et al.* 1948), buttermilk, 'pan' along with associated areca-nut and lime and such others. Even the proportion of salt is too low compared with what is normally consumed by the average South Indian (Moorjani and Subrahmanyan 1949). Still the original Aykroyd and Krishnan's composition, either as such or as modified by the Vanaspati Research Advisory Committee continues to hold sway as the standard for experimental studies.

Necessarily each experiment also included a group of rats on the control unsupplemented poor rice diet. The large mass of data collected by various workers, which has been reviewed by the present authors (Subrahmanyan *et al.* 1954) reveals wide variations in regard to the growth response. In the vast majority of cases, the growth rate has been of the order of 2-5 grams per week. A few freak growth rate values in the range 0-2 grams per week have also been recorded. At the other end of the scale, a number of values in the range 5-6 grams per week have been reported. A value of 9.7 gms. per week encountered by Sundarrajan (1950) at Coonoor merits special consideration. Such values indicate that, under certain conditions, the poor rice diet can promote a fairly high rate of growth.

Roundabout the autumn of 1953, consistently high rates of growth were observed on the poor rice diet in Mysore in the course of studies on supplemen-

tation with different samples of common salt (Subrahmanyan *et al.* 1953). Growth rates of the order of 6-7.5 gms. per week were obtained in the case of 4 groups of rats fed poor rice diet and a value of 8.7 gms per week in the case of another group. These large gains in weight might have been due to several factors, such as the variety of rice used in the experiments, seasonal changes in climate or variation in the stock colony of animals. An exhaustive programme of work was, therefore, initiated with a view to determine the effect of these different factors on the growth-promoting value of poor rice diet. A few animal feeding experiments have been reported in the literature on the effect of diverse factors on the nutritive value of rice—though none using the poor rice composition for the diet. It is relevant here to refer particularly to the work of McCarrison (1928) on the effect of environmental conditions during growing on the nutritive value of rice. He adduced experimental evidence to show that rice grown as a dry crop is superior in nutritive value to that raised as a wet irrigated crop. Sreenivasan and Sadasivan (1942), however, could not confirm this observation, in fact they obtained contrary results.

Experimental

Each group of animals used in these experiments consisted of at least eight weanling rats, usually the same number of males and females, equally distributed with respect to sex, weight and littermates. The period of feeding was invariably eight weeks. The composition of the diet was that recommended by the Vanaspati Research Advisory Committee (1952). The different varieties of rice were highly polished before incorporation in the diet. The animals were weighed weekly. In most of the experiments individual records of food consumption were maintained ; but, where this was not possible the food intake was measured for the group as a whole. The common salt, skimmed milk powder and *Tur Dhal* used in the diets all belonged to the same lot. The vegetables were dehydrated in bulk and equivalent quantities of the dehydrated material were incorporated in the different diets in order to rule out the possibility of day to day variations particularly in their calcium and oxalic acid contents.

Experiments Relating to the Effect of the Variety of Rice

Rat growth experiments were carried out with twentyfive varieties of rice grown in different agricultural farms in Madras and Mysore States. The result obtained with just seven of these varieties are presented in Table I. They show that slight varietal differences in the growth-promoting value of the poor rice diet do exist, but these are by no means large enough to completely explain the wide range of values one meets with in the literature—value as low as one gram per week, at one end of the scale and values as high as ten grams per week at the other.

Experiments Relating to the Effect of Stock Colony Variation in Animals.

Another factor which enters into consideration of rat growth on poor rice diet is the variation in the stock colony of animals at different centres. This is of indirect relevance to the seasonal factor in the sense that the innate capacity of any colony of animals to grow would depend not only on the previous state of nutrition of the animals or their mothers, but also on the environment in which they were bred and reared. Devadas and Sutton (1951) working at Ohio observed a growth rate as low as 0.9 gm. per week on a poor rice diet. The strange feature about this is that colonies of rats in the States usually have a

weaning weight of 60-70 grams and are reputed to be very much faster growing than the Indian colonies. The poor performance of animals belonging to an American colony on a poor rice diet is rather intriguing.

With a view to comparing the performance of rats from the Mysore Colony with that of rats belonging to another colony under identical environmental conditions, some weanling rats were obtained from Bangalore, divided into two groups and fed poor rice diet based on two varities of rice. Concurrently two comparable groups of rats from the Mysore Colony were also fed these diets. It was found that the rats belonging to the Bangalore colony consistently grew slower than the rats belonging to the Mysore colony on both the diets, thereby clearly showing that a definite stock colony variation exists vis-a-vis the rate of growth on the poor rice diets.

EXPERIMENTS RELATING TO THE EFFECT OF SEASONAL VARIATION IN CLIMATE.

Passing on to the effect of seasonal variations in climate on the growth promoting value of the poor rice diet, the point that needs emphasis is that both in 1953 and in 1954, sudden spurts in the rates of growth on the poor rice diet were observed roundabout the months of September and October, which mark the beginning of winter. The obvious inference was that a decrease in the environmental (or atmospheric) temperature would produce a favourable effect on the growth rate. According to the report of the Soya-bean Sub-Committee of the Nutrition Advisory Committee (1946) groups of rats at Coonoor which were fed supplemented as well as unsupplemented poor rice diet grew faster than corresponding groups at Lahore, Dacca or Bombay. This suggested that the cool climate of Coonoor all the year round exerts a beneficial effect on the growth rate. No such striking differences were, however, observed in the growth of groups of animals fed poor rice diet at Bangalore, Calcutta or Izatnagar in experiments carried out under the auspices of the Vanaspati Research Advisory Committee (1952). Interpretation of these results is rendered more difficult by the fact that nothing is mentioned in these monographs about the season of the year during which the different growth experiments were carried out. In a recent publication on the nutritive value of duck egg white, Dikshit and Patwardhan (1954) reported that the growth of rats on synthetic diet containing whole duck egg white or whole hen egg white varied according to the season of the year. The rates of growth were strikingly higher in experiments commenced in the month of March than in experiments commenced in other months. The authors suggest that egg white collected from eggs laid during March is superior in nutritive value to egg white collected from eggs laid during other months, presumably due to the availability of better poultry feeds. It, however, appears that a seasonal variation in the innate capacity of the rats to grow might also be one of the factors responsible for the observed results.

The problem of seasonal variation in the growth of animals fed poor rice diet was tackled in the first instance by following up the performance of rats on poor rice diet based on two varieties of rice (Kar and Rathnachudi) during different seasons of the year. Four sets of experiments have been carried out in this series and the results are presented in Table II. It can be seen from these results that the seasonal variation in the growth-promoting value of poor rice diet based on Rathnachudi rice is much greater than the seasonal variation in the growth promoting value of the poor rice diet based on Kar rice. Further the differences in the growth promoting value between the same two varieties are more pronounced in certain seasons than in others.

In the second set of experiments, the growth promoting values of four

varieties of rice were determined at two different season of the year. Of these four varieties of rice, the first two were higher in protein content than the other two. The results are presented in Table III. In the first experiment started in April 1954, it was found that the two high protein varieties (S-661 and S-139) promoted significantly faster growth than the two low protein varieties (S-749 and S-1092); there was, however, no significant difference in the growth rates of poor rice diets based on the two high protein or those based on the two low protein varieties, between themselves. On the other hand, in the second experiment started in January 1955, while there was general increase in the rate of growth on all the varieties, there were no significant varietal differences in the rates of growth as were observed in the earlier experiment. It is thus obvious that differences in the growth promoting value of poor rice diets based on two or more varieties of rice are greater in experiments carried out during certain seasons than in experiments carried out during others.

Finally an attempt was made to directly test the hypothesis that elevated environmental temperature might depress the rate of growth of animals. The performance of two comparable groups of animals fed poor rice diet based on the same variety of rice was compared, one group being maintained under atmospheric conditions (55°-70°F) and the other, in a room artificially heated by means of a couple of radiators to an ambient temperature of 92°-94°F. The results, presented in Table IV, show that an elevated environmental temperature does have a depressing effect on the rate of growth of animals fed poor rice diet.

SUMMARY

The wide variation observed in the growth-promoting value of poor rice diet is the cumulative effect of a number of factors, not the least important being seasonal variation in climate.

TABLE I

Growth-promoting value of seven varieties of rice grown in Madras and Mysore States.

Group Number	Variety of rice in diet	Protein content of rice %	Calcium content of rice mg. %	Average weekly growth (g)	Average daily food intake (g)
1	S-661	7.4	13.1	4.2	6.7
2	S-139	7.2	16.2	4.3	6.6
3	S-749	5.7	11.8	2.8	5.9
4	S-1092	5.8	8.7	2.6	5.8
5	CO-10	8.4	12.0	6.7	7.7
6	CO-13	6.8	9.6	6.6	7.9
7	PTB-10	7.7	17.5	6.0	8.4

TABLE II

Seasonal variation in the growth promoting values of poor rice diets based on Kar and Rathnachudi rice

Series number	Date of commencement of experiment	Variety of rice in diet	Average weekly growth (gm)	Average daily food in take (gm)
A ..	19-1-1955	Kar	6.4	7.6
A ..	19-1-1955	Rathnachudi	6.5	7.4
B ..	21-2-1955	Kar	6.0	6.9
B ..	21-2-1955	Rathnachudi	5.7	7.1
C ..	27-4-1955	Kar	6.2	7.6
C ..	27-4-1955	Rathnachudi	4.6	7.1
D ..	17-6-1955	Kar	5.7	7.2
D ..	17-6-1955	Rathnachudi	5.7	6.8
E ..	14-9-1955	Kar	6.2	7.3
E ..	14-9-1955	Rathnachudi	5.6	7.0

TABLE III

Growth promoting value of four Mysore varieties of rice at two different seasons of the year

Experiment number	Date of commencement of experiments	Variety of rice in diet	Average weekly growth (gm)	Average daily food intake (gm)
I ..	9-4-1954	S-661	4.2	6.7
I ..	-do-	S-139	4.3	6.6
I ..	-do-	S-749	2.8	5.9
I ..	-do-	S-1092	2.6	5.8
II ..	21-1-1955	S-661	5.3	6.9
II ..	-do-	S-139	6.5	7.1
II ..	-do-	S-749	5.6	7.1
II ..	-do-	S-1092	5.7	7.5

TABLE IV

Effect of environmental temperature on the growth-promoting value of poor rice diet.

Group number	Nature of environment	Average weekly growth (gm)	Average daily food intake (gm)
I	Atmospheric (55°-70°F)	6.6	8.0
II	Heated (92°-94°F)	5.3	7.4

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DISCUSSION

M. N. Rao

The nice work reported from India by the authors is in corroboration of the established fact that there is a seasonal variation in growth curves of animals including growing human beings.

When, therefore, any work is reported as by Coonoor Laboratories on the specific promotion of growth by any particular food factor like the duck eggs, the specificity can be established only when the known variable i.e. the seasonal effect on growth is accounted for in a statistically controlled experiment.

S. P. Agharkar

I wish to ask a question whether the age of the rice used in the feeding experiment has been taken into consideration. It is known that the process of maturation is taking place in nature as is evidenced by the germination percentage of paddy increasing progressively after harvesting. This factor may cause some variation in the results.

V. N. Patwardhan

Since a reference has been made to our observations on the difference in the nutritive value of duck egg white obtained at different seasons, I wish to state that according to us (my colleague and myself) there must be changes in the composition of the duck egg white depending upon the season when the eggs are laid; that is responsible for differences in nutritive value. It is not the alteration in the response of rats that could explain the latter.

H. S. R. Desikachar

Even in human beings, seasonal variation in growth are known, a greater increase in weight being observed during autumn. Changes in the basal metabolic rates and other endocrine functions are also observed. In growth studies it is very necessary to have adequate control group at all stages of the experiment.