Effects of Adding Penicillin and Aureomycin to the Diet of Cats

By CECILIA D. DICKINSON and PATRICIA P. SCOTT

Department of Physiology, Royal Free Hospital School of Medicine, London, W.C. 1

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Slow growth with respiratory and eye infections are the principal obstacles to rearing litters of kittens under laboratory conditions (Scott, 1952*b*). Remarkable increases in growth have been produced by the addition of antibiotics to the diet of piglets and chicks (Stokstad & Jukes, 1950). An increase in the appetite of kittens was observed in this laboratory after parenteral injections of therapeutic doses of penicillin G; it was therefore decided to study the effect of dietary penicillin and aureomycin on the growth of kittens. A preliminary communication has indicated that procaine penicillin potentiates their growth (Dickinson & Scott, 1953).

EXPERIMENTAL

Animal management

The kittens used in these experiments were from the inbred stock maintained in this laboratory. All had the same father. They were free from alimentary and ecto-parasites and in good health when selected for experiment. They were kept in rooms maintained at $70 \pm 2°$ F with an extraction ventilation system affording three to five changes of air per h. Groups of two to four kittens were kept together in specially designed cages (Scott, 1952*a*), in which there was sufficient space for exercise. Cardboard boxes were supplied as bedding, and baking tins filled with sawdust as dirt-trays, which were renewed daily. The cages were sterilized at regular intervals and clean cages were always provided at the beginning of each experiment.

The kittens were weighed each week on Monday, Wednesday and Friday. The experiments were carried out in the spring, summer and autumn.

Diet

Water was constantly available in automatic drinking vessels.

The analysis of the high-protein basal diet used in all experiments is set out in Table 1. It was made by Chappie Ltd, and canned in batches sufficient to last some weeks. A vitamin supplement (Bob Martin Ltd.) of the composition set out in Table 1 was given daily to each animal in the earlier experiments, but in the last it was mixed into the diet. Records were kept of diet consumption by each group of kittens. When antibiotics were added, the amount was calculated on the basis of the wet weight of the diet.

Experimental design

Exp. 1. Six kittens of a similar age from two litters were maintained on the basal diet after weaning. When they were about 14 weeks old they were divided into three groups, A, B and C, of similar total weight, each containing a kitten from each litter. Procaine penicillin (1 mg ≡ 1000 i.u.) was added to the diets at levels of 15 and 30 mg/kg.

The experiment was repeated with a further six kittens divided as before into three groups, D, E and F, but including a higher level of penicillin, 60 mg/kg.

Table 1. *Analysis of basal diet and composition of vitamin supplement*

Diet	Content	
Constituent	On wet weight (%)	On dry weight (%)
Water	72·3	—
Protein*	14·1	50·9
Fat	3·83	13·8
Total ash	2·53	9·1
Carbohydrate (by difference)	7·24	26·2

Calorific value 156 Cal./100 g diet

Daily vitamin supplement to each kitten†

Vitamin A (stabilized)	125 i.u.
Thiamine hydrochloride	93 μg
Riboflavin	0·1 mg
Nicotinic acid	0·5 mg
Liver concentrate	22 mg

* Derived: 70 % from fish origin, 25 % from liver and 5 % from cereal.
† Supplied in tablet form by Bob Martin Ltd.

Exp. 2. Twenty-three kittens from seven litters were divided into two balanced groups. They were weaned on to the basal diet at about 6 weeks of age. The control group (7 ♂, 4♀) was maintained on the basal diet throughout. The test group (5 ♂, 7 ♀) received the basal diet with the addition of procaine penicillin, 30 mg/kg, for 6 weeks.

Exp. 3. Eight kittens from four litters were divided into two groups; the first group received the basal diet with 30 mg procaine penicillin (≡ 3000 i.u.)/kg, and the second group received the basal diet with an equivalent amount of the sodium salt of penicillin G, i.e. 18·2 mg (≡ 3000 i.u.)/kg. After a period of 2½ weeks both groups were put back on the basal diet.

Twelve more kittens from three litters were divided into three groups; the first received a supplement of 30 mg procaine penicillin/kg, the second a supplement of 30 mg aureomycin hydrochloride/kg, and the third the basal diet alone, thus acting as control. This test was carried out for 3 weeks.

RESULTS

The results of Exp. 1 are shown in Table 2, from which it can be seen that the additions of penicillin, at all of the levels used, produced an increase in the weight gain over the controls. Withdrawal of penicillin was accompanied by a decline in weight gains and sometimes by weight losses.

Table 2. *Exp.* 1. *Mean weight changes of kittens receiving various dietary levels of penicillin*

Group*	Penicillin (mg/kg wet diet)	Mean daily weight change (g)	Penicillin (mg/kg wet diet)	Mean daily weight change (g)	Penicillin (mg/kg wet diet)	Mean daily weight change (g)
	Weeks 1–3		Weeks 4–7		Weeks 8–9	
A	30	+20·0	0	+ 4·5	0	− 1·6
B	15	+19·4	0	− 0·4	0	+ 6·0
C	0	+17·0	30	+14·9	0	− 4·7
	Weeks 1–4		Weeks 5–7		Week 8	
D	60	+23·8	0	+12·9	30	+21·9
E	30	+28·1	0	+12·9	60	+21·9
F	0	+21·7	30	+16·9	0	+ 7·8

* Each group contained two kittens.

Table 3. *Exp.* 2. *Effect of penicillin in the diet on the growth of kittens from* $7\frac{1}{2}$ *weeks of age*

Diet	Mean weight at beginning of experiment* (g)	Mean weight after 6 weeks on diet* (g)	Mean weight gain* (g)	Mean daily weight gain (g)	Mean daily food intake* (g)	Weight gain/100 Cal. diet (g)
Basal	650 ± 25(11)	1027 ± 47(8)	428 ± 43·6(8)	10·2	110 ± 4·4(8)	5·95
Basal + 30 mg procain penicillin/kg diet	656 ± 17(12)	1366 ± 28(12)	710 ± 29·9(12)	16·9	139 ± 4·0(12)	7·80

* Value with its standard error. Number of animals given in parentheses.

This finding suggested that it would be desirable to carry out a test with a larger group of younger kittens, with procaine penicillin at a level of 30 mg/kg of wet weight of diet. The results of such a test, Exp. 2, are shown in Fig. 1 and Table 3.

The mean daily weight gain of the group on the basal diet alone was 10·2 g, whereas that for the group receiving penicillin was 16·9 g, over the 6 weeks of the test. The increased weight gain was statistically significant at the level $P < 0{\cdot}001$. Moreover, although the mean food intake of the group receiving penicillin was greater (139 g/day against 110 g), the mean weight gain per 100 Cal. of food ingested was relatively higher still (7·80 g against 5·95 g), showing a greater efficiency of conversion.

The animals receiving penicillin were active, playing at regular intervals even though confined to cages, and remarkably healthy through the whole test period of 6 weeks. Those in the control group were noticeably less so and their general health was not so satisfactory, although the cages were kept side by side; some had to be temporarily isolated for eye and low-grade respiratory infections, and three had to be eliminated from the experiment after $4\frac{1}{2}$, 5 and $5\frac{1}{2}$ weeks respectively because of more serious respiratory infections. Hence the drop in the number of control animals shown in Fig. 1.

The results of Exp. 3 are summarized in Table 4. The increases in weight were similar in all groups receiving antibiotics, and the difference between the mean gains was not statistically significant. When the supplements were withdrawn these groups showed a slight temporary loss in weight, as noticed previously.

Table 4 shows that supplementation of the basal diet with aureomycin seemed to produce a somewhat greater gain in weight than with procaine penicillin, but the difference was not statistically significant. However, it can be seen from the standard

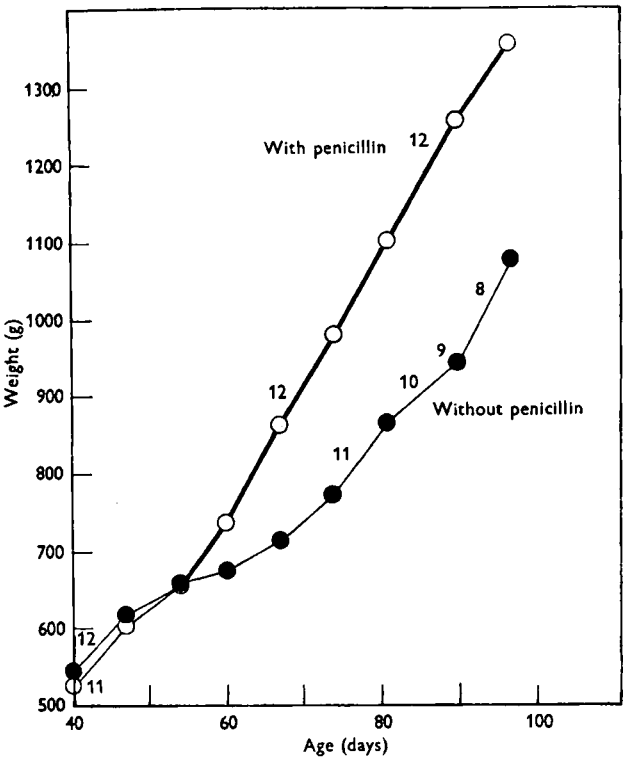

Fig. 1. Effect of the addition of procaine penicillin at the rate of 30 mg/kg diet (wet weight) on the weight gain of kittens. The numbers on the curves indicate the number of animals from which the means were derived.

Table 4. *Exp.* 3. *Comparison of the effect of procaine penicillin, sodium salt of penicillin G, and aureomycin in the diet on the growth of kittens*

Antibiotic supplement	Initial mean weight* (g)	Final mean weight (value with its standard error) (g)	Mean gain in weight (value with its standard error) (g)	Mean gain in weight/day (g)
Penicillin G	819†	1189±45‡	370±21	21·1
Procaine penicillin	816†	1138±41‡	322±36	18·4
Aureomycin	725§	1108±42‖	383±31	18·2
Procaine penicillin	725§	1054±110‖	329±84	16·1
None	743§	940±94‖	197±46	9·4

* Each group contained four kittens.
† At 10 weeks. ‡ After 2½ weeks.
§ At 9 weeks. ‖ After 3 weeks.

errors that the variations in the group receiving penicillin were much greater owing no doubt to the fact that two of the kittens in this group developed a slight respiratory

infection. The control group was also affected, but the group receiving aureomycin showed greater resistance.

The effect of very small concentrations of penicillin G (0·012 units/ml.) on the ability of young cat-tissue homogenates to utilize certain substrates was kindly investigated for us by Dr Brenda E. Ryman, using the Warburg technique. The oxygen consumption of brain tissue respiring in a medium containing pyruvate at a concentration of 0·055M was found to be unaffected by the presence of penicillin at this concentration; likewise, homogenates respiring with 0·011N-succinate as substrate showed no marked effect.

The oxygen consumption of rat-liver and pigeon-liver homogenates, utilizing substrates containing 0·1N-glucose and 0·0167N-citrate respectively, showed no change in the presence of penicillin.

DISCUSSION

Under the conditions of our experiments the addition of either penicillin or aureomycin to the diet of kittens produced considerable increases in growth and a lowered variation within the groups. Saunders (1953, personal communication) obtained somewhat variable results on adding penicillin to his standard diet for kittens, but this may have been due to the fact that he used older kittens in some of his experiments. We have observed that the growth-promoting effect of antibiotics becomes less noticeable as the kittens approach maturity. Moreover, we have found that aureomycin given by mouth to suckling kittens receiving mother's milk only, from birth to 2 weeks of age, is without effect on growth.

The final size attained by the cats was the same whether they had received antibiotics or not, but the time taken to reach the weight at which these animals become sexually mature ($2\frac{1}{2}$ kg in females and 3 kg in males) was very much reduced. The animals that had received antibiotics were capable of normal reproduction and in some of the females the first oestrous period occurred very early (at about 5 months).

It might be thought that the increase in size of the kittens receiving antibiotics was merely due to their increased food intake, but in fact, the efficiency of conversion of food was much higher in these animals.

It has been suggested that the growth-promoting properties of some antibiotics may be due to their action upon certain tissue enzyme systems, but the experiments carried out by Dr Ryman (see above) indicated that small amounts of penicillin had no direct effect on the metabolism of brain- or liver-tissue homogenates.

In studies on the effect of antibiotics in the diet of turkey poults Wilson (1952) commented on the marked improvement in the health of these animals, which are normally difficult to rear. Respiratory and eye infections give rise to similar difficulties in rearing kittens in the laboratory (Scott, 1952*b*; Carvalho da Silva, 1950). The improvement in health and vigour of the kittens receiving antibiotics in their diet was the most notable feature of the experiment and was commented on by all those who saw the experiment in progress. The clear bright eyes and the absence of the normally prevalent conjunctivitis from the kittens receiving antibiotics were very noticeable.

This improvement in health could be explained in more than one way. The antibiotics, although present in very low concentrations, may have a direct effect on pathogenic organisms. Carrère & Roux (1951) found that terramycin, given by mouth to three kittens 1 month old, resulted in the disappearance of *Bacterium coli*, coliforms and *Streptococcus faecalis alcaligenes* from the faeces, leaving only Gram-positive cocci. These authors did not, apparently, observe any growth potentiation and give no precise information as to the dietary régime they used. Alternatively it is possible that a rise in antibody production, resulting from increased food intake, may have resulted in an increased resistance to infection.

SUMMARY

The addition of penicillin and aureomycin to a diet containing 50% protein, mostly of animal origin, produced increased growth in kittens, accompanied by increased food intake and increased efficiency of food conversion, greater freedom from infection and an improvement in general health.

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