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Antibiotics and Endocrine Stimulants as Promoters of Growth in Fattening Pigs

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Barber, Braude & Mitchell (1953) reported that the growth-promoting effect associated with the feeding of an antibiotic to pigs was enhanced when it was fed together with small amounts of L-thyroxine and stilboestrol. In order to investigate these findings further, experiments were arranged at the following four centres: the

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Agricultural Research Council's Field Station, Compton; the Rowett Research Institute, Bucksburn; the Harper Adams Agricultural College, Newport; and the Research Institute of Northern Ireland, Hillsborough. After the experiments at Compton and the Rowett had begun Barber *et al.* (1954) produced at the National Institute for Research in Dairying, Shinfield, near Reading, preliminary evidence suggesting that stilboestrol could be omitted from the supplement without markedly impairing the effectiveness of the combination. Furthermore, as some adverse effects, due apparently to the use of stilboestrol, were encountered at both Compton and the Rowett, the original uniform plan of the experiment was altered to include a comparison of treatments with an antibiotic and L-thyroxine, and with an antibiotic and L-thyroxine and stilboestrol. (For brevity, the five centres will be referred to as Compton, Rowett, Harper Adams, Hillsborough and Shinfield.)

METHODS

Experimental procedure. Table 1 gives the experimental treatments used at the five centres.

Table 1. *Treatments (indicated by ×) used for the pigs at the five centres*

		Experimental treatments								
Centre*	No. of pigs in each group	Control (C)	Thyroxine (T)	Thyroxine +stilb-oestrol (TS)	Aureo-mycin (A)	Peni-cillin (P)	Thyroxine+ aureomycin (TA)	Thyroxine + penicillin (TP)	Thyroxine+ stilboestrol+ aureomycin (TSA)	Thyroxine+ stilboestrol+ penicillin (TSP)
Compton	6	×	—	×	×	×	—	—	×	×
Rowett	5	×	—	×	×†	×	—	—	×	×
Shinfield	9	×†	×	—	×	×†	×	×†	—	—
Harper Adams	5	×	—	—	×	—	×	—	×	—
Hillsborough	6	×	—	—	×	—	×	—	×	—

C: for composition of the control diets see Table 2.
T: thyroxine was included as sodium L-thyroxine pentahydrate (Glaxo Laboratories Ltd), supplying 0·3 mg thyroxine/lb. diet.
TS: as under T, but with diethylstilboestrol added at the rate of 6 mg/lb. diet.
A: aureomycin in the form of Aurofac 2A (Lederle Laboratories Inc.) was mixed in the ration at the rate of 18 g aureomycin/ton.
P: penicillin in the form of procaine penicillin was mixed in the ration at the rate of 18 g/ton.
TA: treatments T and A combined.
TP: treatments T and P combined.
TSA: treatments TS and A combined.
TSP: treatments TS and P combined.
* The pigs were fed individually, except at Compton where they were group fed.
† Results for one pig had to be excluded for reasons not connected with the treatment.

The routine adopted was the same, except for small details, at all centres. Only castrated male pigs were used except at Shinfield where, as stilboestrol was not employed, pigs of both sexes were included. Each experimental unit consisted of litter-mates, one pig from a unit being allocated to each treatment; all the pigs receiving the same treatment were housed together in one pen. The initial weights of the pigs within each experimental unit were similar, but there was considerable variation between the initial weights of pigs in different units and also between centres (cf. Table 3). Individual feeding was practised at all centres except Compton, where group feeding was employed. The pigs were fed twice daily. The food allowance

was based on a 10% increase in the live-weight scale for fattening pigs used by Braude & Mitchell (1950–1), except at Compton where the pigs were fed to appetite, though their maximum intake did not exceed that of the scale used in the other centres. The dry meals were mixed with water immediately before feeding, 3 lb. water being added to each lb. meal. Each centre used its normal ration for fattening pigs except for the experimental supplements, which were standardized. Details of the diets are given in Table 2. The experimental period lasted until the pigs reached about 210 lb. live weight, except at Shinfield where it was limited to 17 weeks, when the pigs were sold for slaughter.

Table 2. *Percentage compositions of the diets given to the pigs*

	Compton		Rowett				
Ingredient	Up to 20 weeks of age	Over 20 weeks of age	Up to 100 lb. live weight	100–200 lb. live weight	Shinfield	Harper Adams	Hills-borough
Barley meal	40	55	43	47	30	30	37
Wheat offals	40	20	10	12	50	50	25
Flaked maize	10	10	15	15	10	10	20*
Fish meal	7·5	—	7	2	10	10	10
Grass meal	2·5	5	5	3	—	—	3
Ground oats	—	10	15	15	—	—	—
Extracted decorticated groundnut meal	—	—	4	4	—	—	5
Minerals	†	†	1‡	2§	‖	—	‖

* Maize meal.

† Plus 44 lb./ton of minerals consisting of 3 parts ground chalk, 1 part steamed bone flour and 1 part salt.

‡ Composed of 103 parts ground limestone, 103 parts salt, 227 parts Adisco (Isaac Spencer & Co., Aberdeen) (containing 1000 i.u. vitamin A and 200 i.u. vitamin D/g).

§ Composed of 66·5 parts ground limestone, 190 parts sterilised steamed bone flour, 75 parts salt, 113·5 parts Adisco.

‖ A small amount of cod-liver oil was added once weekly directly to the troughs.

Biometrical methods. The variations in the number of days in the fattening period and in the food consumed, caused by differences between pigs in initial and final weights, were allowed for by interpolation on the growth curves (for final weight) and by regression analyses (for initial weight). The independent variable in these regression analyses was the initial weight, separate analyses being carried out for each treatment at each centre; the regression coefficients obtained in these analyses were averaged over treatments within centres and the pooled coefficients were used to correct the number of days and the food consumption to a constant initial starting weight. Missing values, caused by the death or removal of some pigs, were estimated by minimizing the within-pen variance. The corrected and completed values for the number of days and for the food consumed were analysed centre by centre in suitable analyses of variance.

The effects of the treatments with aureomycin and with L-thyroxine and aureomycin were compared from the results obtained at Shinfield, Harper Adams and Hillsborough, and the treatments with aureomycin and with L-thyroxine and stilboestrol and aureomycin were studied in the results for Compton, Rowett, Harper Adams and

Hillsborough. In these analyses the interactions between the centre and the treatment were compared with the within-centre residuals, and as in both analyses the interactions were significantly large they, rather than the residuals, were used to test the effects of treatment.

RESULTS

The results obtained at each centre, together with the relevant details of the statistical analysis, are given in Tables 3 and 4. These tables also contain pooled results for treatments carried out at several centres.

Table 3. *Mean daily live-weight gain (lb.) of the pigs at the different centres and on the different treatments*

Centre	Initial weight (lb.)	Treatment* C	T	TS	A	P	TA	TP	TSA	TSP	z test, level of significance (%)	Standard error of each treatment mean
1, Compton	49·6	1·53	—	1·53	1·68	1·62	—	—	1·51	1·63	>20	0·071
2, Rowett	33·5	1·13	—	1·18	1·30	1·28	—	—	1·26	1·28	0·1	0·022
3, Shinfield	45·4	1·19	1·25	—	1·35	1·32	1·44	1·37	—	—	1·0	0·042
4, Harper Adams	56·1	1·14	—	—	1·12	—	1·10	—	1·25	—	>20	0·050
5, Hillsborough	39·8	1·40	—	—	1·41	—	1·48	—	1·57	—	0·1	0·021
3+4+5	—	1·24	—	—	1·29	—	1·34	—	—	—	20	0·039
1+2+4+5	—	1·29	—	—	1·37	—	—	—	1·40	—	>20	0·040

The effects of variations within centres in initial and final weights have been removed as described in the text, p. 193. The z test (Fisher, 1950) refers to the overall comparison between the treatment means. The standard errors for the individual centres were estimated from the within-treatment variation, but those for the pooled analyses were obtained from the centre × treatment interaction.

* See Table 1.

Table 4. *Mean efficiency of food utilization (lb./lb. live-weight gain) of the pigs at the different centres and on the different treatments*

Centre	Initial weight (lb.)	Treatment* C	T	TS	A	P	TA	TP	TSA	TSP	z test, level of significance (%)	Standard error of each treatment mean
1, Compton	49·6	3·06	—	3·08	2·85	2·97	—	—	3·10	3·01	—	—
2, Rowett	33·5	3·77	—	3·58	3·37	3·46	—	—	3·54	3·35	0·1	0·061
3, Shinfield	45·4	3·66	3·57	—	3·60	3·56	3·57	3·55	—	—	10	0·025
4, Harper Adams	56·1	3·73	—	—	3·73	—	3·93	—	3·43	—	1·0	0·075
5, Hillsborough	39·8	3·26	—	—	3·33	—	3·19	—	2·94	—	0·1	0·054
3+4+5	—	3·55	—	—	3·55	—	3·54	—	—	—	>20	0·044
1+2+4+5	—	3·43	—	—	3·30	—	—	—	3·23	—	>20	0·090

The effects of variations within centres in initial and final weights have been removed as described in the text, p. 193. The z test (Fisher, 1950) refers to the overall comparison between the treatment means. No significance tests were possible on the Compton results because individual feeding was not used. The standard errors for the individual centres were estimated from the within-treatment variation, but those for the pooled analyses were obtained from the centre × treatment interaction.

* See Table 1.

At Compton and Rowett, which used the same treatments, there was a stimulation of growth due to the inclusion of antibiotics in the diet. The stimulation obtained at Compton was, however, not significant. The efficiency of food utilization was significantly improved at the Rowett, but statistical analysis of the Compton results was not possible because group feeding was employed there. In both centres the combination of antibiotics and L-thyroxine and stilboestrol produced no significant effect

above that recorded for antibiotics alone. The L-thyroxine plus stilboestrol treatment gave no response whatever at Compton, but a slight improvement in both growth rate and the efficiency of food conversion was recorded at Rowett.

The results from Harper Adams and Hillsborough, where only three of the treatments used at Compton and Rowett were replicated, were not the same as those just described. At Harper Adams and Hillsborough there was no stimulation of growth due to feeding an antibiotic, but there was a significant improvement when L-thyroxine and stilboestrol were fed together with the antibiotic. A significant stimulation with L-thyroxine plus antibiotic (without stilboestrol) was recorded at Hillsborough but not at Harper Adams. The results for the efficiency of food utilization were very similar to those for the rate of growth.

At Shinfield the rate of growth was significantly increased by the feeding of antibiotics, and by the addition of L-thyroxine to the diet; these two effects appeared to be additive. The overall test for treatment differences in the efficiency of food utilization gave a non-significant result, but it appeared that all treatments gave somewhat better results than the control.

In the between-centre analyses described above, in which the effects of some of the treatments at several centres were compared, although interactions between treatments were significant, the pooled treatment differences were not.

At Compton in the 2nd week of the experiment, five pigs receiving the treatment with L-thyroxine and stilboestrol became ill, and within a short time three of them died. The signs encountered have been described fully by Taylor & Gordon (1955), who, after some additional investigation, attributed them to stilboestrol poisoning. At Rowett, two animals appeared to be similarly affected, but after a few days of isolation they recovered. No similar cases were observed at Harper Adams, Hillsborough, or in the previous experiments in which stilboestrol was used at Shinfield.

DISCUSSION

The main difficulty in the interpretation of these results is the marked variation in response to a given treatment at the different centres. No doubt this variation was to some extent due to the use of animals of different origin and of diets of different composition. The prevalence of virus pneumonia in most of the centres may also have had some adverse effect on the uniformity of the results.

Although in two out of the four centres the results of Barber *et al.* (1953), pointing to the possibility of enhancing the growth-promoting effect of antibiotics by feeding them together with L-thyroxine and stilboestrol, were confirmed, we do not think that such a treatment merits further consideration because of the possibility of stilboestrol poisoning (Taylor & Gordon, 1955). The toxicity of stilboestrol needs further investigation.

When stilboestrol is left out of the combination, it appears that under the conditions of two out of three centres a significant improvement in the rate of growth may be obtained by adding L-thyroxine to diets containing an antibiotic, over and above the improvement obtained with the antibiotic alone. Further experimental work is needed to confirm this result under practical conditions.

SUMMARY

1. A co-ordinated experiment involving 154 pigs in five centres was carried out in order to establish whether the growth-promoting effect associated with the feeding of an antibiotic with a normal fattening diet was enhanced when the antibiotic was supplemented with L-thyroxine alone or with stilboestrol.

2. Marked variation in response to a given treatment was recorded at the different centres. In one of the centres toxic signs were observed, apparently associated with the feeding of stilboestrol, and the advisability of using the substance for promoting growth is thus open to doubt. In two out of three centres a significant growth response was obtained by adding L-thyroxine to diets containing an antibiotic.

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