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Thyroxine, Stilboestrol and Antibiotics in Rations for Castrated Male Pigs

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The experiment reported in this paper was one of a series undertaken by various research stations on behalf of the U.K. Agricultural Research Council and co-ordinated by Dr R. Braude. A summary of all these experiments has been published (Braude, Campbell, Lucas, Luscombe, Robinson & Taylor, 1955), but it was impracticable to include in this summary all details of results obtained and opinions expressed by each research station, and we give our results in more detail in this report.

Braude (1950) described four experiments on feeding iodinated casein and stilboestrol to castrated male pigs. The results were more promising than in former experiments when iodinated casein and stilboestrol were fed separately. Later Barber, Braude & Mitchell (1953) reported that the inclusion of 0·3 mg L-thyroxine pentahydrate and 6 mg stilboestrol/lb. meal resulted in a 6·4% increase in growth rate over that of unsupplemented controls. A supplement of 5 lb. Aurofac 2A (Lederle Laboratories Division, Cyanamid Products Ltd, London) per ton of meal resulted in a 12·0% increase in growth rate, but when L-thyroxine pentahydrate and stilboestrol and Aurofac were all included in the same ration the positive growth response was 21·2%, with a 10% advantage in food conversion efficiency. The objects of the experiment reported here were:

(1) To confirm the observation that a combination of thyroxine, stilboestrol and aureomycin in rations for castrated male pigs produces a growth response considerably greater than that induced by aureomycin alone.

(2) To extend the observations by studying the effects of rations containing procaine penicillin and procaine penicillin with thyroxine and stilboestrol.

EXPERIMENTAL

Housing. Six wooden ark huts were used, each having a small run on concrete. Each unit of hut and run was fitted with eight individual feeding compartments.

Pigs. Six castrated males were taken from each of eight litters. The pigs were about 9 weeks old at the beginning of the experiment.

Litters A and D were pure-bred Wessex Saddleback hogs, and litter E was by a Wessex Saddleback boar out of a Large White sow. These litters were bred at the Institute. Their conditions of health and appearance at the beginning of the experiment were good.

Litter F was pure-bred Large White. It was purchased from a commercial pig breeder and the health and appearance of the pigs were excellent.

Litters B, C and G were pure-bred Large Whites purchased from a commercial pig keeper. The weaning weights of the pigs from these litters were poor, but the pigs, although they looked 'rough', showed no signs of any disorders or diseases.

Litter H was by a Large White boar out of a Large White × Welsh sow. The pigs were purchased from a smallholder and their conditions of health and appearance were fair.

Considerable difficulties were encountered in obtaining six males from each of eight litters all of the same age. This was accomplished, however, but it was disappointing that the average weaning weights of pigs of three of the litters were only about 25 lb. and thus not altogether satisfactory.

After the litters had been collected together at the Institute they were all de-wormed with sodium fluoride.

Treatments. There were six treatments. One of five different supplements was added to a basal meal mixture. The sixth treatment was a 'control' with the unsupplemented basal meal. The treatments are shown in Table 1.

Table 1. *Antibiotic and hormone supplements added to the basal meal fed to the pigs on the six treatments*

	Supplement added to 1 lb. basal meal			
Treatment no.	Aurofac 2A* (g)	Procaine penicillin concentrate† (mg)	Sodium L-thyroxine pentahydrate concentrate‡ (mg)	Stilboestrol (mg)
1 (C)	—	—	—	—
2 (H)	—	—	30·0	6·0
3 (A)	1·01	—	—	—
4 (P)	—	228·0	—	—
5 (HA)	1·01	—	30·0	6·0
6 (HP)	—	228·0	30·0	6·0

* Contains 3·6 g aureomycin/lb. 1·01 g Aurofac/lb. meal is equivalent to 5 lb. Aurofac (containing 18·0 g aureomycin)/ton meal.

† Contains 16 g procaine penicillin/lb. 228 mg concentrate/lb. meal is equivalent to 511 g (containing 18·0 g procaine penicillin)/ton meal.

‡ Contains 1 g sodium L-thyroxine pentahydrate/100 g.

The composition of the basal meal mixture was changed slightly after the pigs had reached 100 lb. live weight. The compositions and chemical analyses of the basal mixtures are given in Tables 2 and 3.

Feeding. The pigs were fed twice daily in individual feeding compartments. About 2 lb. water was poured on to each 1 lb. dry meal. In addition, water was available *ad lib.* from troughs.

Table 2. *Composition of basal meal mixtures given to the pigs*

Ingredient	Pig meal no. 231 Fed up to 100 lb. live weight	Pig meal no. 232 Fed between 100 and 200 lb. live weight
Ground barley (%)	43	47
Ground oats (%)	15	15
Flaked maize (%)	15	15
Fine bran (%)	10	12
Dried-grass meal (%)	5	3
White fish meal (%)	7	2
Extracted decorticated groundnut meal (%)	4	4
Mineral-vitamin mixture (%)	1	2
Composition of mineral-vitamin mixture		
Ground limestone (g)	103	130
Sterilized steamed bone flour (g)	—	380
Salt (g)	103	150
Adisco*(g)	227	227
Barley meal (g)	21	21
	454 g (1 lb.)	908 g (2 lb.)

* A proprietary compound containing, in stable form, 1000 i.u. vitamin A and 200 i.u. vitamin D/g.

Table 3. *Chemical composition of basal meal mixtures*

	Determined values (air-dry basis)				Calculated values* (per lb. air-dry meal)							
Pig meal no.	Dry matter (%)	Crude protein (%)	Crude fibre (%)	Crude fat (%)	Ca (g)	P (g)	NaCl (g)	Thiamine (mg)	Riboflavin (mg)	Nicotinic acid (mg)	Pantothenic acid (mg)	Pyridoxin (mg)
231	89·3	17·2	6·2	4·5	3·1	2·7	2·4	2·1	1·2	29·5	5·3	2·2
232	88·6	13·6	5·1	2·8	3·0	2·4	2·4	2·3	0·9	30·7	5·2	2·4

* These calculations were made on the basis of the mineral contents of foodstuffs as tabulated by Woodman (1952) and of the vitamin contents of foodstuffs as tabulated by Lucas & Calder (1955).

The food allowance for each pig was determined from the feeding scale given in Table 4. The amounts fed were adjusted each week after the pigs had been weighed.

Allocation of pigs to treatments. Because of the possibility that the pigs might pick up hormones or antibiotics from each other's faeces, only one diet was fed in each pen. One pig from each litter was thus allocated to each hut and the treatment effects and hut effects were confounded. This was unfortunate, but was considered unavoidable in an experiment of this nature. Until the pigs reached 100 lb. live weight there were eight pigs on each treatment, but between 100 and 200 lb. live weight the accommodation was sufficient only to hold five pigs on each treatment. These pigs were slaughtered at 200 lb. live weight, the weight being taken after 15 h starvation.

Records. For each pig records were kept of daily food intake, live weight each week and certain carcass-quality measurements.

All carcass-quality measurements were taken on sides after they had been chilled for 24 h, cured by brine injection and immersion in brine tanks for 5 days and drained and matured for 12 days. Before the measurements were taken the sides were hung up by the fore end.

Table 4. *Feeding scale for the pigs*

Live weight of pig (lb.)	Food (lb./day)	Live weight of pig (lb.)	Food (lb./day)	Live weight of pig (lb.)	Food (lb./day)	Live weight of pig (lb.)	Food (lb./day)
32–36	2·2	73–75	3·6	112–114	5·1	151–153	6·5
37–39	2·3	76–78	3·7	115–117	5·2	154–156	6·6
40–42	2·4	79–81	3·9	118–120	5·3	157–159	6·7
43–45	2·5	82–84	4·0	121–123	5·4	160–162	6·8
46–48	2·6	85–87	4·1	124–126	5·5	163–165	6·9
49–51	2·8	88–90	4·2	127–129	5·6	166–168	7·0
52–54	2·9	91–93	4·3	130–132	5·7	169–175	7·2
55–57	3·0	94–96	4·4	133–135	5·8	176–181	7·3
58–60	3·1	97–99	4·5	136–138	5·9	182–187	7·4
61–63	3·2	100–102	4·6	139–141	6·1	188–193	7·5
64–66	3·3	103–105	4·7	142–144	6·2	194–199	7·6
67–69	3·4	106–108	4·8	145–147	6·3	200	7·7
70–72	3·5	109–111	4·9	148–150	6·4		

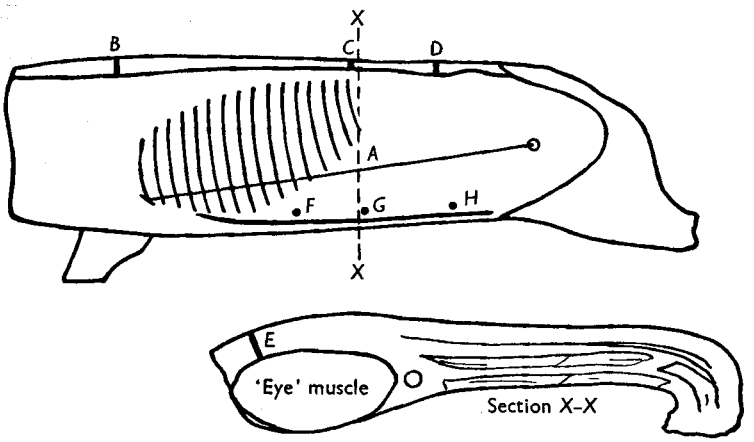

Fig. 1. Diagrams showing carcass-quality measurements taken. *A*, length; *B*, maximum shoulder fat; *C*, minimum back fat; *D*, maximum loin fat; *E*, fat over 'eye' muscle; *F*, *G*, *H*, thickness of streak.

The measurement of length was between the junction of the first rib and sternum, and the centre of the ligament attachment visible on the symphysis pubis. Measurements of depth of fat did not include the thickness of the skin. The area of the 'eye' muscle and the depth of fat over the 'eye' muscle (point *E* on Fig. 1) were taken from a tracing of the bacon rasher cut at the level of the last rib. Thickness of streak was an average of three readings taken by pushing a graduated probe through the carcass at the level of the line of teats at points *F*, *G* and *H* on Fig. 1.

Killing-out percentages were calculated from the final live weight recorded after 15 h starvation and the dead weight for which payment is made to the producer. This dead weight is the weight, within 1 h of killing, of the bled carcass from which the hair, heart, lungs, liver, intestines and spleen have been removed, after subtracting from it a weight to allow for shrinkage during chilling. This subtraction, which is a standard practice throughout British bacon factories, is 3 lb. for a carcass weighing 113–143 lb. and 4 lb. for a carcass weighing 144–189 lb. With very few exceptions our pigs were in the second weight group.

RESULTS

Progress of the experiment

The experiment began on 26 August 1953, when the pigs were about 9 weeks old. Shortly after that one pig on treatment 1 died as a result of an accident when it attempted to jump out of its pen. After 14 weeks a pig from litter H on treatment 3 became ill and was removed from the experiment. The illness could not be attributed to the dietary treatment. Values for these two pigs were supplied by the standard missing-plot technique before the results from the experiment were analysed statistically.

On 7 September the pig from litter A on treatment 2 suffered a prolapse of the rectum. The animal was removed to an individual pen, a veterinary surgeon replaced and sewed in the rectum and the pig was returned to the experiment 5 days later. On 11 September another pig from litter A, but on treatment 6, suffered a similar prolapse and was treated in the same way. It was returned to the experiment 10 days later. After return to the experiment both pigs regained excellent health and grew well. Their performance figures have been retained in the statistical analysis of the results.

The pigs on treatments 3–6 were eating their correct food allowances after about 7–10 days on experiment, but it was some 3–4 weeks before all pigs on treatments 1 and 2 would eat theirs. This was possibly because the feeding scale used was rather high when the ration fed did not contain an antibiotic. Robinson, Coey & Burnett (1953) found that the feeding of procaine penicillin increased the zest for food, although experiments with weanling pigs failed to show that procaine penicillin promoted significantly an increased food consumption when the diet contained 10% white fish meal.

Growth rates and food-conversion efficiences

Growth rates and food-conversion efficiencies* are reported in three sections, the first covering the 'growing' period from the beginning of the experiment to approx. 100 lb. live weight, the second covering the 'finishing' period from about 100 to 200 lb. live weight and the third covering both periods. During the 'growing' period there were eight animals on each treatment, and during the 'finishing' and combined periods there were only five.

* 'Food-conversion efficiency' was measured by the amount of feed in lb. required to produce an increase of 1 lb. in live body-weight.

Growing period (*approx.* 40–100 *lb. live weight*). The mean live weights at the beginning of the experiment and at the end of the 'growing' period are given in Table 5.

Table 5. *Mean live weight* (*lb.*) *of the pigs at the beginning and end of the 'growing' period*

	Treatment no.					
	1 (C)	2 (H)	3 (A)	4 (P)	5 (HA)	6 (HP)
Beginning of period	40	40	40	39	39	37
End of period	101	101	103	100	102	101

The mean growth rates and efficiencies of food conversion are given in Table 6.

Table 6. *Mean growth rates and efficiencies of food conversion of the pigs during the 'growing' period* (*approx.* 40–100 *lb. live weight*)

	Treatment no.						Standard error of differences between means
	1 (C)	2 (H)	3 (A)	4 (P)	5 (HA)	6 (HP)	
Rate of live-weight increase:							
lb./week	6·40	6·64	7·86	7·72	7·36	6·89	±0·36
As percentage of that of controls	100	104	123	121	115	108	—
Efficiency of food conversion:							
lb. food/lb. live-weight increase	3·26	3·15	2·82	2·79	3·03	3·01	±0·12
As percentage of that of controls	100	97	86	85	93	92	—

For significance at the 5, 1 or 0·1 % levels a difference between means should be 2·0, 2·7 or 3·6 times the standard error respectively.

The rate of live-weight increase did not appear to be influenced by initial weight and the latter was ignored in analysing growth rates.

For growth rates, differences between treatments and between litters were both significant at the 0·1 % level.

The addition of hormones alone had no statistically significant effect and there was also no difference between the observed effects of the two antibiotics. The comparison of treatments 3 and 4 (both with antibiotics) with treatments 1 and 2 (both without antibiotics) was therefore made, the 22 % faster growth rate in treatments with antibiotics being highly significant ($P \ll 0{\cdot}001$).

There was no significant difference between the group receiving hormones with aureomycin and that receiving them with penicillin, and the comparison, antibiotic with hormones versus antibiotic without hormones, was made. This proved significant at the 5 % level, the presence of hormone reducing the rate of increase by 8 %.

For efficiencies of food conversion differences between treatments were significant at the 1 % level, differences between litters at the 0·1 % level.

These results followed the same pattern as those for growth rates, and the same comparisons were made. The 15 % benefit derived from antibiotics was significant

at the 0·1 % level and the reduction in efficiency resulting from the addition of hormone to antibiotic in the meals was significant at the 5 % level.

Finishing period (*approx.* 100–200 *lb. live weight*). The mean starved live weights (lb.) of the pigs at slaughter were as follows:

Treatment no.					
1 (C)	2 (H)	3 (A)	4 (P)	5 (HA)	6 (HP)
199	200	203	200	204	200

The mean growth rates and efficiencies of food conversion are given in Table 7.

Table 7. *Mean growth rates and efficiencies of food conversion of the pigs during the 'finishing' period* (*approx.* 100–200 *lb. live weight*)

	Treatment no.						Standard error of differences between means
	1 (C)	2 (H)	3 (A)	4 (P)	5 (HA)	6 (HP)	
Rate of live-weight increase:							
lb./week	9·92	10·72	10·64	10·64	10·52	11·20	±0·27
As percentage of that of controls	100	108	107	107	106	113	—
Efficiency of food conversion:							
lb. food/lb. live-weight increase	4·14	3·83	3·88	3·98	3·97	3·65	±0·11
As percentage of that of controls	100	92	94	96	96	88	—

For significance at the 5, 1 or 0·1 % levels, a difference between means should be 2·09, 2·86 or 3·88 times the standard error respectively.

For both growth rates and efficiencies of food conversion differences between treatments were significant at the 1 % level; but litter differences were not significant.

The results in the 'finishing' period were somewhat more complicated than in the 'growing' period. The beneficial effects of feeding antibiotics in rations were reduced to a 7 % increase in growth rate and a 5 % increase in food-conversion efficiency over the controls. In contrast to what happened during the 'growing' period, the group fed thyroxine and stilboestrol had a significant advantage over the controls and was now in line with those groups receiving antibiotics. There was no detrimental effect from including the hormones in rations already containing Aurofac, and in rations already containing procaine penicillin they gave a significant additional advantage of 6 % in rate of growth and 8 % in efficiency of food conversion.

Combined 'growing' and 'finishing' periods (*approx.* 40–200 *lb. live weight*). The average growth rates and efficiencies of food conversion are given in Table 8.

For growth rates, treatment differences were significant at the 0·1 % level, and litter differences were significant at the 1 % level. For efficiencies of food conversion treatment differences were significant at the 0·1 % level, but litter differences were not significant.

Over the whole experimental period pigs receiving hormones in their diet grew 6 % faster and 4 % more efficiently than the controls, whereas pigs receiving antibiotics grew about 15 % faster and 8 % more efficiently than the controls. There was

no significant difference between the effects of the two different antibiotics on the performance of the pigs.

For growth rates no statistically significant effect resulted from the inclusion of thyroxine and stilboestrol in rations already containing antibiotics. It was observed, however, that the average growth rates for the groups receiving procaine penicillin and procaine penicillin with hormones were very similar, whereas pigs receiving hormones and Aurofac grew 6% more slowly than those receiving rations containing Aurofac alone.

Table 8. *Mean growth rates and efficiencies of food conversion of the pigs during the combined 'growing' and 'finishing' periods (approx. 40–200 lb. live weight)*

	Treatment no.						Standard error of differences between means
	1 (C)	2 (H)	3 (A)	4 (P)	5 (HA)	6 (HP)	
Rate of live-weight increase:							
lb./week	7·86	8·34	9·18	8·92	8·74	8·94	±0·23
As percentage of that of controls	100	106	117	114	111	114	—
Efficiency of food conversion:							
lb. food/lb. live-weight increase	3·77	3·61	3·44	3·47	3·62	3·33	±0·07
As percentage of that of controls	100	96	91	92	96	88	—

For significance at the 5, 1 or 0·1% levels, a difference between means should be 2·09, 2·86 or 3·88 times the standard error respectively.

For efficiency of food conversion the effect of adding hormones to rations containing Aurofac reduced efficiency by 5%, this difference being statistically significant. On the other hand, when hormones were added to rations containing procaine penicillin, there was a 4% additional increase in efficiency, which was just significant.

Carcass-quality measurements

The carcass-quality measurements taken are shown diagrammatically in Fig. 1.

Unfortunately, for six pigs tracings of bacon rashers could not be obtained and so for the measurements of area of 'eye' muscle and depth of fat over the 'eye' muscle six missing values were calculated before the data were analysed. For each of the other measurements there was one missing value.

The mean figures for the carcass-quality measurements are given in Table 9. For maximum shoulder fat, minimum back fat, maximum loin fat, thickness of streak and area of 'eye' muscle, neither treatment nor litter differences were statistically significant.

For length of carcass and killing-out percentage treatment differences were not significant, but litter differences were significant at the 0·1 and 5% levels respectively.

For fat over the 'eye' muscle treatment differences were almost entirely due to a low value for treatment 6. The comparison of treatment 6 against the other treatments reached significance at the 5% level. Litter differences were again significant at the 5% level.

Table 9. *Mean carcass-quality measurements* of the pigs*

	Treatment no.						Standard error of differences between pairs of means†	
	1 (C)	2 (H)	3 (A)	4 (P)	5 (HA)	6 (HP)	(*a*)	(*b*)
Maximum shoulder fat (cm)	5·8	5·8	5·3	5·4	5·6	5·4	±0·42	±0·39
Minimum back fat (cm)	2·6	2·6	2·6	2·8	2·6	2·5	±0·28	±0·27
Maximum loin fat (cm)	3·6	3·8	3·6	3·6	3·4	3·5	±0·22	±0·21
Fat over 'eye' muscle (cm)‡	2·6	2·5	2·6	2·5	2·5	2·2	±0·20	±0·20
Thickness of streak (cm)	3·6	3·2	3·2	3·3	3·4	3·2	±0·29	±0·28
Length of carcass (cm)	78·1	79·1	77·8	79·4	79·4	79·9	±1·0	±1·0
Area of 'eye' muscle (cm^2)‡	24·5	25·7	26·9	26·7	26·2	26·6	±2·5	±2·5
Killing-out percentage§	76·4	74·5	75·7	75·4	75·9	75·2	±0·87	±0·82

* See p. 270 and Fig. 1.

† When comparing an average for treatment 3 with another average, standard error (*a*) should be used. For other comparisons standard error (*b*) should be used.

‡ For significance at the 5, 1 or 0·1 % level, a difference between means should be 2·14, 3·00 or 4·14 times its standard error. For other measures, differences would have to be 2·09, 2·86 or 3·88 times their standard error.

§ See p. 271.

DISCUSSION

During the experiment reported here the effects of antibiotics were in line with expectations. The antibiotics had a beneficial effect both upon growth rates and efficiencies of food conversion, this effect being more marked during the earlier stages of growth. During the 'growing' period this stimulation might have been interrelated with appetite to some extent, for the antibiotic-fed pigs ate slightly more per unit of body-weight during the first few weeks of the experiment than the controls. (The controls and hormone-fed pigs were slow to take the full meal allowance allotted to them by the feeding scale, whereas the antibiotic-fed pigs were not.) During the 'finishing' period, however, the stimulation of rate and efficiency of growth cannot have been interrelated with appetite, as all pigs were consuming the full amounts allotted to them by the feeding scale. We did not find any differences between the effects of Aurofac 2A or of procaine penicillin included in the rations.

When the hormones were included in rations not containing antibiotics they caused slight, statistically insignificant, increases in rate and efficiency of growth during the 'growing' period, but these increases were greater and became statistically significant during the 'finishing' period. When included in rations containing antibiotic the hormones depressed rate and efficiency of growth during the growing period. During the 'finishing' period they increased rate and efficiency of growth when included in rations containing procaine penicillin, but had no effect in rations containing aureomycin. This interaction between hormones and type of antibiotic (and, indeed, all treatment comparisons) must be considered with some caution, for in this experiment treatments were confounded with units of a hut holding five pigs. Although the pigs on rations containing Aurofac and hormones showed no signs of disease, it is possible that they contracted a mild and undetected infection at some time during the 'finishing' period. It is extremely unlikely that the difference in physical environment between huts would have caused this difference in performance.

Over the whole experimental period the inclusion of hormones in meals not containing antibiotic was significantly advantageous, but had no significant effect upon growth rates of pigs fed rations already containing either antibiotic. However, they did have a significantly beneficial effect upon food-conversion efficiency in the ration containing procaine penicillin and a significantly detrimental effect upon food-conversion efficiency in the ration containing Aurofac.

It is interesting that there were two cases of prolapse of the rectum during this experiment, whereas there had been none amongst the 400 pigs fattened in the Rowett Institute piggery during the previous 18 months. Jordan (1953) has reported prolapse of the rectum in wether lambs treated with stilboestrol, but the observation was made in a large flock that did not contain untreated animals. Taylor & Gordon (1955), co-operating in the co-ordinated trial of which our experiment was a part, found that five pigs showed signs suggestive of stilboestrol toxicity. One of these signs was prolapse of the rectum. However, in our experiment there were two factors in common between the pigs that developed prolapses. Both were from the same litter and both were fed rations containing thyroxine and stilboestrol. It is not possible from our results to make any definite statement on the cause of these prolapses.

The statistical analysis of the data from this experiment has shown significant litter differences for growth rates, efficiencies of food conversion, and some carcass-quality measurements. These may be taken to indicate that a considerable improvement in experimental accuracy was obtained by the use of litter-mates in the design.

The results give rise to two main questions. (1) Why was the response to the hormones different during the periods before and after 100 lb. live weight? (2) Why do the results differ from those reported by Barber *et al.* (1953)?

The answer to the first question may probably be found by considering Braude's (1950) data. He fed three constant levels of iodinated casein and stilboestrol to pigs regardless of their live weights and found that the higher levels became more effective as the experiment progressed. The doses given and the calculated approximate average amounts fed/lb. live weight at three stages of the experiment are shown in Table 10, which shows that the optimum dose of hormones appeared to be related to the weight of the pig and that this optimum was about 3 mg iodinated casein and 0·2 mg stilboestrol/ lb. live weight. As iodinated casein has about one three-hundredth of the activity of synthetic thyroxine* when fed by mouth (Kay, 1953–4), 3 mg iodinated casein would be equivalent to 0·01 mg sodium L-thyroxine pentahydrate. For comparison, the amounts of hormones fed per lb. live weight in the experiment reported in this paper are given in Table 11 for live weights of 50, 100, 150 and 200 lb.

Table 11 shows that in this experiment the doses of hormones per 1 lb. live weight came nearer to the optimum as the experiment progressed. It is therefore not surprising that the results show the growth response induced by the hormones to have been greater during the 'finishing' than during the 'growing' period.

The divergence between our results and those of Barber *et al.* (1953) is difficult to

* The synthetic thyroxine used in the experiments summarized by Kay (1953–4) was sodium L-thyroxine pentahydrate. The factor used to express iodinated casein in terms of thyroxine activity was determined in experiments upon the stimulation of lactation in dairy cattle.

explain. A partial explanation may be that our pigs began and finished in the experiment at lighter weights than theirs did. Thus the total growth period of our pigs contained proportionately more 'growing' period—when the hormone dosage was probably not optimal—and proportionately less 'finishing' period, when the hormones had their most beneficial effect. Until more evidence comes forward the possibility

Table 10. *Amount of hormone given daily to the pigs by Braude* et al. (1955) *calculated on the basis of live weight of pig*

Amount given (mg/pig)		Amount given calculated as mg/lb. live weight					
		First 10 weeks of experiment (mean weight of pig 100 lb.)*		Last 9 weeks of experiment (mean weight of pig 180 lb.)*		Last 3 weeks of experiment (mean weight of pig 210 lb.)*	
Iodinated casein	Stilboestrol	Iodinated casein	Stilboestrol	Iodinated casein	Stilboestrol	Iodinated casein	Stilboestrol
340	20	3·4†	0·2†	1·9	0·1	1·6	0·1
510	30	5·1	0·3	2·8†	0·2†	2·4	0·1
680	40	6·8	0·4	3·8	0·2	3·2†	0·2†

* Estimated from data of Braude *et al.* (1955).
† Doses producing the maximum rate and efficiency of gain during the three periods.

Table 11. *Amount of hormone given daily to the pigs in the present experiment on the basis of live weight of pig*

Live weight of pig (lb.)	Sodium L-thyroxine pentahydrate (mg/lb. live weight)	Stilboestrol (mg/lb. live weight)
50	0·017	0·336
100	0·014	0·276
150	0·013	0·256
200	0·012	0·231

should also be considered that the many factors affecting the pig's metabolic rate might have a considerable influence upon the doses of thyroxine and stilboestrol that cause maximum stimulation of growth. Several factors that might well affect metabolic rate were not held constant between our experiments and those of Barber *et al.* (1953). Examples of such factors are the intakes of digestible energy by the pig, the balance of nutrients within the ration, the breed and strain of pig and the environment.

SUMMARY

1. Six castrated male pigs from each of eight litters were allocated to six treatment groups, each group consisting of one pig from each litter, and were fed individually from weaning to 100 lb. live weight. Five pigs in each group, all from the same litters, were retained in the experiment from 100 lb. to slaughter at 200 lb. live weight.

2. One group was fed an unsupplemented control diet containing fish meal, and the other groups were fed the control diet supplemented with either thyroxine and

stilboestrol, or Aurofac 2A, or procaine penicillin, or Aurofac and both hormones, or procaine penicillin and both hormones.

3. Results for growth rates and efficiencies of food conversion are given for the 'growing' period from weaning to 100 lb., the 'finishing' period from 100 lb. to slaughter, and the combined periods from weaning to slaughter.

4. In comparison with the controls, pigs fed diets containing Aurofac or penicillin grew 23 and 21% faster respectively and 14 and 15% more efficiently respectively during the 'growing' period. During the 'finishing' period the advantages were smaller, being 7 and 7% respectively for growth rate and 6 and 4% for efficiency of food conversion.

5. In comparison with the controls, pigs fed a diet containing thyroxine and stilboestrol grew 4% faster and 3% more efficiently during the 'growing' period, and 8% faster and 8% more efficiently during the 'finishing' period. The advantages of feeding hormones during the 'growing' period were not statistically significant.

6. The addition of both hormones to meal mixtures already containing one or other of the antibiotics significantly reduced growth rate by 8% and efficiency of food conversion by 8% during the 'growing' period. During the 'finishing' period the addition of the hormones to the diet containing Aurofac affected neither rate nor efficiency of growth, but when they were added to the diet containing penicillin there were significant increases of 6% in growth rate and 8% in efficiency of food conversion.

7. In comparison with the performance of the controls from weaning to slaughter, pigs fed a diet supplemented with Aurofac 2A or procaine penicillin grew 15% faster and 8% more efficiently, whilst pigs fed a diet supplemented with thyroxine and stilboestrol grew 6% faster and 4% more efficiently. All of these differences were statistically significant.

8. There was no significant overall effect on growth rate from weaning to slaughter of including both hormones in diets already containing Aurofac or penicillin. However, supplementing the diet containing penicillin with both hormones significantly improved efficiency of food conversion by 5%, but supplementing the diet containing Aurofac with both hormones significantly lowered efficiency of food conversion by 5%.

9. There were no significant treatment effects upon killing-out percentage, or upon the majority of carcass measurements, but pigs fed the diet containing hormones and penicillin had the least fat over the 'eye' muscle as measured from bacon rashers cut at the level of the last rib.

The statistical design and analysis of data from this experiment were undertaken by Mr A. W. Boyne and Mr G. Park of the Statistics Department, Rowett Research Institute.

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Fat in Liver and Kidneys of Pregnant Sheep at Different Levels of Nutrition and during Starvation

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The amount of fat in the liver of pregnant sheep, in animals both on adequate and on poor diets, has been a subject of disagreement amongst workers for many years. The literature is reviewed by Ferguson (1954), who published the results of an experiment in which he kept forty-four ewes under controlled conditions. He studied the effect during pregnancy of two planes of nutrition, one high and the other low, on the liver fat which was determined gravimetrically as the total ether-soluble fraction. At the time of slaughter of these animals, portions of appropriate size were taken from the liver and kidneys and placed in 5% formol saline. This paper reports the results of a histological examination of these specimens and thus is a study complementary to Ferguson's work.

A summary of the experimental procedure used by Ferguson (1954) is given here; for a detailed account the reader is referred to the original paper. The forty-four ewes were kept on an old pasture and received no supplementary food for 5 weeks before the beginning of the experiment. They were then penned singly indoors except for 5–6 h each day when they were allowed exercise in an uncovered yard. They were fed singly in their pens. The ewes were slaughtered after varying periods, five being killed at random as non-pregnant controls on the day of service of the remainder. For the first 100 days of pregnancy an adequate diet was provided, described as 'high-plane'; from the 95th to the 102nd day of pregnancy a further six were killed and a random division was made of the rest of the animals into two groups, fifteen in one and eighteen in the other. The first group was kept on the high-plane diet and the second on a low-plane diet which was insufficient for the requirements of the pregnant ewe. The animals from both these groups were killed at varying intervals from the 119th to the 144th day. From the 138th day of pregnancy onwards food, but not water, was