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## THE EFFECT OF TWO DIFFERENT FEED LEVELS ON THE DEVELOPMENT OF THE REPRODUCTIVE ORGANS IN BOARS

By

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EINARSSON, S., M. HOLTMAN, K. LARSSON, I. SETTERGREN and A. BANE: *The effect of two different feed levels on the development of the reproductive organs in boars.* Acta vet. scand. 1979, 20, 1—9. — The aim of the present investigation was to study the development of the reproductive organs in boars fed restrictively and fed ad libitum. A total of 120 boars were purchased by the experimental station at 20 kg live weight. Three groups of 4 litter mates were selected after each of 10 A.I. boars (7 Swedish Landrace and 3 Swedish Yorkshire). The dams were unselected sows from piglet-producing herds. Two boar pigs from each litter were allocated at random among 2 treatment groups. One group (=N) was fed restrictively and the other group (=A) ad libitum. The boars were slaughtered at 90 kg or at 120 kg live weight. The reproductive organs were removed at slaughter and examined.

The ad libitum fed boars were about 2 weeks younger at slaughter than those fed restrictively (16.5 and 13.7 days respectively for the 2 weight classes). The weights of the testes were somewhat higher for ad libitum fed than for restrictively fed boars. Out of 94 examined pairs of testes, epididymides, seminal vesicles and bulbo-urethral glands, the left was heavier than the right in 68 %, 62 %, 48 %, and 36 %, respectively. Fewer (4/23) ad libitum fed than restrictively fed boars (9/26) had reached puberty at 90 kg live weight. Age at puberty thus seems to be less variable than body size in boars.

boars; feed level; development; reproductive organs.

Several factors influence the age at puberty in swine. The age and body weight at which sexual maturity is attained vary among breeds (e.g. *Niwa & Mizuho* 1955). Swedish Landrace and Swedish Yorkshire boars attain puberty at about 7—8 months according to *Lagerlöf & Carlquist* (1961) and *Bane et al.* (1965). Crossed gilts of Poland China and Chester White attained puberty significantly earlier than either parent breed (*Zimmerman et al.*

1960). *Dutt & Barnhart* (1959) found weight but not age at puberty to differ significantly among boars on different planes of nutrition. *Robertson et al.* (1951) demonstrated in the same way that age at puberty was less variable than weight at puberty for gilts. Full-fed gilts were significantly heavier at puberty than restrictively fed. *Zimmerman et al.* reported that full-fed gilts grew more rapidly and attained puberty at an earlier age than restrictively fed. Their earlier age at puberty was explained on the basis of their greater growth rates. On the other hand *Self et al.* (1953) found that full-fed gilts were significantly older at puberty than restrictively fed and it was suggested that fatness may affect attainment of puberty. Thus there are divergent opinions on the effect of the plane of nutrition on sexual maturity of swine.

The present study was designed to determine the development of the reproductive organs in boars on restricted feed or fed ad libitum and slaughtered at 90 or 120 kg live weight.

#### MATERIAL AND METHODS

A total of 120 boars were bought from private farmers and taken to the experimental station during the period August—September 1970. The boars were at about 20 kg live weight on arrival. The dams of the boars were unselected sows from piglet-producing herds, inseminated with semen from 10 A.I. boars (7 Swedish Landrace and 3 Swedish Yorkshire boars). Three groups of 4 litter mates (boar pigs) were selected after each of the 10 boars.

One week after arrival at the station the boar pigs from each litter were allocated at random among 2 treatment groups. One group (=N) was on restricted feed according to the official recommendations in Sweden (ration per animal per day: 1.0 kg at 20 kg live weight, gradually increased to 2.7 kg at 83 kg live weight, and thereafter constant amount until slaughter) and the other group (=A) was fed ad libitum. The same commercial feed for growing boars was used for both groups. The composition is given in Table 1. During the whole period the boars were reared in pens. Two boars from each of 2 litters were reared in each pen. In the restrictively fed groups the amount of feed was calculated on the group weight; individual feeding was not used. The boars were weighed once a week during the whole experimental period.

Table 1. Composition of the feed given to the boars during the experimental period.

Crude protein	17.0 %
Digestible crude protein	15.5 %
Crude fat	3.5 %
Crude fibre	6.5 %
Water	12.0 %
Metabolizable energy	11 MJ per kg
Calcium	1.2 %
Phosphorus	1.0 %
Vitamin A, i.u. per kg minimum	12,500
Vitamin D <sub>3</sub> , i.u. per kg minimum	1,200
Vitamin E, mg per kg minimum	12
Trace elements: Fe, Cu, Mn, Zn	

Three boars belonging to the ad libitum feed groups and 1 boar belonging to the restricted feed groups died during the very first weeks of the experimental period.

One litter mate from each treatment group was slaughtered in the week they reached the live weight of 90 kg. Except for 14 boars trained for semen collection, the remainder were slaughtered at 120 kg live weight.

Testes, epididymides and accessory glands were removed at slaughter and sent to the Department of Obstetrics and Gynaecology for examination. The genital organs from 7 boars were lost at slaughter. All genital organs were examined macroscopically and weighed. One boar with 1 testis in the abdomen was excluded from the material. For examination of the sperm morphology, cauda epididymal contents were transferred to buffered formol saline and examined according to *Hancock* (1957) and *Bane* (1961) in wet condition under phase contrast microscope at  $\times 900$  magnification. Sperm head morphology was studied after direct smearing of the epididymal contents, diluted in formol saline, on slides. The smears were stained and examined under the light microscope at  $\times 1000$  (*Lagerlöf* 1934).

The sperm morphology in the cauda epididymal semen was used as the indicator on sexual maturity. Boars with less than 10 % proximal cytoplasmic droplets and with less than 10 % abnormal sperm heads were judged as sexually mature. Statistical analyses were performed by Student's t-test (*Snedecor* 1966).

## RESULTS

The average live weights and ages of the boars at slaughter are presented in Table 3. The ad libitum fed boars were about 2 weeks younger than those fed restrictively (16.5 and 13.7 days, respectively, for the 2 weight classes). Data concerning feed consumption and growing rate of the boars are summarized in Table 2 (previously presented by *Persson 1971*).

Table 2. Average daily gain and feed consumption of the restrictively fed and ad libitum fed boars (*Persson 1971*).

	Average daily gain (g)		Average feed consumption: Mcal/kg gain
	live weight 20—35 kg	live weight 36—90 kg	
Restricted feed	484	750	8.6
Ad libitum feed	518	865	9.8

The weights of the testes (left and right) were somewhat higher for ad libitum fed than for restrictively fed boars (Table 3). The difference was almost significant at 120 kg live weight. The epididymal weights were a little higher for the restrictively fed than for the ad libitum fed boars in both weight classes. The epididymal weights were almost twice as high for boars slaughtered at 120 kg body weight as for boars slaughtered at 90 kg.

The average weights of the seminal vesicles are presented in Table 3. No systematic difference existed between treatment groups. The average weights of the bulbo-urethral glands were roughly the same in the lower weight class for the 2 groups. In the heavier weight class, however, the bulbo-urethral glands were heavier in the restricted feed than in the ad libitum feed groups (Table 3).

From Table 3 it is evident that the left testis was on an average heavier than the right in all groups. The same was found for the epididymides. No similar systematic weight differences between left and right side were found for the seminal vesicles or for the bulbo-urethral glands. Out of 94 examined pairs of testes, epididymides, seminal vesicles and bulbo-urethral glands the left was heavier than the right in 68 %, 62 %, 48 % and 36 % of the pairs.

Table 3. Average ages, live weights, sperm morphology of the caudal contents and weights of the genital organs of the boars at slaughter. Mean values of the left and right side are presented separately. Mean  $\pm$  s.e.m.

Experimental group	N 90	A 90	N 120	A 120
Numbers of boars	26	23	21	24
Live weight at slaughter (kg)	91.4 $\pm$ 0.6	91.6 $\pm$ 0.7	121.0 $\pm$ 0.6	123.3 $\pm$ 1.1
Age at slaughter (days)	180.3 $\pm$ 3.2 <sup>a</sup>	163.8 $\pm$ 3.5 <sup>a</sup>	220.8 $\pm$ 3.9 <sup>b</sup>	207.1 $\pm$ 2.3 <sup>b</sup>
Sperm morphology (%)				
Path. sperm heads	5.8 $\pm$ 0.8	6.2 $\pm$ 0.9	2.9 $\pm$ 0.3	3.4 $\pm$ 0.4
Prox. cytopl. dropl.	23.7 $\pm$ 5.0	30.6 $\pm$ 4.8	5.7 $\pm$ 4.8	8.1 $\pm$ 2.7
Sexually mature (%)	35	17	81	79
Weight (g)				
Testes: left	204.6 $\pm$ 13.0	209.3 $\pm$ 12.8	280.6 $\pm$ 10.4 <sup>c</sup>	310.1 $\pm$ 7.9 <sup>c</sup>
right	193.4 $\pm$ 10.6	199.2 $\pm$ 12.6	271.5 $\pm$ 10.3 <sup>d</sup>	303.0 $\pm$ 8.7 <sup>d</sup>
Epididymides:				
left	36.7 $\pm$ 2.4	33.1 $\pm$ 1.7	62.6 $\pm$ 2.8	59.2 $\pm$ 3.1
right	36.0 $\pm$ 2.2	32.1 $\pm$ 1.7	61.6 $\pm$ 2.7	57.1 $\pm$ 2.9
Seminal vesicles:				
left	46.0 $\pm$ 5.2	38.7 $\pm$ 4.9	90.9 $\pm$ 11.5	94.4 $\pm$ 8.6
right	44.2 $\pm$ 4.9	39.3 $\pm$ 4.6	96.6 $\pm$ 10.5	98.5 $\pm$ 7.4
Bulbo-urethral glands:				
left	48.3 $\pm$ 3.9	45.5 $\pm$ 6.8	80.8 $\pm$ 7.5	64.6 $\pm$ 4.1
right	48.1 $\pm$ 4.1	46.1 $\pm$ 6.6	83.2 $\pm$ 8.4	66.1 $\pm$ 3.9

<sup>a</sup>  $P < 0.001$

<sup>b</sup>  $0.01 < P < 0.05$

<sup>c</sup>  $0.01 < P < 0.05$

<sup>d</sup>  $0.01 < P < 0.05$

According to the definition of sexual maturity given in Material and Methods, 9/26 (35 %) were mature in the N 90 group and 4/23 (17 %) in the A 90 group. No difference between groups was found for the heavier weight class (Table 3).

The mean frequencies of spermatozoa with pathological sperm heads and with proximal cytoplasmic droplets, respectively, are presented in Table 3. The ad libitum fed boars had a numerically higher frequency of pathological heads and of proximal droplets than did restrictively fed boars within weight classes.

The average weights of the reproductive organs for sexually mature and for non-mature boars within weight classes are presented in Table 4. As can be seen from this table, the reproductive organs were heavier for mature than for prepuberal boars within both weight classes. The differences were statistically significant for testes, epididymides as well as for seminal vesicles within the lower weight class.

Table 4. Weights (g) of the testes, the epididymides, the seminal vesicles and of the bulbo-urethral glands of sexually mature boars within weight classes. Mean  $\pm$  s.e.m.

Weight class (N+A)	90		120	
	sexually mature	prepuberal	sexually mature	prepuberal
Testes	463.7 $\pm$ 22.8 <sup>a</sup> (13)	374.8 $\pm$ 19.3 <sup>a</sup> (36)	594.2 $\pm$ 13.3 (36)	545.9 $\pm$ 40.7 (9)
Epididymides	89.4 $\pm$ 5.1 <sup>b</sup> (13)	61.7 $\pm$ 2.5 <sup>b</sup> (35)	123.2 $\pm$ 4.0 (36)	105.0 $\pm$ 11.3 (9)
Seminal vesicles	119.1 $\pm$ 15.2 <sup>c</sup> (12)	70.4 $\pm$ 5.5 <sup>c</sup> (34)	194.7 $\pm$ 14.8 (33)	173.9 $\pm$ 26.7 (8)
Bulbo-urethral glands	114.8 $\pm$ 12.7 (6)	90.2 $\pm$ 7.9 (26)	151.1 $\pm$ 10.5 (30)	130.3 $\pm$ 16.2 (6)

<sup>a</sup> 0.001 < P < 0.01

<sup>b</sup> P < 0.001

<sup>c</sup> 0.001 < P < 0.01

## DISCUSSION

Puberty is reached when the sexual organs are fully developed, the sexual instincts are prominent and reproduction is possible (c.f. *Abdel-Raouf* 1960). However, according to that definition the attainment of puberty does not signify full reproductive capacity. Under the conditions of the present study it was not possible to test the mating ability (behaviour) or the fertility of the boars. Therefore sexual maturity was defined according to the morphology of the cauda epididymal spermatozoa. The criteria chosen have, according to the experience in our semen laboratory, proved indicative of the ability for normal reproduction in boars. They have also been utilized in previous studies (*Bane et al.* 1965). Furthermore the sperm morphology in the cauda epididymidis represents testicular as well as epididymal function.

The ad libitum fed boars grew more rapidly than those on restricted feed and were consequently younger at slaughter. Fewer ad libitum fed than restrictively fed boars had, however, reached puberty at 90 kg live weight (Table 3). Judging from these results the age at puberty seems to be less variable than the body weight. These results are in close agreement with those of *Dutt & Barnhart* (1959) and *Robertson et al.* (1951). *Dutt & Barnhart* found that weight but not age at puberty was significantly different among boars on different planes of nutrition.

The testes of the ad libitum fed boars were heavier than the testes of those on restricted feed. The weights of the testes thus seem to be more closely related to growing rate than to age in young boars. This conclusion is in close agreement with the observations made by *Hauser et al.* (1952) that the rate of testicular development is more closely associated with body size than with age. Also *Bane* (1954) reported higher testicular weights for bulls on higher rearing intensity.

The results presented in Table 4 further demonstrate the relationship between body weight and the weights of the reproductive organs. Although sexual maturity was followed by increased weights of the reproductive organs within weight classes the genital organs of the prepuberal boars in the higher weight class were heavier than those of the mature boars in the lower weight class.

The testes and the epididymides on the left side were frequently heavier than on the right. Also *Hauser et al.* and *Swierstra & Rahnefeld* (1967) reported that the left testicle was significantly heavier than the right. The reason for this asymmetry is, however, not known. No similar difference in weight was found between the left and right sides for the seminal vesicles or for the bulbo-urethral glands. In bulls, on the other hand, asymmetry was observed not only for testes and epididymides but also for the accessory sex glands (*Abdel-Raouf*).

## CONCLUSION

The ad libitum fed boars were younger at slaughter than those fed restrictively. The weights of the testes were somewhat higher for ad libitum fed than for restrictively fed boars.

In boars, age at puberty seems to be less variable than body weight.

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## SAMMANFATTNING

*Effekten av två olika utfodringsintensiteter på utvecklingen av könsorganen hos galtar.*

Målsättningen för föreliggande undersökning var att studera utvecklingen av könsorganen hos galtar efter restriktiv respektive ad libitum utfodring. Totalt 120 galtar inköptes till försöksstationen vid 20 kg vikt. Tre grupper med 4 kullbröder selekterades efter var och en av 10 AI galtar (7 Svensk Lantras och 3 Svensk Yorkshire). Mödrarna, till försöksgaltarna, var oselekerade suggor ur smågrisproducerande besättningar. Två galtgrisar från varje kull fördelades slumpmässigt till respektive försöksgrupp. En grupp (=N) utfodrades restriktivt och den andra gruppen (=A) ad libitum. Galtarna slaktades vid 90 eller vid 120 kg levande vikt. Könsorganen togs ur vid slakten och undersöktes därefter med avseende på vikt, och spermie-morfologin undersöktes i prov från cauda epididymidis.

De ad libitum utfodrade galtarna var cirka 2 veckor yngre vid slakt än de som utfodrats restriktivt (16,5 respektive 13,7 dagar för de 2 viktclasserna). Testikelvikterna var något högre för ad libitum utfodrade än för restriktivt utfodrade galtar. Av 94 undersökta par av testiklar, bitestiklar, sädesblåsor och bulbo-urethral körtlar var den vänstra tyngre än den högra i respektive 68, 62, 48 och 36 % av fallen. Färre (4/23) ad libitum utfodrade än restriktivt utfodrade (9/26) galtar hade nått könsmognad vid 90 kg levande vikt. Åldern vid könsmognaden synes således vara mindre variabel än kroppsstorleken hos galtar.

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