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Original article

Studies on a long-term use of rapeseed products in diets for boars. Pathomorphological changes in the reproductive system, liver and thyroid gland

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Summary — Three feeding groups were used: the control (SOY) was fed diets without rapeseed products, and the two experimental groups were fed with either 10% rapeseed meal (RSM) or with 12% OO rape seeds (PFRS). Half of the boars from each group were slaughtered after 1 or 2 years. In RSM and PFRS boars steroid-3-beta-ol-dehydrogenase activity was high, whilst Leydig cells were not numerous after 1 year. Degeneration and necrosis of seminiferous epithelium resulting in atrophy of seminiferous tubules appeared in RSM boars after 2 years. In the PFRS group the lesions were stronger and proliferation of Leydig cells with high steroid-3-beta-ol-dehydrogenase activity was observed. In 1-year-old RSM and PFRS boars there were foci of necrosis in the epididymal epithelium. Thyroid weight in RSM boars and liver weight in PFRS boars were distinctly higher only during the first year. In these thyroid glands flattening of glandular epithelium and enlargement of colloid masses were observed, while in the livers, parenchymatic degeneration and structural transformation appeared. Testis weight increased after 2 years in RSM and PFRS boars; however, this had little effect on semen production.

boar / rapeseed / testis / liver / thyroid gland

Résumé — Études sur l'usage à long terme de composants du colza dans le régime alimentaire de verrats. Lésions morphopathologiques dans l'appareil reproducteur, le foie et la glande thyroïde. Trois lots de verrats ont été utilisés : les témoins (SOY), nourris sans colza, les groupes expérimentaux nourris avec 10 % de tourteaux de colza (RSM) et 12 % de graines de colza 00 (PFRS). La moitié des verrats de chaque lot a été abattue après un an, l'autre moitié au bout de deux ans. Dans

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les lots RSM et PFRS, l'activité stéroide-3-béta-ol déhydrogénase était élevée au bout de 2 ans, alors que le nombre de cellules de Leydig était faible à la fin de la première année. Dégénérescence et nécrose ont été observées dans l'épithélium des tubes séminifères qui s'atrophient chez les verrats du lot RSM au bout de 2 ans. Dans le groupe PFRS, les lésions étaient plus importantes et on a observé une prolifération des cellules de Leydig et une forte activité stéroïde-3-béta-ol déhydrogénase. Dans les deux groupes expérimentaux, des foyers de nécrose se sont formés dans l'épithélium épididymaire au bout de 1 an. Pendant la première année, le poids de la thyroïde (groupe RSM) et du foie (groupe PFRS) a augmenté. L'aplatissement de l'épithélium glandulaire thyroïdien et la croissance de masses colloïdes ont été observés. Dans le foie, des transformations de structure et une dégénérescence du parenchyme se sont produites. Le poids des testicules s'est accru au bout de deux ans dans les deux groupes, mais sans effet sur la production de spermatozoïdes.

verrat / colza / testicule / foie / thyroïde.

INTRODUCTION

Rapeseed meal and rape seeds can be a valuable component of animal feeds. Therefore, there is an increasing cultivation of triply improved rape varieties. Studies on the use of rape seeds or rapeseed meal in the diets of boars are few. Only one paper by Fritz et al (1992) was found in the available literature, where the authors used feeds containing 5 and 12% of rapeseed meal produced from the 00 Jantar variety. It was found that a 12% concentration of this meal was excessive. Boars fed these diets were characterised by slower growth and worse feed conversion, but there was no effect on semen quality or its quantitative parameters, nor on the weight of liver, kidneys or testes. Only the thyroid gland increased in weight.

The objective of this study was to determine morphological changes in the reproductive system, liver and thyroid gland of boars consuming diets containing 10% rapeseed meal or 12% rape seeds over an extended period.

MATERIAL AND METHODS

Forty-eight boars were used in the experiment (♂ Polish Landrace × ♀ Polish Large White) of 42–45 kg body weight. The animals were divided into three feeding groups: SOY, without rapeseed products; RSM, with 10% rapeseed meal; and PFRS, with 12% 00 rape seeds. There were 16 boars in each group. The animals were given complete feeds; their chemical composition and the percentages of particular components are given in table I. The boars were kept in litterless pens, two animals per pen. Feed consumption was controlled daily and each animal was weighed every fortnight. Twenty-four boars (eight per group) were slaughtered by bleeding

Table I. Composition and nutritive value of the experimental diets (%).

Components	*Diets*		
	SOY	*RSM*	*PFRS*
Soya bean meal	18.00	11.50	15.00
Rapeseed meal	—	10.00	—
Full-fat rapeseed	—	—	12.00
Ground barley	52.346	48.849	43.38
Ground wheat	25.00	25.00	25.00
Limestone	0.70	0.70	0.70
Fodder phosphate	2.50	2.50	2.50
Salt	0.30	0.30	0.30
Mineral–vitamin premix	1.00	1.00	1.00
Lysine (99%)	0.154	0.151	0.12
Total	100.00	100.00	100.00
Nutritive value of 1 kg diet:			
MJ EM (calculated)	12.54	12.27	13.21
crude protein (g) (analysed)	172	178	175

after electric stunning, after attaining a body weight of about 115 kg. The remaining boars were slaughtered at the end of the experiment (2 years).

The reproductive system was examined directly after slaughter. The weight and size of each testis (length and width) were determined and samples were collected from the organs for microscopy examination. Samples for histopathological examination were collected at the free brim of the testis, fixed in Bouin solution and embedded in paraffin blocks. Samples for electron transmission (TEM) and scanning (SEM) microscopy were collected from the same place. Samples designated for TEM were preserved in glutaric aldehyde and phosphate buffer, immersed in Epon 812. Ultra-thin sections were stained using standard methods and examined in a Tesla BS 500 microscope. Those specimens designated for SEM examination were fixed in glutaric aldehyde, dehydrated and coated with carbon and gold layer before being examined in a scanning microscope Tesla BS 300. Samples were also collected for histochemical analyses. The activity of steroid-3-beta-ol-dehydrogenase (3βHSD) in cryostatic sections was determined using the method by Levy et al (1959).

Samples of epididymis (head, corpus, tail), prostate gland, vesicular glands and bulbourethral glands were also collected for histopathological examination. They were fixed in buffered 10% formalin, embedded in paraffin blocks, and the obtained microtome sections were stained with hematoxilin and eosin (HE) and periodic acid Schiff (PAS) according to McManus and Mowry (1960).

Samples of liver and thyroid gland were collected for microscopic examination. Microtome sections obtained from paraffin blocks were stained using HE and PAS. Morphometric measurements were made on the thyroid gland to determine the volume of vesicles and depth of the vesicular epithelium. Finally, morphometric results were analysed statistically with the Student–Newman–Keuls q-test and F-test of significance for two-factorial experiments.

Samples of ejaculates were taken during the second year of the study by the manual method once a week. Evaluation of semen quality (volume, concentration, motile) was carried out every 2 weeks by Bielański's method (1979). The results were analysed with the Duncan test for one-factorial experiment.

RESULTS

Morphometric characteristics of boar testes are presented in table II.

Testes of boars from the SOY group at the end of the first year were composed of oval tubules lined with seminiferous epithelium showing some signs of early degeneration. Elongated and circular spermatids separated from the supporting cells (fig 7) and gigantic spermatid cells could be observed in the lumen of individual tubules. Numerous collagen fibres were present around the tubules and blood vessels. Lysis of individual cells, their dissociation or pycnotic nuclei were observed in the interstitial cells (fig 8). Leydig cells showed moderate activity of 3βHSD.

Epithelium hypertrophy was observed in the head and corpus of the epididymides of boars from the SOY group, indicated by verrucal thickenings and intraepithelial cysts. These changes resulted in a festoon outline of the duct lumen. Atrophy of cilia was observed in epithelial cells of the epididymal tail (fig 9).

Testes of RSM boars at the end of the first year were composed of oval seminiferous tubules in which thin germinal epithelium was observed (fig 10). Numerous collagen fibres were observed around the tubules and blood vessels as in the SOY group. Leydig cells were not so numerous as in the SOY group, and showed strong 3βHSD activity.

Epithelium of the epididymal duct was undulated and small foci of coagulation necrosis were observed while cells of the head and corpus in many places did not have cilia just as in the epididymal tail of the SOY group.

Testes of PFRS boars at the end of the first year were composed of seminiferous tubules of different shapes with their germinal epithelium desquamated into the lumen. Some tubules underwent atrophy (fig 11), and others had thin germinal epithe-

Table II. Comparison of morphometrical signs in testis of boars.

Specification	*SOY* $\bar{X} \pm SEM$	*RSM* $\bar{X} \pm SEM$	*PFRS* $\bar{X} \pm SEM$
Left testis weight after first year of experiment (g)	347.5 ± 16.9 a,x	363.9 ± 24.3 a,x	400.5 ± 26.0 a,X
Left testis weight after second year of experiment (g)	415.0 ± 61.3 a,x	536.7 ± 167.4 a,x	665.5 ± 104.8 a,Y
Right testis weight after first year of experiment (g)	331.5 ± 18.4 a,x	367.8 ± 24.7 a,x	386.0 ± 21.5 a,x
Right testis weight after second year of experiment (g)	407.5 ± 47.9 a,x	550.0 ± 125.0 a,y	572.5 ± 131.4 a,y
Left testis length after first year of experiment (mm)	111.2 ± 3.5 a,x	108.0 ± 3.9 a,x	113.2 ± 4.2 a,x
Left testis length after second year of experiment (mm)	114.7 ± 11.3 a,x	118.3 ± 10.9 a,x	128.8 ± 3.8 a,y
Right testis length after first year of experiment (mm)	104.2 ± 5.5 a,x	104.0 ± 3.7 a,x	114.2 ± 3.9 a,x
Right testis length after second year of experiment (mm)	114.7 ± 19.9 a,x	112.7 ± 20.8 a,x	137.0 ± 3.0 a,y
Left testis breadth after first year of experiment (mm)	71.5 ± 3.5 a,x	64.3 ± 3.3 a,x	73.8 ± 2.5 a,x
Left testis breadth after second year of experiment (mm)	69.7 ± 2.8 a,x	75.3 ± 10.3 a,x	91.7 ± 8.8 a,y
Right testis breadth after first year of experiment (mm)	69.5 ± 2.3 a,x	65.1 ± 3.5 a,x	72.2 ± 1.9 a,X
Right testis breadth after second year of experiment (mm)	72.3 ± 4.3 a,x	83.0 ± 6.1 a,y	92.7 ± 9.3 a,Y

a, Differences between groups; X,x,Y,y, differences in groups; a,x,y: $P \leq 0.05$; X, Y: $P \leq 0.01$.

lium similar to the RSM group. Thick connective tissue bands and numerous collagen fibres were noticeable around blood vessels similar to other animals after the first year of the study; also Leydig cells were not numerous, and analogous to the RSM group showed strong 3βHSD activity. Epithelium of the epididymal duct was similar to the SOY group but additionally small necrotic foci of epithelial cells of the head and corpus were observed.

Seminiferous tubules of SOY boars contained some gigantic cells (fig 12) on completion of the 2-year study while vacuolisation of germ cells was observed. In individual tubules the epithelium was separated from the basement membrane and desquamated into the tubule lumen stronger than after the first year (fig 13). TEM examination revealed the presence of additional laminae in the basement membrane. Sertoli cells contained large lipid drops and myelin-like structures as pathological changes. Unusually, numerous collagen fibres were present around tubules and in the intertubular tissue. Myofibroblasts contained fragments of

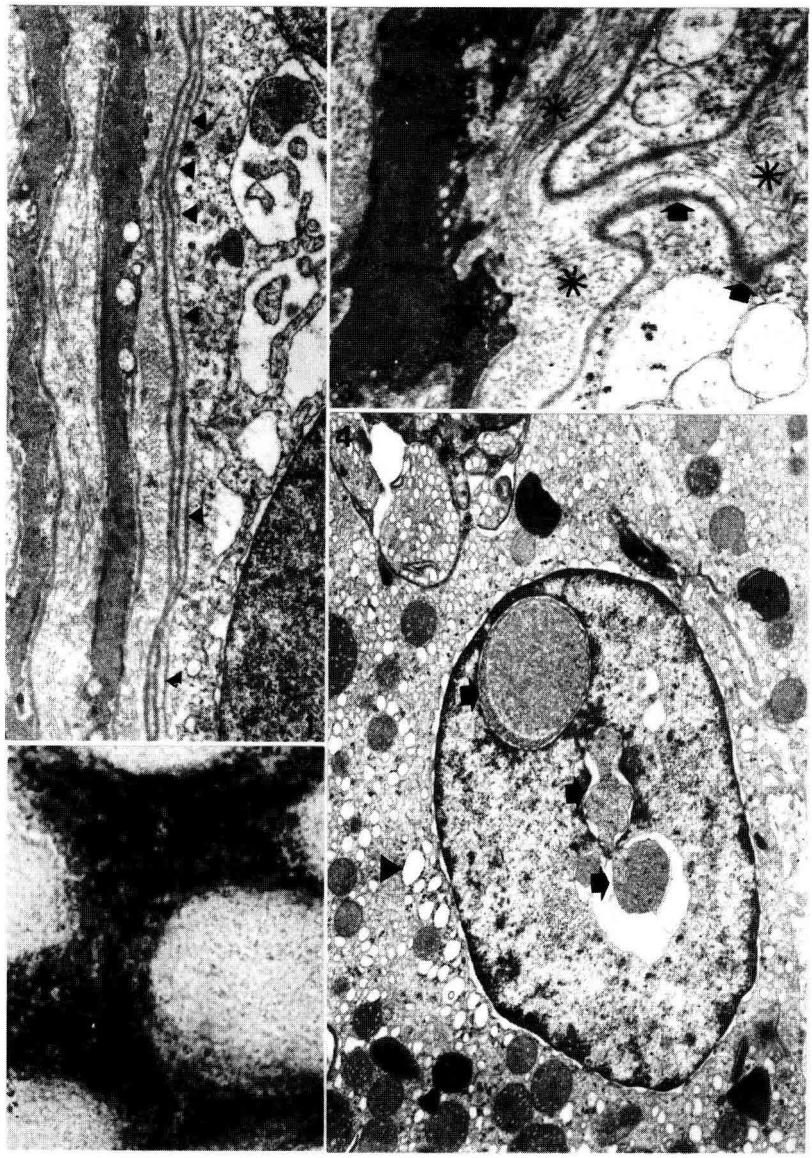


Fig 1. Additional laminae in the basement membrane (arrowhead) of the RSM boar after 2 years of the experiment. TEM, original magnification × 6 000.
Fig 2. High activity of steroid-3-beta-ol-dehydrogenase in Leydig cells of the RSM boar after 2 years of the experiment. Reaction according to Levy et al (1953), original magnification × 480.
Fig 3. Thickening of the basement membrane of seminiferous tubules (arrow) and numerous collagen fibres (asterix) in the PFRS boar after 2 years of the experiment. TEM, original magnification × 10 000.
Fig 4. Inclusion bodies in the nucleus of a Leydig cell (arrow) and enlarged tubules of smooth endoplasmatic reticulum (arrowhead) in the PFRS boar after 2 years of the experiment. TEM, original magnification × 6 000.

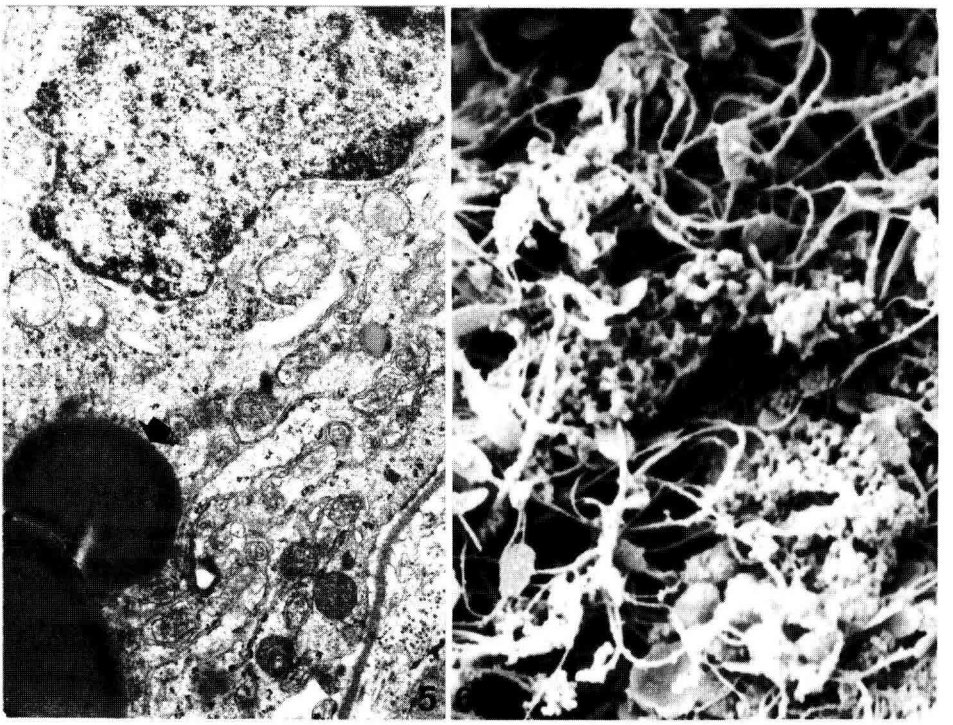


Fig 5. Numerous lipid drops in a Sertoli cell (arrow) in the PFRS boar after 2 years of the experiment. TEM, original magnification × 8 000.
Fig 6. Numerous spermatozoa and protein substance in the lumen of a seminiferous tubule of the PFRS boar after 2 years of the experiment. SEM, original magnification × 2 500.

collagen fibres, a sign of disturbances of collagen metabolism or dysfunction of myofibroblasts.

Evidence of vacuolisation and disintegration of germinal epithelium was observed in the seminiferous tubules of RSM boars after 2 years (fig 14). Some tubules were atrophied. Numerous collagen fibres were present around the tubules and blood vessels, and also in the intertubular tissue (fig 14). TEM examination revealed the presence of additional laminae in tubule basement membranes (fig 1). Sertoli cells contained large lipid drops. Leydig cells were not numerous and some had pycnotic nuclei while others had undergone necrosis and lysis (fig 15), whereas others showed a high activity of 3βHSD (fig 2).

Seminiferous tubules of PFRS boars contained numerous gigantic eosinophilic cells and their epithelium was composed of a few primary spermatocytes and of spermatids. Membrane propria atrophied in some tubules and numerous collagen fibres were present between them. TEM examination revealed thickening of the basement membrane (fig 3) often consisting of several laminae, the same as in the RSM group. Sertoli cells contained large lipid drops (fig 5). Nuclei and cytoplasm of Leydig cells on the other hand contained myelin-like structures and inclusion bodies (fig 4).

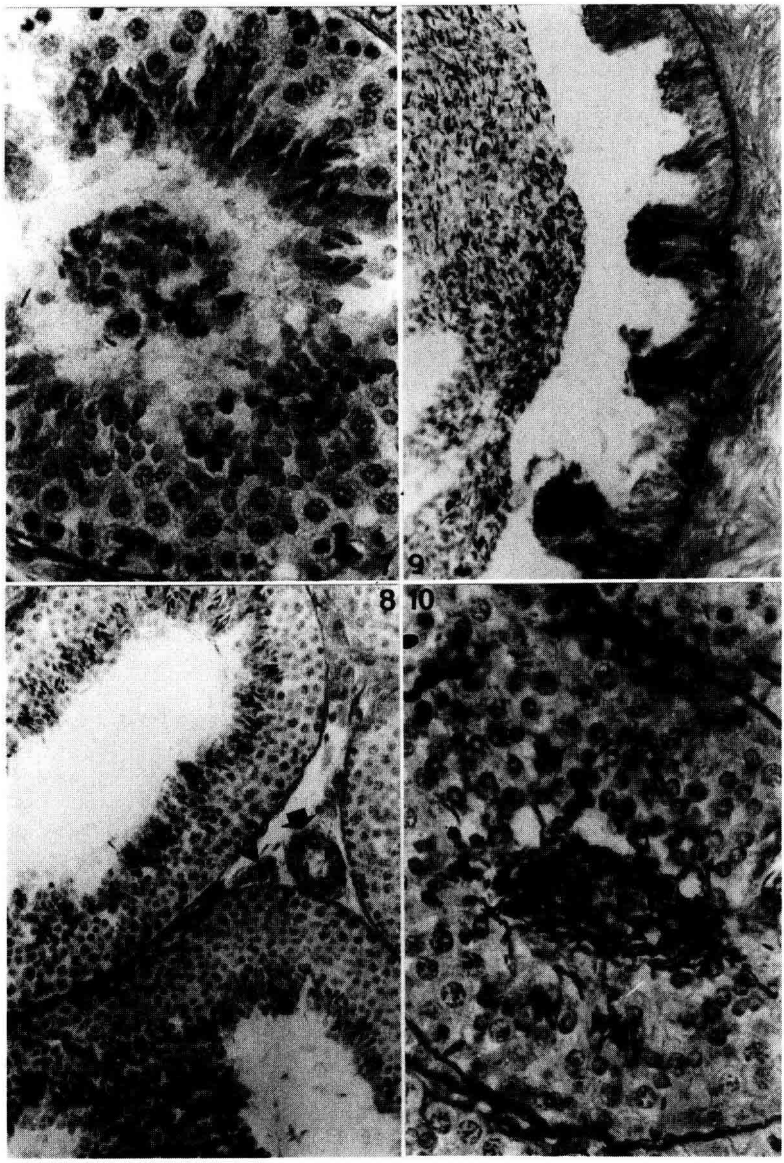


Fig 7. The SOY group testis after 1 year. Elongated and circular spermatids in the lumen of the tubule. HE stained, original magnification × 960.
Fig 8. The SOY group testis after 1 year. Fibrosis around a blood vessel (arrow). Pycnosis of an interstitial cell nuclei (arrowhead) and lysis of Leydig cells. Normal germinal epithelium. PAS stained, original magnification × 480.
Fig 9. The SOY group testis after 1 year. Atrophy of cilia in epithelial cells of the epididymal tail. PAS stained, original magnification × 480.
Fig 10. The RSM group testis after 1 year. Thin germinal epithelium with relatively few primary spermatocytes. Stasis of semen in the tubule lumen. PAS stained, original magnification × 960.

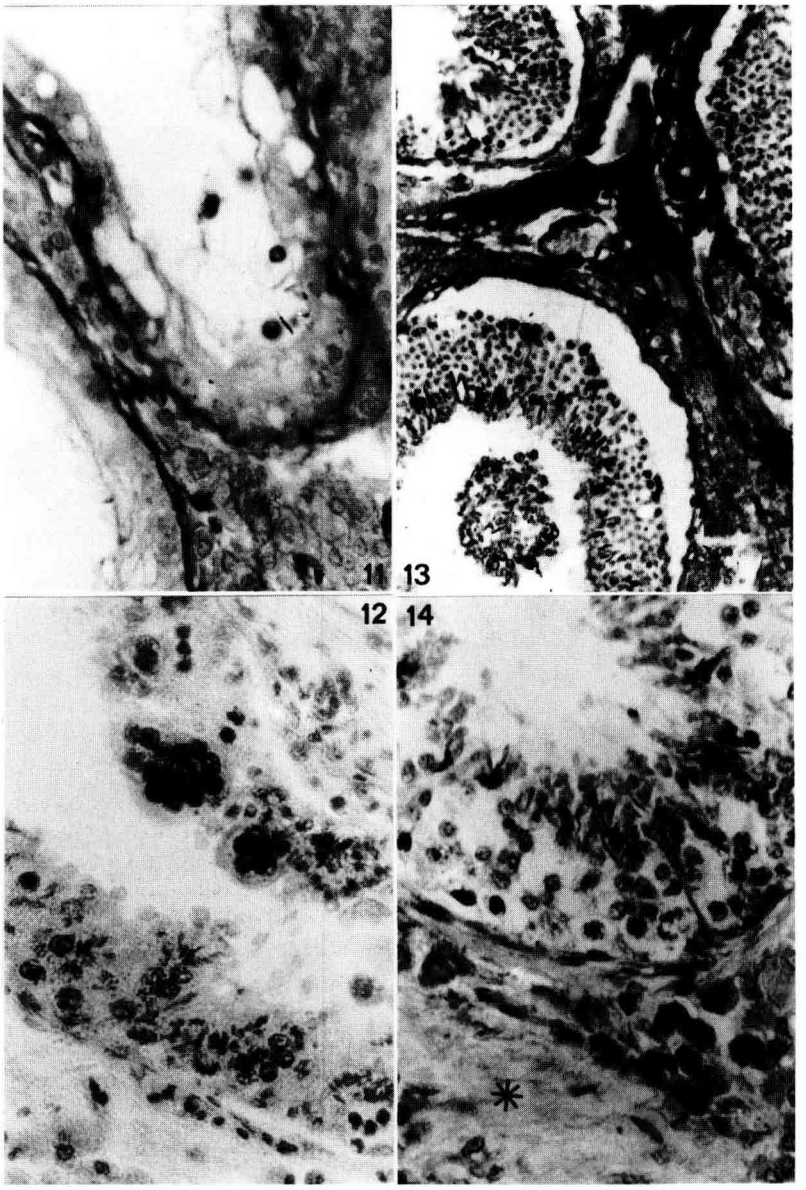


Fig 11. The PFRS group testis after 1 year. Atrophy of seminiferous tubules. PAS stained, original magnification × 960.
Fig 12. The SOY group testis after the second year. Gigantic cells in greminal epithelium. HE stained, original magnification × 960.
Fig 13. The SOY group testis after the second year. Desquamation of germinal epithelium into the tubule lumen. Fibrosis and hyalinisation of interstitial tissue. PAS stained, original magnification × 480.
Fig 14. The RSM group testis after the second year. Vacuolisation and disintegration of germinal epithelium. Fibrosis of intertubular tissue (asterix). HE stained, original magnification × 960.

After 2 years of the experiment, the epididimal duct was covered with epithelium of varying thickness (fig 16) containing verrucal thickenings and foci without cilia.

SEM revealed that the epithelium of seminiferous tubules was composed of closely packed cells of different size. There were spermatozoa and concretions of granular protein substance in tubule lumen (fig 6).

After the first year of the experiment, the morphological picture of the prostate gland was normal in all boars. After 2 years, SOY and RSM boars showed infiltration of lymphoid cells, histocytes, and some neutrophil granulocytes in their prostates. Proliferation of glandular epithelium and its hypertrophy, as well as proliferation of connective tissue were observed in some boars.

There was also cell infiltration, proliferation of glandular epithelium in the prostate of PFRS boars, and stasis of secretion was observed.

Vesicular glands were composed of normal large vesicles with fairly thick epithelium after the first year, and contained large amounts of PAS-positive secretion in all animals.

After 2 years of the experiment, vesicular glands in the control animals were normal. In RSM boars vesicles of various size were observed, and many vesicles had very thick and proliferating epithelium. Gland content also varied; it was homogeneous in some vesicles, dense and darker stained with eosin in others, frequently with fibrous structure and strongly PAS-positive. Similar changes were observed in vesicular glands of PFRS boars.

The parameters of semen are presented in table V. The data showed that the ejaculates of RSM boars were of smaller volume than others, but semen concentration, total number of spermatozoa and sperm motility were highest in this group. The differences between means were statistically significant.

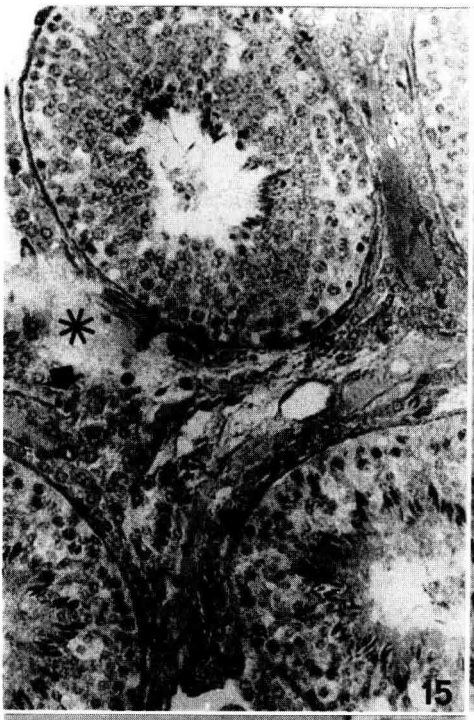
Thyroid glands of SOY boars were composed of one-size vesicles after the first as well as the second year, lined with fairly thick epithelium and contained homogeneous colloidal matter. A few marginal vacuoles were present at the colloid periphery.

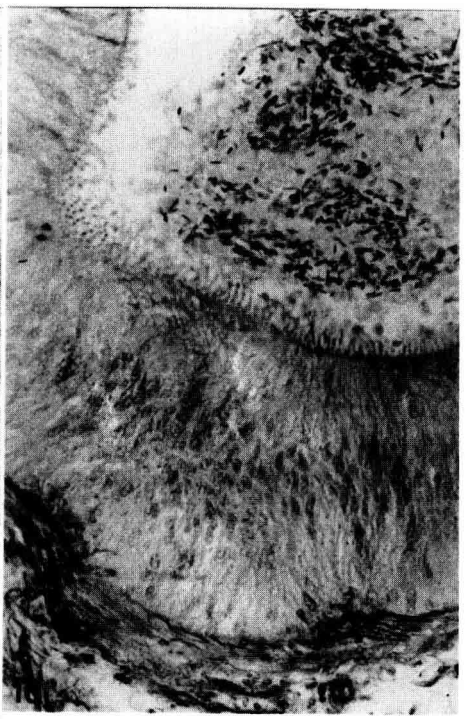
Thyroid glands of RSM boars were enlarged after 1 year of the experiment, composed of numerous large vesicles lined with very flat epithelium. They also contained medium-size and small vesicles, but these were lined with thick epithelium composed of cylindrical cells. Vesicle colloid was homogeneous, although fairly numerous marginal vacuoles were present at its periphery. Thyroid glands of these boars contained prevalent vesicles of medium size after 2 years of studies, whilst very large vesicles were present at the periphery of the glands. Epithelium lining the vesicles was flat and colloid was homogeneous with few marginal vacuoles.

Thyroid glands of PFRS boars were composed mostly of small and medium-size vesicles. Large and very large vesicles predominated at the gland's periphery. Epithelium lining these vesicles was very varied; there were vesicles with very flat as well as very thick epithelium. Colloid was homogeneous and contained a few marginal vacuoles. Large and medium-size vesicles predominated after 2 years; they were lined with flat epithelium (fig 17). The results of morphometric examinations of thyroid glands are presented in table III.

Livers of SOY boars were composed of properly developed lobules surrounded by clearly visible stripes of connective tissue. Hepatocytes contained some glycogen grains. Focal proliferation of hepatocytes and forming of pseudo-lobules surrounded by thin stripes of connective tissue was observed in some boars.

Livers of the animals from the RSM and PFRS groups had a similar structure to SOY boars after 1 year of the experiment. Liver lobules were surrounded by thick stripes of





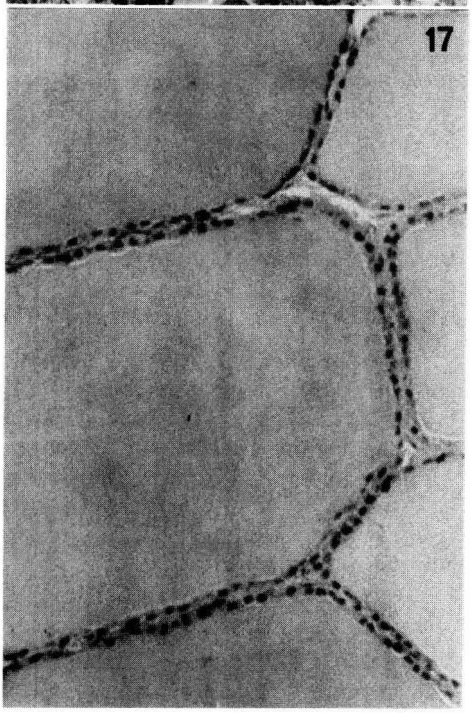


Fig 15. The RSM group testis after the second year. Pycnosis of Leydig cell nuclei (arrow). Foci of interstitial cell lysis (asterix). HE stained, original magnification × 480.
Fig 16. The PFRS group epididymis after the second year. Epididymal duct epithelium hypertrophy. HE stained, original magnification × 480.
Fig 17. The RSM group thyroid after 1 year. Flat epithelium lined large vesicles. HE stained, original magnification × 480.

Table III. Comparison of morphometrical signs in thyroid glands of boars.

Specification	*SOY* $\bar{X} \pm SEM$	*RSM* $\bar{X} \pm SEM$	*PFRS* $\bar{X} \pm SEM$
Thyroid gland weight after first year of experiment (g)	8.25 ± 0.51 b X	15.01 ± 1.91 a x	12.86 ± 1.66 ab X
Thyroid gland weight after second year of experiment (g)	21.01 ± 1.94 a Y	24.15 ± 1.35 a y	28.80 ± 6.52 a Y
Percentage number of very large vesicles $0.1 < V$ mm^3 after first year of experiment	3.05	7.46	7.98
Percentage number of large vesicles $0.01 < V < 0.1$ mm^3 after first year of experiment	17.38	19.75	24.57
Percentage number of medium-sized vesicles $0.001 < V < 0.01$ mm^3 after first year of experiment	48.78	44.68	43.26
Percentage number of small vesicles $V < 0.001$ mm^3 after first year of experiment	30.79	28.11	24.19
Percentage number of very large vesicles $0.1 < V$ mm^3 after second year of experiment	5.09	6.54	5.64
Percentage number of large vesicles $0.01 < V < 0.1$ mm^3 after second year of experiment	19.96	17.48	25.88
Percentage number of medium-sized vesicles $0.001 < V < 0.01$ mm^3 after second year of experiment	42.47	56.64	47.33
Percentage number of small vesicles $V < 0.001$ mm^3 after second year of experiment	32.48	19.34	21.15

a,b, Differences between groups; X,x,Y,y, differences in groups; a,b,x,y: $P \leq 0.05$; X,Y: $P \leq 0.01$.

connective tissue. Infiltration of eosinophilic and lymphoid cells was observed around vessels of portal spaces. Pseudo-lobules and proliferation of hepatocytes were also noted. Some glycogen granules were present in liver cells. Liver weight in the boars from RSM and PFRS groups was greater than in other animals and this variation was statistically significant (table IV).

The structure of the liver in SOY boars after 2 years was similar to that after 1 year of the experiment. In contrast livers of RSM boars had numerous pseudo-lobules, proliferated interlobular connective tissue, and infiltration of lymphoid cells and eosinophilic granulocytes in portal spaces. Hepatocytes around central veins were parenchymatic and vacuolar degenerated;

Table IV. Weight of boar liver (g).

Specification	*SOY* $\bar{X} \pm SEM$	*RSM* $\bar{X} \pm SEM$	*PFRS* $\bar{X} \pm SEM$
Average weight after first year of experiment	1819 ± 74 B X	2142 ± 118 A,B x	2201 ± 92 A X
Average weight after second year of experiment	2463 ± 284 a Y	2883 ± 217 a y	3165 ± 380 a Y

A,a,B, Differences between groups; X,x,Y,y, differences in groups; a,b,x,y: $P \leq 0.05$; X,Y: $P \leq 0.01$.

Table V. Semen quality and quantity of boars.

Specification	*SOY* *n = 148*	*RSM* *n = 97*	*PFRS* *n = 143*
Ejaculate volume (cm^3)	260.30 ± 3.78 A	234.30 ± 5.00 B	268.30 ± 4.48 A
Strained volume (cm^3)	197.00 ± 2.66 a,b	184.20 ± 3.47 B,b	208.80 ± 3.61 A,a
Spermatozoa concentration ($\times 10^9/cm^3$)	0.365 ± 0.012 B	0.488 ± 0.022 A	0.378 ± 0.009 B
Total number of spermatozoa in ejaculate ($\times 10^9$)	71.50 ± 2.22 B	87.03 ± 3.31 A	76.77 ± 1.87 B
Motile sperm (%)	59.80 ± 1.22 B	70.80 ± 1.38 A	67.60 ± 1.05 A

A, B, Significant differences ($P \leq 0.01$); a, b, significant differences ($P \leq 0.05$).

they were frequently dissociated from each other. Stellate cells were enlarged and proliferated in many places while liver cells contained some PAS-positive granules. The morphotic picture of the liver in the PFRS group after 2 years was the same as that of RSM boars. The changes may be interpreted as adaptative processes.

DISCUSSION

Rapeseed meal and rape seeds can be added to the diet of domestic animals as a source of protein, but the percentage level of these components should not be too high owing to the fact that rape seeds contain substances affecting thyroid gland and liver function. Studies carried out by Fritz et al (1992) suggested that diets containing 5% rapeseed meal of the 00 Jantar variety were suitable for feeding boars. No information was found in the available literature on the effect of rapeseed meal or rape seeds upon morphology of the reproductive system in these animals.

Administration of feeds with proper protein content is especially important for the

functioning of the boar reproductive system. Studies by Louis et al (1994) showed that low protein levels had a negative effect on the animal libido, ejaculate volume and 17-beta estradiol concentration in the blood. This had a detrimental effect on the function of Sertoli and Leydig cells, as shown in the studies by Carreau et al (1994) and Yazama et al (1990). These authors revealed the key role of Sertoli cells in the formation of a favourable microenvironment for production of germ cells, specially by formation of a blood–testis barrier. In our study there were additional layers of basal lamina produced by myofibroblasts and Sertoli cells.

Testes and epididymides of boars are also very susceptible to feeding regimes, food components or toxic substances in the feed. Wallgren et al (1993) showed high susceptibility of boar testes to intoxication in the studies on endotoxines, and so did Piskac et al (1982), who studied the effect of aflatoxins on testis structure. Studies by Brun et al (1991) performed on boars revealed that the testes were also injured by some medicines and various feed components. Morphotic responses of testes to toxins in the diet consist of degeneration of seminiferous epithelium, changes in the tubule membrane, hyalinisation of blood vessels and tubules, thickening of basement membranes or changes in the amount of connective tissue and injury to interstitial cells. A diet containing rapeseed meal and rape seeds caused similar degenerative changes including collapse of the seminiferous tubule accompanied by an increase in 3βHSD activity, testis fibrosis as well as changes in the epididymal duct epithelium. The histological picture of the testis also depends to a large extent on the amount of ingested feeds, as shown by Langenfeld et al (1992). These authors used different feeding rates and showed that in the case of boars there were significant differences in the diameter of seminiferous tubules, size of interstitial cells and the epididymis structure.

Morphotic and functional responses of boar testes to destructive factors depend on the animal age, breed, body weight and even on testis size, as has been shown in the studies by Basurto-Kuba (1983), Buchanan (1987), Dubiel et al (1992), Borg et al (1993). The increase in testis weight, which was caused more by connective tissue and collagen fibre proliferation than by hypertrophy of seminiferous tubules, seems to be an adaptative and protective response of the animal to a diet containing rapeseed products.

Degenerative-productive changes in testes and epididymides intensified with animal age (Frankenhuis et al, 1982; Shyu et al, 1985; Kojima 1990). Studies by Houszka et al (1988) and Osvath and Wekerle (1989) revealed that these processes took place in old sterile boars, which subsequently underwent castration. Our studies also showed an intensification of damage to the seminiferous tubule as the boar grew older. Such damage included early degeneration of seminiferous epithelium and connective tissue proliferation as well as injury of the epithelium in the epididymal duct. These changes appeared even in the control group.

Time-related changes were observed in boars of different age in the course of the studies by Lunstra et al (1986). Leydig cells show submicroscopic changes which increase with age, in numerous organelles, mostly in the smooth and rough endoplasmatic reticulum, mitochondria and nuclei. A similar pattern was observed in the experiment. Also an increase in size and weight of internal organs of all of the examined animals was caused by growth.

Testosterone production is the essential function of Leydig cells (Payne and Youngblood 1995). The ability to produce steroid hormones changes with animal age, as has been shown by Allrich et al (1983). Steroid-3-beta-ol-dehydrogenase (3βHSD) activity is a good index of production of these hormones. Our studies showing that 3βHSD

activity increased in boars on diets containing rape products suggest that the organism tends to sustain production of spermatozoa even when the seminiferous epithelium is damaged.

The boar epididymidis was extensively studied by a number of scientists, including Kozumplik (1987), Wystub et al (1989a, b), Stoffel et al (1990, 1991), Stoffel and Friess (1994), who showed a high sensitivity of the epithelium to damage and its ability to hypertrophy. The same phenomena were seen in all animals in our experiment.

The parameters of ejaculates were similar to the results of experiments described by Łyczynski (1984), Dubiel (1987), Czarnecki et al (1991), Fritz et al (1992) and Glogowski (1993), Michalski and Polańska (1983). The results showed that there was no unequivocal and consequent influence on the quality and quantity parameter of semen. Only secretion of accessory glands was significantly lower in experimental groups, which was manifested by low semen volume.

Vesicular glands and the prostate gland play an important role in semen production in the boar. RSM and PFRS boars showed negative changes in the accessory glands resulting in reduced volume and lower protein content in the ejaculates as was described above.

The damaging effect of the discussed diets on thyroid structure was observed only after 1 year of a diet of feeds containing rapeseed meal. There was no such effect when the animals were on diets containing rape seeds. It is difficult to interpret the enlargement of thyroid glands. It can be assumed that the enzyme myrosinase was liberated during rapeseed meal production. This enzyme causes synthesis of glucosinolates that inhibit thyroid function. Hence, intact rape seeds were less toxic than rapeseed meal, so that their inhibiting effect on the thyroid gland became noticeable only after 2 years of this diet.

The effect of diets containing rape seeds or rapeseed meal on the thyroid gland is directly reflected in the function of Sertoli cells. Studies by Palmero et al (1995) showed that there were specific receptors of T3-iodothyronine in Sertoli cells, so that feeds containing substances which inhibit thyroid might disturb development and function of boar testes as well as have an influence on low protein content, as earlier described.

The examined diets containing rape seeds or rapeseed meal injured the liver. The microscopic observations indicated that the liver injury was characteristic for toxic hepatitis and portal cirrhosis.

The causes of portal cirrhosis and acute toxic hepatitis are thought to be the same; however, the kind of inflammation depends on the amount of toxic substances ingested in a given period. Smaller amounts act more slowly and produce the portal cirrhosis. On the other hand, some cases of portal cirrhosis may represent the final result of an attack of acute toxic hepatitis. In domestic animals chronic poisoning by plants is suspected to be the most likely cause. In our study the low amount of poison led to portal cirrhosis and to infiltration with inflammatory cells in the portal areas. Increased amount of rapeseed products in diets may cause acute toxic hepatitis and even hepatocyte necrosis.

Our studies revealed morphotic changes in the boar reproductive system, the liver and the thyroid gland. These processes were accompanied by adaptation that enabled production of normal spermatozoa in the testes.

Our experiment was extended over a period of 2 years and showed that the effect of 10% 00 rapeseed meal in the boar diet was similar to the effect of a 12% content of seeds of the same rape variety. Such diets could be fed to boars. However, there is a danger that exceeding the 10 and 12% limits may well lead to exceeding the adaptative ability of the boar organism.

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