

Performance, immune response and metabolic state of pigs after feeding of rapeseed meal and interactions between goitrogenic compounds and iodine supplementation

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Prerequisites for the feeding of rapeseed meal (RSM) primarily from high glucosinolate varieties are the supplementation of diets with I, but the removal of anti-nutritive substances as well. Due to the infiltration of RSM with a copper sulphate solution (Cu^{2+}) with following drying, oxazolidinethiones (OT) and isothiocyanates (ITC) were inactivated and the performance of growing pigs was almost normalized (Lüdke and Schöne 1987). We hypothesized that the antinutritiva (i.e. I antagonists) inactivation affected the I state of growing pigs. Therefore, diets containing 8 % untreated RSM or RSM treated with Cu^{2+} were supplemented from 0 to 1 mg I/kg and the resulting thyroid (hormone) status was investigated. The immune response and clinical-chemical criteria were used to complete the evaluation of I supply and goitrogenic compounds exposure.

Material and methods

The trial was carried out with 50 crossbred pigs (Landrace x Large White) with a mean initial weight of 20 kg. The experimental diets contained 8 % RSM untreated (0.38 % ITC and 1.19 % OT in the RSM dry matter) or treated by means of Cu^{2+} (OT and ITC non detectable). The composition and the nutrient content of diets and

the number of animals per I dosage group were given by Schöne et al. (1985). Apart from the biweekly determination of body weight and feed intake, blood was sampled (after 12-hour feed withdrawal) at the end of the 4th, 10th and 15th week.

For the detection of the immune response at the end of the experiment, 42 animals were vaccinated with three antigens on the 90th day (for details see Schöne et al. 1987). The parameters used as well as the analytical methods and the statistical evaluation of results are described by Schöne et al. (1985, 1986 and 1987). The results are given as the arithmetic mean (\bar{x}) and standard deviation (s).

Results

The feeding of the diet containing untreated RSM without I supplementation reduced feed intake and live weight gain from the 6th week onwards. On the 70th day, the feed intake depression caused by the dietary I deficit and goitrogenic compounds was significant (Tab. 1).

Since there were no significant differences in the performance criteria between the tested I dosages both in the RSM groups and in the RSM Cu^{2+} groups (Schöne et al. 1985), these data were pooled. Further findings were dealt with in a similar way. Compared to the groups with untreated RSM, feed intake, live weight gain and feed gain ratio were significantly improved when RSM treated with Cu^{2+} was given. Even pigs fed the RSM- Cu^{2+} diet without I supplementation achieved the fattening performance of the control group (Tab. 1).

Feeding the RSM as well the RSM Cu^{2+} diet without I supplementation caused a T_4 deficit and a strongly increased thyroid weight (Tab. 2). However only the animals which received the RSM diet showed visible I deficiency symptoms (myxedema and cretinism). These hypothyroid animals had the heaviest livers (Tab. 2) and the serum urea level was significantly increased (Tab. 1). With regard to the other serum parameters, only

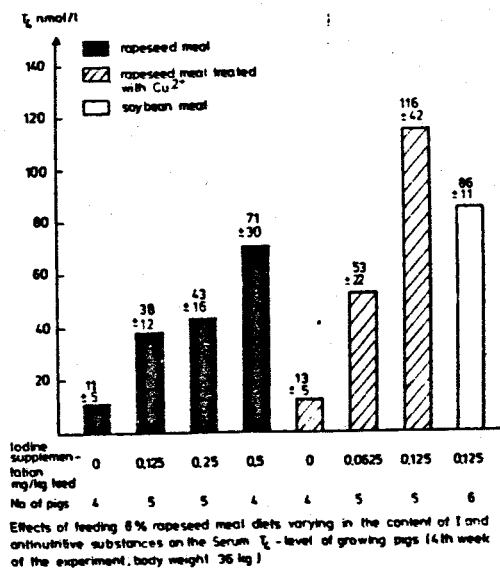
Table 1 : Performance and blood (serum) constituents of growing pigs fed rapeseed meal diets varying in the content of I and antinutritive substances (10th week of the experiment)

I supplementation	Rapeseed meal		Cu ²⁺ treated rapeseed meal		Soybean meal	Significance		
	-	+	-	+		P < 0.05	I	Cu ²⁺
n	4	18	4	18	6			
Feed intake kg/d	\bar{x} 1.82 s 0.06	2,16 0.10	2,32 0.12	2,34 0.18	2.33 0.13	*	*	*
Live weight gain g/d	\bar{x} 454 s 103	601 57	710 63	698 64	682 44	-	*	*
Feed gain ratio	\bar{x} 4.14 s 0.82	3.62 0.34	3.28 0.19	3.35 0.17	3.41 0.08	-	*	*
Live weight kg	\bar{x} 53 s 8	63 4	71 5	70 5	69 4	-	*	*
<u>Blood</u>								
Red blood cell count 10 ⁶ /ml	\bar{x} 3.9 s 0.4	4.7 0.6	4.0 0.7	5.1 0.5	5.0 0.4	*	-	-
Hemoglobin mmol/l	\bar{x} 5.8 s 0.6	6.8 1.0	6.5 0.6	7.3 0.5	7.2 1.2	-	-	-
<u>Serum per l</u>								
T ₄ nmol	\bar{x} 16 s 2	75 30	15 2	91 29	61 14	*	-	-
Urea mmol	\bar{x} 6.6 s 1.0	5.0 0.6	5.6 0.8	4.8 0.6	5.3 0.8	*	*	-
Inorganic P mmol	\bar{x} 2.9 s 0.3	3.7 0.5	2.9 0.2	3.5 0.4	3.4 0.4	*	-	-
Alkaline phosphatase nmol	\bar{x} 0.40 s 0.08	0.79 0.14	0.80 0.25	1.12 0.24	0.97 0.10	*	*	*
Zn μ mol	\bar{x} 7 s 2	18 4	14 3	21 2	20 4	*	*	-
Cu μ mol	\bar{x} 26 s 2	28 3	29 2	35 4	38 4	-	*	*
Fe μ mol	\bar{x} 27 s 7	18 6	17 8	21 7	19 6	-	-	-

Table 2: Thyroid and liver weight (per kg body weight) of growing pigs fed rapeseed meal diets varying in the content of I and antinutritive substances (day 105 of the experiment)

I supplementation	Rapeseed meal		Cu ²⁺ treated rapeseed meal		Soybean meal	Significance $P < 0.05$		
	-	+	-	+	+	I	Cu ²⁺	Diets
n	4	17	3	18	6			
Thyroid mg	\bar{x} 805 s 353	\bar{x} 273 s 113	\bar{x} 648 s 355	\bar{x} 112 s 45	\bar{x} 89 s 29	*	*	*
Liver g	\bar{x} 24.7 s 2.4	\bar{x} 18.8 s 1.0	\bar{x} 16.0 s 2.4	\bar{x} 14.3 s 1.6	\bar{x} 13.4 s 1.0	*	*	*

the depressed alkaline phosphatase and the Zn level clearly reacted to the I deficit connected with higher (RSM) or lower (RSM Cu²⁺) exposure via goitrogenic compounds. The serum T₄ level depended on the I supplementation. A clear effect of the different I dosage and antinutritiva ingested was only found after four weeks (Fig.).



The pigs fed RSM showed an increase of the serum T_4 level of up to 0.5 mg I supplementation/kg feed. But, when RSM Cu^{2+} was fed the serum T_4 content reached a very high level and a plateau even at 0.125 I supplementation/kg feed. A complete survey of the serum T_4 and T_3 levels in all dosage groups after 4, 10 and 15 weeks was given by Schöne et al. (1985). In the RSM as the RSM Cu^{2+} diet, the deficient I supply significantly impaired the serum antibody titers to the HGG and especially the LPS antigen (Tab. 3). In the case of the H anti-

Table 3: Serum antibody titers (-log 2) of growing pigs fed rapeseed meal diets varying in the content of I and antinutritive substances (administration of antigens 15 d before blood sampling at 105 d)

I supplementation	Rapeseed Cu^{2+} treated Soybean meal				Significance $P < 0.05$ I Cu^{2+} Diets			
	-	+	-	+				
n	4	14	3	15	6			
Antibody response to								
- H antigen ¹⁾	\bar{x} 3.8	4.1	5.0	4.2	4.0	-	-	-
- Lipopolysaccharid (LPS) ¹⁾	\bar{x} 3.0	5.9	4.0	5.9	7.2	*	-	-
- Human gamma globulin (HGG)	\bar{x} 5.0	6.9	5.3	6.3	7.0	*	-	-
	s 1.4	1.3	3.5	1.7	0.8			

1) from Salmonella dublin

gen, however, an effect of the diets on the serum antibody titer was not detected.

Discussion

In the present animal experiment, the usefulness of criteria of performance as well as of thyroid and liver status to evaluate the Cu^{2+} detoxified RSM was established.

In spite of the normal performance, the I deficit together with a lower quantity of goitrogenic compounds (RSM Cu^{2+}) also impaired the red blood cell count and some antibodies and the T_4 and P level in the serum. In another experiment, pigs which were given the same quantity of feed with I supplementation as their littermates suffering from I deficiency did not differ from the ad lib. control in respect to these serum parameters. The Zn content of serum and that of the bone (unpublished results), however, indicated the lack of I and goitrogenic compounds in the feed very sensitively. The serum alkaline phosphatase (a Zn-metalloenzyme, Roth and Kirchgessner 1979) reacted in the same way. An antagonism between Zn and antinutritiva of rapeseed meal (Anderson et al. 1976, Anke et al. 1979) and thyroistatics (Hennig et al. 1969) was described in rats and pigs. On the other hand, high Cu-dosages also impair the Zn state. We conclude from the results of our experiments that the goitrogenic compounds of RSM are more potent inhibitors of the Zn metabolism than the high Cu dosage. In further investigations, a normalized Zn status could be an indicator of the higher feed value of RSM from newer OO winter varieties.

Summary

In a trial with 50 growing pigs, untreated RSM (0.38 % ITC and 1.19 % OT in the dry matter) was compared to RSM treated with Cu^{2+} (ITC and VO not detectable). The diets were fed without and with I supplementation, 6 pigs fed a I-supplemented SBM diet served as control. Only the feeding of untreated RSM without I supplementation resulted in symptoms of I deficiency (myxedema and cretinism). But goiter, liver enlargement a depressed immune response and a decreased red blood cell count and serum T_4 and P level were also observed in animals which were given the RSM Cu^{2+} diet without I supplementation. In spite of the I supplementation, the feeding of untreated RSM impaired the performance, the thyroid (hormone), the liver and the Zn status. The detoxication of RSM with Cu^{2+} resul-

ted in a complete normalization of these criteria, with the I supplementation of these diets being the prerequisite.

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