Feeding of high glucosinolate rapeseed meal or administration of potassium thiocyanate and excretion of SCN^- in the urine of growing pigs.

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Glucosinolates contained in rapeseed (B. napus) are hydrolyzed to oxazolidinthiones (OT), isothiocyanates (ITC), nitriles, organic thiocyanates and thiocyanate ions (SCN^-; Bell 1984). Rapeseed meal (RSM) feeding increased the SCN^- concentration in blood serum, urine and milk in different species (for review see Schöne et al. 1986). In present investigations with growing pigs the urine SCN^- concentration and excretion should be evaluated with regard to the administration of defined RSM amounts. Animals fed diets without RSM or with KSCN were used as controls. The investigation of the serum SCN^- content in dependence on RSM or KSCN intake was carried out under consideration of possible interactions with iodine supply and the thyroid (hormone) status respectively.

Material and methods

In 54 piglets and 24 fattening pigs received RSM (experiment I) and RSM or KSCN (experiment II) the serum SCN^- content and thyroid (hormone) status were investigated. In 11 piglets and 25 fattening pigs fed RSM and in 12 piglets received KSCN, urine was collected in metabolic cages and the SCN^- excretion was determined (experiment III, IV and V). The SCN^- determination in serum and urine based on Aldridge's method modified by Langer and Michajlovskij (1958). Serum T_4 and T_3 were analyzed by a radioimmunoassay (for further data see Schöne et al. 1986). The experiments' results are given as arithmetic mean ($\bar{x}$) and standard deviation mean (s).

Results

Serum SCN^- and thyroid hormone content

Growing pigs fed a 8 % RSM diet without I supplementation suffered from hypothyroidism characterized by a deficiency of thyroid hormones, reduced feed intake and growth, cretinism and myxedema (table 1). When I or I and Cu

Table 1: Effect of feeding a 8 % rapeseed meal diet on body weight, thyroid (hormone) status and serum SCN^- level of growing pigs (Experiment I, 6 animals/group, initial body weight 27 kg, duration 19 weeks)

Supplementation/ kg diet		Soybean meal 0.1 mg I	Rapeseed meal –	1mg I	1mg I +250mg Cu	Significant difference P< 0.05
Body weight, kg	$\bar{x}$	132	77	107	116	26
	s	15	22	17	9	
Thyroid weight, mg/kg body weight	$\bar{x}$	93	1303	309	161	501
	s	38	433	149	11	
T_4, nmol/l serum	$\bar{x}$	62	<10	57	55	23
	s	16		22	10	
T_3, nmol/l serum	$\bar{x}$	1.73	0.82	1.27	1.32	0.50
	s	0.18	0.14	0.14	0.14	
SCN^-, mg/l serum	$\bar{x}$	1.6	3.0	3.6	4.2	1.5
	s	0.2	1.1	1.0	1.0	

were supplemented, the thyroid enlargement was partly compensated. Irrespective of the trace element supplementation or different goitre stage the serum SCN^- level of pigs fed the RSM diet was significantly increased.

In weaned piglets the administration of 200 mg KSCN/kg feed or feeding a 3 % RSM diet did not influence the performance (not shown). The serum SCN^- level of the control animals fed a diet consisting of grain, soybean meal and dried skimmed milk amounted to 0.7 mg/l. The inclusion of RSM or KSCN in the diet significantly increased the serum SCN^- level by factor 2 (1.5 mg/l) or 6 (4.0 mg/l). The serum T_3 level was significantly reduced by both SCN^- sources. The T_4 level was slightly depressed in the RSM group but it did not respond to the KSCN administration (for further data see Schöne et al. 1986).

SCN^- excretion via urine

In experiment III piglets were given an extreme diet with 20 % RSM. There was a highly significant linear relation between the intake of RSM and the excretion of SCN^- (Fig. 1). This interrelation is noticeable because of the intake varying within a relatively narrow range.

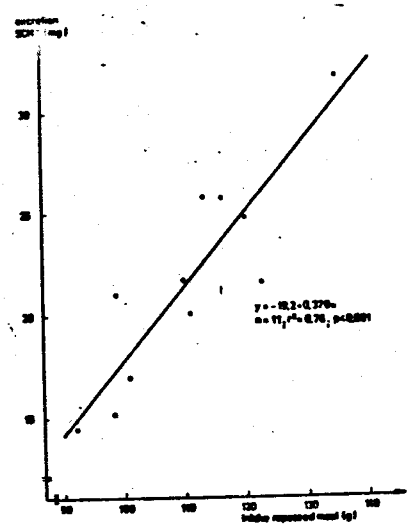

Figure 1: Relation between intake of rapeseed meal and excretion of SCN^- in the urine of piglets (11 piglets over 11 d, data per animal and d)

In fattening pigs, which were given the same feed amount of 2.5 kg/d, even 1 % RSM was reflected by an increased SCN^- concentration in urine (table 2).

Table 2: Effect of feeding a different rapeseed meal (RSM) quantum on the concentration and excretion of SCN^- in urine of growing pigs (114 kg body weight, 2.5 kg feed intake/d, 8 d collection of urine)

RSM % of the diet RSM intake (g/d)		0 0	1 25	2 50	4 100	8 200	Significant difference $P < 0.05$
Concentration (mg/l)							
- whole urine	$\bar{x}$	3.1	7.8	9.6	14.5	23.7	3.9
	s	0.3	1.8	1.7	3.7	1.4	
- spontaneous urine	$\bar{x}$	.	8.9	9.5	14.2	26.6	6.5
	s	.	1.0	1.5	3.4	6.0	
Excretion (mg/d)	$\bar{x}$	9.6	21.4	30.9	45.4	73.1	8.0
	s	2.3	2.0	2.5	6.6	5.6	

All tested RSM doses from 0 to 8 % were clearly reflected by an increasing urine SCN^- concentration. This is true both for urine samples representing the total test period and for those collected on the 5th experimental day.
In order to evaluate the SCN^- excretion of piglets and fattening pigs fed a certain RSM quantum, the SCN^- excretion dependent on the KSCN supply was determined.
With regard to 64, 192 and 576 mg SCN^- dosages offered daily 37, 57 and 48 % were recovered in urine (not shown).

Discussion

The intake of RSM and KSCN increased the serum and urine SCN^- level of growing pigs and reduced the serum T_3 level. These results generally confirm with findings in calves due to the administration of NaSCN (Steinbach et al. 1982, Weuffen et al. 1982) and point to an effect on the thyroid function or the deiodination reactions of thyroid hormones in peripherous tissues (Visser 1980). On the other hand the SCN^- level did not correlate with the goitrogenic action of the RSM administered (Tab. 1). According to Michajlovskij (1984) under these conditions the serum SCN^- increase only indicated the presence of stronger goitrogenic compounds (OT) in the organism. The origin of SCN^- is controversially discussed. It is known that SCN^- is formed by hydrolysis of indolylmethylglucosinolates and of sinalbine (Olsen and Sørensen 1980). Apart from this SCN^- release from precursors (McGregor 1978), a detoxication primarily of ITC and of nitriles via sulfur transferases (rhodanese) is assumed (Vennesland 1982). In figure 2 available experimental data with regard to the effect of RSM feeding on SCN^- excretion were contrasted with in vitro findings on the maximum SCN^- release from RSM.

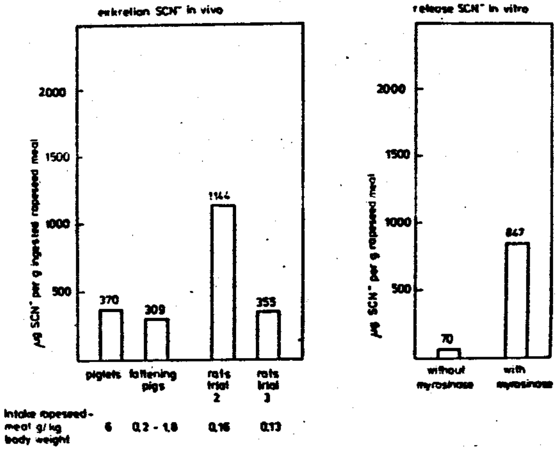

Figure 2: Excretion of SCN^- via urine in pig (Schöne et al. 1986) and rat (Paik et al. 1980) fed rapeseed meal and maximum in-vitro-release of SCN^- from rapeseed meal (McGregor 1978)

Under the assumption of 50 per cent absorption of SCN^- in the gastrointestinal tract, the amount of SCN^- recovered in urine of piglets (Fig. 1) and fattening pigs (Table 2) did not exceed the maximum amount released in vitro through myrosinase, following hydrolysis. According to these findings SCN^- appears in urine to the extent to which it had been originally contained in rapeseed meal or has been released through myrosinase of the gastrointestinal flora from glucosinolates. The detoxication of glucosinolate degradation products via rhodanese seems to be of less importance.

Summary

Five experiments were conducted with 126 growing pigs to establish the effects of rapeseed meal and potassium thiocyanate (KSCN) on serum levels of thiocyanate ions (SCN^-), T_4 and T_3 as well as on concentration and excretion of SCN^- in urine. Uptake of rapeseed meal or KSCN increased SCN^- levels in serum and urine and depressed the serum T_3 level. Serum SCN^- concentrations, following administration of rapeseed meal with and without addition of iodine or copper, failed to correlate with goitrogenic action and can be accepted merely as an indicator to the presence of agents with higher goitrogenic effect in the organism. Very close correlations were found between urineexcreted SCN^- and intake of KSCN or rapeseed meal. 370 respectively 309 µg SCN^-/g consumed rapeseed meal were excreted from piglets respectively fattening pigs.

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