Influence of low glucosinolate rapeseed meal on gestation, lactation and growth of rats in long-time feeding trial

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Introduction

Varieties of rapeseed /Brassica napus/ cultivated up to now in Poland are rich in toxic glucosinolates which severly limit utilization of rapeseed meal /RSM/ in animal feeding. During a last few years Polish plant breeders greatly reduced the level of glucosinolates in RSM with the introduction of low glucosinolate variety Start "OO". For this reason it should be possible to use substantially higher amounts of RSM in animal feeding withought any depression in growth. However, it has been shown that oilseed are high in phytic acid and perhaps other binding agents which might reduce mineral availability, especialy zinc. Zinc deficiency during gestation of rats fed rapeseed protein concentrate was reported to cause a marked loss of appetite and an increase in the percentage of still-born pups and its lower weight relative to casein control animals /Jones, 1979/. In our previous feeding trials /unpublished data/ it was shown that the Zn deficiency is much more severe in rats fed water-washed RSM than untreated RSM.

Presented studies were undertaken to determine the effect of long-term feeding of rapeseed meal from the low glucosinolate variety Start "OO" on growth, outcome of gestation, lactation and femur Zn and Ca content.

Materials and methods

Seed of Start "OO" variety /Brassica napus/ was treated with boiling water to destroy the enzyme myrosinase and extracted with hexane to remove the oil. The following glucosinolate composition was found /mg aglycone/ g meal/: butenyl isothiocyanate 0.50; pentenyl isothiocyanate 0.06; and oxasolidinethione 1.16. Phytate content was 3.45%.

Eight females successfully mated /mother generation/ were assigned to each of the two diets providing 20% of protein from Start meal and control- - casein supplemented with methionine. Three days after parturition one pup from each litter was taken for Zn and Ca analyses in carcass. All litters were standardised up to eight pups per litter. Twenty-six days after birth the mothers as well as offsprings, one from each litter, were killed and thyroid, liver, spleen, kidneys and femur were removed. Remaining animals were fed up to 54 days and eight rats from each group were killed and thyroid, liver, spleen and kidneys were weighted. 75 days after birth next rats were taken for measuring of organ weights and analyses of minerals in femur. Some females and males of the first generation, maintained on above diets, were mated, whereafter eight females with signs of pregnancy were put on further observations. Second gestation and lactation as well as growth of delivered rats were treated in the same way. Feed intake and weight gains were measured every 2 or 3 days.

Femur Zn and Ca contents were determined by atomic absorption spectroscopy after digestion of bone in an acid mixture as described by Brown et al. /1976/.

Results and discussion

The details of the reproductive performance of the two generations of rats are presented in Table 1. Feeding with Start meal during gestation of the mother females caused a reduction in weight gain, feed intake and weight of the first generation of pups but did not affect the number of the pups born. Lower body weight gain of the first generation of females, maintained on Start diet from birth, had no effect on gestation and lactation but lower body weight was observed in delivered pups of second generation, 20% and 30% lower in comparison with pups of first generation and pups on control diet, respectively. Feeding Start meal reduced also weight of the young rats 21 days after birth.

The thyroids and livers of the Start-fed females were enlarged compared to the casein fed groups /Table 2/. The increased liver weight reflects, at least in part, the lower body weight of the Start-fed rats. The kidneys and spleens weight of the mother rats were not affected by consumption of the RSM.

Weight gain and feed intake data of the growing rats of the first and second generation were significantly lower than the analogous data for casein fed rats /Table 3/. This could be due in part to the presence of glucosinolates in the meal. It is well known that myrosinase inactivation does not completely inhibit the hydrolysis of glucosinolates in the gastro--intenstinal tract of rats /Appelqvist and Ohlson, 1972/. In our experiment this was proved by significantly higher thyroid weight of growing rats /Table 4/ and of females after lactation /Table 2/.

The concentration of Zn found in pups carcasses and femur of females and growing rats are shown in Table 5. No difference was observed in Zn level in pups althought concentration of this mineral in femur of mothers indicated a reduced Zn availability. The lowest levels of Zn were noted in femur of growing rats 75 days after birth. The deficiency of Zn was more deep in the second generation. No effect of tested meal on Ca femur content was observed.

It is concluded that lower weight gain of rats fed rapeseed meal is due to glucosinolate content and probably in part to some constituents involved in Zn availability. However, symptoms of toxicity were not observed during gestation of females and the number of pups born and litter size were not affected.

References

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Table 1. Litter size, body weight gain and feed intake of the mother rats and pups fed rapeseed meal cv. Start "00"

	Mother generation		First generation	
	Control	RSM cv. Start	Control	RSM cv. Start
Number of rats	8	8	8	8
Body weight gain during gestation/g/	91.6±8.2[1,a]	73.8±7.8[b]	93.4±14.4[a]	75.4±9.1[b]
Feed intake during gestation/g/rat/day/	20.2±1.6[a]	15.7±1.0[b]	20.9±1.5[a]	16.1±1.8[b]
Number of live born litters	8	8	8	8
Litter size at birth				
Live $\bar{x}$	10.3	10.0	9.7	10.6
Range	8 - 14	7 - 15	8 - 15	8 - 15
Dead $\bar{x}$	0.0	0.0	0.3	0.0
Weight of offspring				
3 days after birth	8.1±0.8[a]	7.2±1.0[a]	8.2±1.8[a]	5.8±0.4[b]
21 days after birth	40.3±2.1[a]	33.6±2.8[b]	41.2±2.4[a]	29.8±2.3[c]

[1] Mean ± standard deviation, [a,b,c] Values having different superscripts vary significantly from each other /$p < 0.05$/

Table 2. Organ weight of females after lactation

	Mother generation		First generation	
	Control	RSM cv. Start	Control	RSM cv. Start
Thyroids, mg/100 g body wt	7.1±1.4[1,a]	13.8±3.4[b]	6.8±1.6[a]	12.1±2.0[b]
Kidneys, g/100 g body wt	0.93±0.06[a]	0.92±0.05[a]	0.91±0.07[a]	0.94±0.09[a]
Spleen, g/100 g body wt	0.26±0.03[a]	0.25±0.02[a]	0.26±0.04[a]	0.27±0.02[a]
Liver, g/100 g body wt	4.32±0.36[a]	5.85±0.67[b]	4.26±0.24[a]	6.25±0.56[b]

[1] Mean ± standard deviation, [a,b] Values having different superscripts vary significantly from each other /$p < 0.05$/

Table 3. Feed intake and body weight gain of growing rats /21 ÷ 62 days after birth/

	First generation		Second generation	
	Control	RSM cv. Start	Control	RSM cv. Start
Body weight gain /g/rat/day/	4.8±0.2[1,a]	3.1±0.1[b]	4.9±0.2[a]	2.7±0.2[c]
Feed intake /g/rat/day/	16.1±1.1[a]	10.1±0.6[b]	16.6±1.7[a]	9.4±0.7[b]

[1] Mean ± standard deviation, [a,b,c] Values having different superscripts vary significantly from each other /$p < 0.05$/

Table 4. Wet weight of thyroids /mg/100 g body wt/

	Growing rats /days after birth/		
	26	54	75
First generation			
Control	12.9±2.4[1,a]	6.8±2.1[a]	6.5±1.8[a]
RSM cv.Start	20.8±3.2[b]	14.6±2.6[b]	12.8±2.4[b]
Second generation			
Control	13.7±2.0[a]	7.0±1.7[a]	6.3±2.1[a]
RSM cv.Start	23.3±9.1[b]	15.1±1.9[b]	13.3±1.9[b]

[1] Mean ± standard deviation, [a,b] Values having different superscripts vary significantly from each other /$p < 0.05$/

Table 5. Influence of rapeseed meal cv. Start "OO" on the level of Zn in pups carcasses and femur of females and growing rats /μg/g d.wt./

Protein source	Pups /3 days after birth/	Females after lactation	Growing rats	
			26 days after birth	75 days after birth
Control	147 ± 13[1], a	264 ± 17 a	265 ± 18 a	266 ± 16 a
RSM cv. Start				
- mother generation		238 ± 13 b		
- first generation	155 ± 11 a	223 ± 20 b	275 ± 28 a	194 ± 28 b
- second generation	140 ± 18 a		210 ± 18 b	157 ± 36 c

[1] Mean ± standard deviation, a,b,c Values having different superscripts vary significantly from each other /$p < 0.01$/