

EFFECT OF DIETARY RAPESEED PROTEIN CONCENTRATE ON TISSUE LEVELS OF ZINC,
TOCOPHEROL AND LIPIDS

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The occurrence of toxic effects during late pregnancy in rats fed on essentially glucosinolate-free rapeseed protein concentrates (RPC) has been reported previously (1,2). Later studies have demonstrated effects in pregnant as well as non-pregnant rats of dietary RPC on tissue zinc (3, 4) and plasma tocopherol contents (4, 5).

Since the RPC-preparations often contain significant amounts of phytate, this metal-binding substance may play an important role in reducing the bioavailability of dietary zinc. McLaughlan et al (3) have suggested that the toxic effects of RPC in pregnant rats is due to zinc deficiency. Anderson et al have further demonstrated that the feeding of detoxified rapeseed flours causes mineral deficiency in rats (6).

In our group we have studied the effect of feeding weanling male rats diets containing RPC at various levels of zinc supplementation on bone zinc content and protein efficiency ratios (PER). The test diets were fed at a 10 % protein and 5 % fat level. The dietary protein was entirely derived from RPC (prepared from Brassica napus cv. Sinus) or in the case of control diets from methionine-enriched casein.

The phytate content of RPC-diets was estimated to be 0.51 %. As appears from Table I also the casein-based diets were found to contain some phytate (0.18 %) which presumably was derived from the commercial rice starch preparation included in the diet. From the results shown in Table I it is obvious that the bioavailability of zinc was markedly reduced in the diets containing RPC. It was not until the RPC-diet contained about 120 μg zinc per g that the rats attained a bone zinc level similar to that reached in rats consuming a casein diet containing only 19 μg zinc per g.

Within the range of dietary zinc levels studied in this experiment the PER-values were not changed with increasing zinc content.

The feeding of female rats on RPC-diets at 20 % protein and 10 % fat level have recently been found to result in reduced levels of tocopherol as well as low density lipoproteins (LDL) and very low density lipoproteins (VLDL) (4). In an attempt to find out whether this change was due to a condition of zinc deficiency, groups of five female rats were fed for 4-week periods on diets containing either RPC or casein as the sole protein source at the dietary protein and fat level specified above. Both diets were supplemented with 0.5 % methionine and in addition the RPC-diet was supplemented with a quite substantial amount of zinc. This experiment was repeated three times with the casein diet and twice with the RPC-diet under identical conditions. Some of the observations made in these experiments are accounted for in Table II.

TABLE 1

TIBIA ZINC AND PER-VALUES OBTAINED WITH RATS FED FOR A 3-WEEK PERIOD ON RPC- OR CONTROL DIETS AT 10 % PROTEIN AND VARIOUS LEVELS OF ZINC SUPPLEMENTATION. MEAN \pm STANDARD DEVIATION OF 5 RATS PER GROUP

Dietary group	Dietary phytate %	Dietary zinc $\mu\text{g/g}$	Tibia zinc $\mu\text{g/g}$ dry weight	PER
Casein + methionine	0.18	19	188 \pm 8	3.81 \pm 0.28
		53	209 \pm 33	3.84 \pm 0.13
		122	203 \pm 12	3.67 \pm 0.29
RPC	0.51	35	120 \pm 10	3.86 \pm 0.15
		49	148 \pm 7	3.76 \pm 0.08
		75	183 \pm 6	3.70 \pm 0.09
		120	196 \pm 11	3.73 \pm 0.06
		137	207 \pm 11	3.86 \pm 0.20

The RPC-diet contained 0.95 % of phytate and 470 μg zinc per g. The corresponding figures for the casein diet was 0.06 % and 73 μg per g, respectively. Both types of diet contained a similar amount of tocopherol.

There were very similar bone zinc contents in rats fed on different diet indicating that the level of zinc supplementation was sufficient. A slight increase in the plasma zinc concentration was observed in the rats fed on RPC-diet. Apparently, the levels of plasma proteins (albumin and retinol binding protein) were not changed by different dietary treatment. In contrast the levels of LDL and VLDL, triglycerides, cholesterol and tocopherol were all within a distinctly lower range in the groups of rats fed on RPC-diet compared with the casein-fed groups. These results strongly indicate that in the female rat the plasma concentration of the lower density lipoprotein classes is in some way influenced by some component related to the source of dietary protein. In this respect the zinc status of the rat does not seem to be of primary importance.

The liver total lipid content of the RPC-fed female rats increased by 21 % in comparison with that of the casein-fed rats ($0.001 < p \leq 0.01$). Perhaps this change, in connection with the reduced plasma levels of LDL and VLDL found in these rats, may suggest that the RPC-diet causes some interference with the hepatic secretion of lipoproteins in the female rat.

TABLE II

BONE ZINC CONTENTS AND PLASMA LEVELS OF ZINC, PROTEINS AND LIPIDS IN FEMALE RATS FED FOR A 4-WEEK PERIOD ON RPC- OR CONTROL-DIETS AT 20 % PROTEIN AND 10 % FAT LEVEL. RANGE OF MEAN VALUES OBTAINED FROM GROUPS OF 5 RATS

Analytical data	Dietary groups	
	Casein + methionine	RPC + methionine
<u>Dietary composition</u>		
Phytate, %	0.06	0.95
Zinc, $\mu\text{g/g}$	73	470
Tocopherol, mg/100 g	13.5	15.3
<u>Bone tissue content (tibia)</u>		
Zinc, $\mu\text{g/g}$ dry weight	212 - 230	215 - 227
<u>Plasma contents</u>		
Zinc, $\mu\text{mol/l}$	23.1-24.9	26.5-27.1
Albumin, mg/ml	29.6-32.6	30.0-32.0
Retinol binding protein, $\mu\text{g/ml}$	43.5-58.5	39.5-44.5
LDL + VLDL, E_{680}^x	0.390-0.420	0.248-0.257
Triglycerides, $\mu\text{mol/l}$	0.543-0.962	0.296-0.485
Cholesterol, $\mu\text{mol/l}$	2.203-2.506	1.937-2.172
Tocopherol, $\mu\text{mol/l}$	38.5-40.6	24.6-29.5
<u>Liver content</u>		
Total lipids, % of dry weight	14.0-15.7	16.5-19.6

^{x/} turbidimetric reading after precipitation of plasma with dextran sulphate in the presence of Ca^{++} -ions (7).

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