Trace Metal Content of Rapeseed Meals, Oils and Seeds

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ABSTRACT

The concentration of lead, copper, cadmium and zinc as determined by anodic stripping voltammetry and atomic absorption spectrophotometry in a series of rapeseed oils, meals, and seeds is reported. The metal content of rapeseed seeds is not influenced by growing area; however, the variety appears to affect the metal levels. In general, meals contain twice the heavy metal burden of the seeds. The partitioning of metals between meals and oils heavily favors the meals except for lead where the distribution is approximately two to one.

INTRODUCTION

In a recent report, we documented the trace metal content of a typical commercial marine oil and the effect of pilot-plant processing upon the metal levels (1). Metals such as lead and cadmium were of particular interest because of their toxicity and their link to coronary heart disease and hypertension (2).

As a continuation of this work, a series of rapeseed products have been analyzed for zinc, cadmium, copper and lead. The present study describes the influence of rapeseed type and growing area on the metal content of seeds, oils and meals. Furthermore, the distribution of heavy metals between oils and meals is also shown.

EXPERIMENTAL

The reagents, instrumentation, stock solutions and methods of analysis have been described previously (1), and only a brief outline of the procedures is given here. One-half gram of oils, meals and seeds was digested under reflux in Kjeldahl flasks with 6 ml HNO_3 and 2 ml $HClO_4$ and subsequently heated to fumes of $HClO_4$.

The metal concentrations in the seeds and meals were determined by anodic stripping voltammetry. The pH of the digested samples was adjusted to 4.5 by addition of NH_4OH and acetate buffer; 1 ml of 100 ppm Ga solution was also added. The solution was diluted to 25 ml and transferred to a polarographic cell.

Oils were analyzed by atomic absorption spectrophotometer. The digested samples were diluted to 10 ml, and Cd, Pb and Cu were measured by injecting 10 μl aliquots into an electrothermal atomizer coupled to the spectrophotometer. Zinc was determined from the same 10 ml sample by injection into an air/acetylene flame.

In both methods of analysis, the metal levels were quantified by the method of standard additions.

RESULTS

The metal content of the seeds, meals and oils is presented in Tables I, II and III, respectively. The error limits represent 95% confidence limits based on at least three determinations. The detection limits are based on a signal equal to twice the baseline noise and typical dilutions and sample size.

The Midas seeds from Saskatoon arrived with a dust or dirt coating. This dirt was found to contain a high concentration of metals (Zinc 16 ppm, Lead 10 ppm, Cadmium 0.6 ppm and Copper 16 ppm), and the seeds were, therefore, placed in a Buchner funnel, washed with methanol and air-dried prior to analysis.

Table III also contains the results of analysis of a corn oil and a peanut oil. These oils were studied to provide references for the rapeseed oils.

DISCUSSION

The results of Table I suggest that the growing area does not influence the metal levels in the seeds of the Tower variety. However, different varieties appear to have different metal contents; e.g., the Span and Midas varieties

TABLE I

Metal Content of Seeds

	Metal levels (ppm)			
Sample and source	Zinc	Lead	Cadmium	Copper
Tower – C.S.P. Foods, Altona	30.3 ± 1.1	0.38 ± 0.05	0.03 ± 0.01	2.6 ± 1.0
Tower – Coop Rape Test, Saskatoon	29.8 ± 3.3	0.48 ± 0.04	0.04 ± 0.01	2.5 ± 0.1
Span – Coop Rape Test, Saskatoon	22.7 ±0.5	0.73 ± 0.08	0.14 ± 0.01	2.6 ± 0.1
Midas – Coop Rape Test, Saskatoon	24.6 ± 4.7	0.45 ± 0.14	0.16 ± 0.01	2.1 ± 0.2

TABLE II

Metal Content of Meals

	Metal levels (ppm)			
Sample and source	Zinc	Lead	Cadmium	Copper
Tower – C.S.P. Foods, Altona	56.4 ± 1.6	0.53 ± 0.03	0.10 ± 0.02	4.6 ± 0.5
Span – Canbra Foods, Lethbridge	62.7 ± 12.9	0.27 ± 0.09	0.13 ± 0.02	3.8 ± 0.2
Midas – C.S.P. Foods, Saskatoon	56.0 ± 7.4	0.65 ± 0.04	Bdl[a]	3.6 ± 0.8
Midas – C.S.P. Foods, Nipawin	73.0 ± 2.8	0.47 ± 0.04	0.05 ± 0.01	3.8 ± 0.1

[a]Bdl = below detection limit (<0.02 ppm).

TABLE III

Metal Content of Oils

Sample and source	Metal levels (ppm)			
	Zinc	Lead	Cadmium	Copper
Crude tower – C.S.P. Foods, Altona	2.4 ± 0.4	0.24 ± 0.02	Bdl[a]	Bdl
Deodorized tower – C.S.P. Foods, Altona	Bdl[a]	0.07 ± 0.02	Bdl	Bdl
Crude tower – C.S.P. Foods, Nipawin	1.0 ± 0.2	0.06 ± 0.02	Bdl	Bdl
Crude tower – received spring, 1975 (source unknown)	3.6 ± 0.4	0.22 ± 0.02	Bdl	Bdl
Refined tower – received spring, 1975 (source unknown)	1.1 ± 0.2	Bdl	Bdl	Bdl
Degummed lear – C.S.P. Foods, Saskatoon	2.1 ± 0.3	Bdl	Bdl	Bdl
Crude span – Canbra Foods, Lethbridge	2.9 ± 0.5	Bdl	Bdl	Bdl
Corn oil – Mazola brand, lot No. 0586	Bdl	Bdl	Bdl	Bdl
Peanut oil – Planter's brand, lot No. R3612	Bdl	Bdl	Bdl	Bdl

[a]Bdl = below detection limit (<0.05 ppm Cu, <0.005 ppm Cd, <0.02 ppm Pb, <0.8 ppm Zn).

contain more cadmium than the Tower variety, and Span also contains more lead than the others. It is recognized, however, that conclusions drawn on such a limited sampling are somewhat speculative. This is confirmed when the metal content of the meals is considered; e.g., the Midas meal from Saskatoon has the lowest cadmium content.

The meals are enriched in metals as compared to the seeds by an average factor of two based on the results of the Tower variety samples from Altona. In general, the zinc content of all the meals is in agreement with the levels reported by Blair & Scougall (3); however, the copper values are approximately half theirs. They did not report levels for cadmium and lead.

The values in Table III demonstrate that all the oils are of a high quality with respect to their levels of cadmium and copper, and the only samples that do not meet the Codex standards (4) are two of the crude Tower oils which contain greater than 0.1 ppm lead. Processing the crude oils lowered the metal content to the values that satisfy the Codex requirements. The metal content of herring oils also decreased upon processing (1). Both the corn and peanut oils had been refined and their metal content was negligible. Van A. Thomas has reported (5) levels of lead and cadmium in several crude oils: soybean oil, 0.08 ppm lead and 0.008 ppm cadmium; sunflower oil, 0.10 ppm lead and 0.007 ppm cadmium. The values reported here are in agreement with those values.

The ratios of the levels of the metals in the meal to those in the oil are approximately the same for both the Span meal and oil from Lethbridge and the Tower meal and oil from Altona. This result suggests that metals are partitioned between the protein and oil fractions to the same extent independent of the type of rapeseed. However, the ratios vary markedly from metal to metal: in the case of the Tower variety meal and oil from Altona, the ratio of the metal concentration in the meal to that in the oil equals 24 for zinc, 2 for lead, greater than 20 for cadmium and greater than 92 for copper.

If it is assumed that seeds from the Tower variety are 50% protein and 50% oil an error of ca. 13% (6) – then the average of the metal levels of the Altona meal (Table II) and crude oil (Table III) should be equal to the observed values for the corresponding seed (Table I). In fact, the agreement is quite good, indicating that the analytical results are consistent and that a metal contamination has not been introduced in preparing the meal and oil.

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