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RAPESEED MEAL

III.*—A simple method for detoxification

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Two types of treatments of presscake meal of rapeseed (*Brassica napus*), steaming and water extraction, were tested to remove the thioglucosides responsible for its toxicity. The efficiency of each was judged by the residual concentration of isothiocyanates and oxazolidinethiones and the biological quality, available lysine, net protein utilisation and digestibility in rats.

Double water extraction gave the best results. It resulted in a reduction of 84% in oxazolidinethiones, the factor directly responsible for toxicity, and 77% in isothiocyanates. Net protein utilisation increased to levels corresponding to those of animal proteins, from 40 to 69%. The improvement in digestibility was reflected in the growth of rats.

Steaming and simple water extraction, however, reduced toxicity only slightly and improved biological quality very little.

The greatest change of the gross chemical composition in treated samples was observed in crude fibre, which appeared to increase.

Introduction

In a previous paper[1] it was reported that rapeseed presscake meal has a high protein content with a well balanced amino acid pattern, but that its biological quality is impaired by the toxicity due to the presence of isothiocyanates [3-butenyl isothiocyanate] and oxazolidinethiones [L-5-vinyl-2-oxazolidinethione] (VTO), which are released from the thioglucocides upon enzymic hydrolysis.

A number of methods have been proposed to remove the toxicity from the meal, but the majority of them have not been completely successful.[2-4] Since rapeseed is widely cultivated as an oilseed, the large quantities of protein left after oil extraction make it worth considerable effort to render it useful as a protein source for animal and/or human feeding.

This paper is concerned with attempts, based on steaming and water extraction, to remove the water-soluble thioglucosides from the meal.

Experimental

Materials

A pool made from 12 samples of rapeseed meal from 3 edible-oil factories was used to test two types of treatments, steaming and water extraction, as described in Table I. In steaming, 1 part of meal and 2 parts of water were used, while in water extraction the ratio was 1:5. After each treatment, the samples were filtered and dried at 50°, ground and stored in a cold room until chemical and biological analyses were performed.

Methods

Chemical analysis

Water, total ash, calcium, phosphorus, iron, ether extract, crude fibre, nitrogen, available lysine, isothiocyanates, and oxazolidinethiones were determined by methods reported elsewhere.[1]

Biological tests

Net protein utilisation (*NPU*) of the protein and digestibility were measured in all samples according to established methods.[5]

Results

The gross chemical composition of the samples was not greatly influenced by different treatments (Table II). The protein content remained unchanged in all treated samples, as did ether extract and total ash, even when slight increases in calcium and iron were observed. The significant increase in crude fibre can be ascribed to partial dissolution of carbohydrates. However, the level at which rapeseed meal would be included in rations would not cause undesirable effects.

Table III shows the levels of isothiocyanate, VTO, available lysine, *NPU* and digestibility. In all cases a decrease in the isothiocyanate and VTO contents was observed. Similarly, the available lysine values showed a slight decrease. However, *NPU* improved markedly, the highest values being those obtained by double extraction in water. This effect was paralleled by an increase in digestibility values. The efficiency of the different treatments was also reflected in the growth of rats.

TABLE I

Treatments used to remove the toxic factors of rapeseed presscake meal

Sample	Treatment
T-1(a)	Indirect steaming, 20 lb/in² at 60°c for 3 h
T-1(b)	Direct steaming, 20 lb/in² at 100°c for 3 h
T-2(a)	Water extraction at room temperature for 10 h
T-2(b)	Water extraction at room temperature for 12 h
T-2(c)	Water extraction at room temperature for 14 h
T-3(a)	Water extraction for 8 h followed by a second extraction of 2 h at room temperature
T-3(b)	Water extraction for 8 h followed by a second extraction of 2 h at 50°c
T-4	Water extraction for 12 h followed by a second extraction of 3 h at room temperature
T-5	Water extraction for 14 h followed by a second extraction of 1 h at room temperature

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TABLE II

Chemical composition and calorie content of rapeseed presscake meal before and after the different treatments
% in dry matter

Sample	Total ash, %	Protein (N × 6·25)	Ether extract, g/100 g	Crude fibre, g/100 g	Ca, mg	P, mg	Fe, mg	N-free extract	Calories, kcal/100 g
Original	6·6	37·2	2·9	14·8	698	1093	17	38·5	325
T-1(a)	6·3	38·9	2·0	18·1	759	1143	18	34·7	312
T-1(b)	6·1	39·7	2·8	19·7	838	1215	17	31·7	311
T-2(a)	6·2	35·3	2·2	19·1	843	1011	16	37·2	310
T-2(b)	6·2	35·6	2·1	18·7	892	1035	18	37·4	311
T-2(c)	6·3	35·4	2·2	19·0	847	996	16	37·1	310
T-3(a)	5·9	35·8	2·4	19·5	864	945	20	36·4	310
T-3(b)	5·7	35·0	2·3	19·2	873	901	22	37·8	312
T-4	6·0	35·6	2·2	20·9	941	1128	17	35·3	303
T-5	5·5	36·4	2·7	19·5	992	1133	17	35·9	313

TABLE III

Effect of the different treatments upon the biological quality and isothiocyanates and thio-oxazolidones (VTO) of meal

Treatment	Available lysine, g/100 g crude protein	*NPU*	Digestibility[a]	Isothiocyanates,[b] mg/g	VTO,[c] mg/g
None	4·42	40	67	1·39	7·71
T-1(a)	3·60	49	69	0·72	6·50
T-1(b)	3·65	63	72	0·32	2·74
T-2(a)	3·61	56	66	0·69	4·01
T-2(b)	3·69	62	71	0·66	3·94
T-2(c)	3·66	58	67	0·56	3·59
T-3(a)	3·72	62	71	0·38	1·44
T-3(b)	3·80	68	75	0·35	1·37
T-4	3·96	68	77	0·37	1·32
T-5	4·10	69	77	0·33	1·23

[a] Digestibility of the protein
[b] As 3-butenyl isothiocyanate
[c] As (−)-5-vinyl-2-thio-oxazolidone

Discussion

The different treatments used in the present work lessened to varied degrees the toxicity of rapseed presscake meal, measured through the contents of isothiocyanates, VTO and biological quality in experimental animals. Indirect steaming reduced isothiocyanate content by almost 50%, but only slightly decreased the VTO level. This result is in agreement with the volatility of isothiocyanates. Since VTO is directly responsible for toxicity, the biological value was only slightly modified.

In contrast, steaming considerably reduced the levels of both isothiocyanates and VTO, and the biological value increased accordingly.

Simple water extraction reduced both isothiocyanates and VTO by almost 50% and biological quality (measured as *NPU*), rose to a value of 62%; however, this treatment was less effective than indirect steaming.

Double water extraction gave the best results, since it resulted in a reduction of 84% in VTO and 77% in isothiocyanates. Similarly, *NPU* increased to levels corresponding to those of animal proteins. The different treatments also produced a slight increase in digestibility which may have favourably influenced *NPU*.

Available lysine showed a minor reduction, especially by steam processing. One explanation of this is that exposure to heating may have led to the binding of the ε-amino group of this amino acid.

It is possible that the higher growth rate of rats fed double water-extracted meal was partly due to increased palatability of this sample, since dietary intake in this group was 3 times that of the group fed untreated material, or 0·14 and 0·04 g/rat/day respectively.

The results of the present experiments emphasise the possibility of significantly reducing the content of toxic substances in rapeseed meal. It is reasonable to expect that when the ideal conditions of water extraction have been found, complete removal will be attained.

The slight residual concentration of isothiocyanates and VTO remaining after double extraction in water did not adversely influence protein quality, inasmuch as the values found for *NPU* confirmed the high quality of the protein anticipated from amino acid analysis data.

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