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EFFECT OF PROCESSING CONDITIONS ON THE NUTRITIVE VALUE OF MUSTARD SEED MEAL

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The effect of processing conditions on the proximate composition of mustard seed cake and meal and the digestibility of enzymic detoxified mustard meal was investigated. Maximum amount of oil was extracted when the seeds were crushed twice in a screw press (sc. cone distance 0.38 mm). Maximum digestibility of the mustard meal was 29.8, 26.6 and 24.3 % with single extraction technique (sc. cone distance 1.14 mm) after 9 hr incubation with trypsin, pepsin and papain respectively. It was also observed that the digestibility was always more after single extraction than after double extraction.

INTRODUCTION

Industrial processing of mustard seeds for oil extraction causes changes in the natural properties of the cake. Apart from small quantities of vitamins, the proteins are denatured by heat. Goering [1] and Bloizot [2] have reported that the quality of protein is adversely affected at elevated temperatures. Rutkowaki *et al.* [3] and Rutkowaki [4] reported that thermal conditions are frequently detrimental to proteins. The pressed cake left after oil extraction contains 35–40 % protein, with amino acids pattern comparable with that of soya or any other good quality source of protein [5, 6]. Clandinin [7] reported that the quality of mustard and rape seed meals is adversely affected at high temperature during processing due to destruction of the heat labile amino-acids or partial conversion of proteins into a more insoluble form.

The present studies were carried to investigate the effect of processing conditions on the proximate composition of mustard seed cake and meal, and digestibility of protein in detoxified mustard seed meal.

MATERIALS AND METHODS

Two varieties of mustard seed *(Brassica juncea)* namely RL-18 and Poorbi Raya were collected from the Ayub Agriculture Research Institute, Faisalabad. The seeds were crushed in a screw press, solvent extracted, and detoxified for the present investigations.

Processing

a) *Mustard Seed Cake.* A 510 Hander Model from Japan was employed in these study. Mustard seed cake was prepared as follows:

i) *Screw Pressing.* 5 kg of mustard seeds were crushed by the shearing action of screw press. The distance between the screw and cone was adjusted at 0.38 mm and the seeds were pressed twice to get maximum extraction of oil.

ii) *Pre-pressing.* 5 kg of mustard seeds were pre-pressed by increasing the distance between screw and cone to 0.76 mm and 1.14 mm.

iii) *Direct Solvent Extraction.* 500 g of crushed mustard seeds (20 mesh) were refluxed in a Soxhlet extracted for 20 hr with n-hexane to reduce the oil content to the minimum (2 %) and then dried at 60° ± 2.

b) *Mustard Seed Meal.* The mustard cake obtained after screw pressing or prepressing was refluxed in a solvent extractor for 20 hr to reduce oil content to the minimum. The defatted cake (meal) was dried at 60° ± 2 and ground to 20 mesh size.

c) *Detoxification.* Enzymic detoxification of mustard seed cake was carried out as reported elsewhere [8].

Analytical Methods.

Analytical methods for the estimation of moisture, ash, crude protein, crude fibre, fat and allyl isothiocyanate have been reported elsewhere [9, 10].

Digestibility

In vitro digestibility of enzymic detoxified mustard seed meal was determined using trypsin, pepsin and papain [11, 12].

RESULT AND DISCUSSION

Effect of processing conditions on the composition of mustard seed cake and meal. Effect of processing condi-

tions on the extraction of oil and the composition of the cakes and meals of the two varieties, RL-18 and Poorbi Raya of mustard seeds, is shown in Tables 1–4. The minor variations in the composition of cakes appeared to be due to the variable amount of oil present in the cake. No significant difference in the amount of proteins, fibre and ash contents in RL-18 and Poorbi Raya meal was noticed which seems to be due to the complete removal of oil from

Table 1. Effect of processing conditions on the proximate composition of RL-18, mustard seed cake.

Processing conditions					Oil %				Recovery %	
Distance between screw & cone (mm)	No. of extractions	Process	Moisture %	Protein %	Extracted*	Residual**	Allyl isothio-cyanate %	Ash %	w/w basis	Protein basis
0.38	2	Screw pressing	7.7	39.5	25.2	13.5	1.30	6.7	64.7	93.5
0.76	1	Pre-pressing	7.6	36.9	19.1	21.1	0.99	5.7	72.6	98.2
0.76	2	Pre-Pressing	8.3	37.7	24.3	16.1	1.08	6.0	67.1	92.8
1.14	1	Pre-pressing	7.75	35.4	18.3	22.2	0.95	5.9	75.7	98.2
1.14	2	Pre-pressing	8.3	37.4	23.2	17.5	1.00	6.3	68.2	92.5

*on seed basis; **on cake basis

Table 2. Effect of processing conditions on the proximate composition of poorbi raya, mustard seed cake.

Processing conditions					Oil %				Recovery %	
Distance between screw & cone (mm)	No. of Extractions	Process	Moisture %	Protein %	Extracted*	Residual**	Allyl isothio-cyanate %	Ash %	w/w basis	Protein basis
0.38	2	Screw pressing	4.1	38.1	22.1	11.0	1.06	5.8	70.0	97.1
0.76	1	Pre-pressing	8.1	34.0	13.8	23.1	0.98	5.2	72.9	90.3
0.76	2	Pre-pressing	11.0	36.0	17.0	18.1	1.03	5.6	71.1	93.2
1.14	1	Pre-pressing	8.8	33.4	12.7	23.8	0.98	5.2	71.4	89.1
1.14	2	Pre-pressing	10.3	34.3	14.6	21.7	1.00	5.5	71.7	89.5

*on seed basis; **on cake basis.

Table 3. Effect of processing conditions on the proximate composition of RL-18 mustard seed meal.

Professing conditions			Moisture %	Protein %	Allyl isothiocyanate %	Ash %	Fibre %
Distance between screw and cone (mm)	No. of extractions	Process					
–	–	Solvent extraction	5.2	41.9	1.53	7.7	10.8
0.38	2	i) Screw pressing ii) Solvent extraction	2.6	40.3	1.32	7.5	11.6
0.76	1	i) Pre-pressing ii) Solvent extraction	2.5	42.9	1.26	7.2	11.0
0.76	2	i) Pre-pressing ii) Solvent extraction	2.9	43.0	1.22	7.0	10.7
1.14	1	i) Pre-pressing ii) Solvent Extraction	3.1	42.4	1.25	7.1	11.9
1.14	2	i) Pre-pressing ii) Solvent extraction	3.1	42.5	1.23	7.4	10.3

Table 4. Effect of processing conditions on the proximate composition of poorbi raya, mustard seed meal.

Processing conditions			Moisture %	Protein %	Allyl isothiocyanate %	Ash %	Fibre %
Distance between screw & cone (mm)	No. of extractions	Process					
–	–	Solvent extraction	4.8	42.9	1.39	6.3	13.4
0.38	2	i) Screw pressing ii) Solvent extraction	2.9	43.2	1.20	5.9	12.8
0.76	1	i) Pre-pressing ii) Solvent extraction	3.5	44.1	1.25	6.1	12.9
0.76	2	i) Pre-pressing ii) Solvent extraction	2.6	43.3	1.23	5.8	12.6
1.14	1	i) Pre-pressing ii) Solvent Extraction	3.6	43.1	1.25	5.7	12.9
1.14	2	i) Pre-pressing ii) Solvent extraction	2.9	42.7	1.24	6.0	12.0

Table 5. Effect of processing conditions on the digestibility of enzymic detoxified RL-18 mustard seed meal.

Enzyme	Time in hours	Percentage digestibility						
		Screw & cone distance 0.38 mm		Screw & cone distance 0.76 mm		Screw & cone distance 1.14 mm		
		Single ext.	Double ext.	Single ext.	Double ext.	Single ext.	Double ext.	Solvent extracted
Trypsin 250 mg pH .7	3	20.1	17.4	22.3	19.2	23.4	20.9	25.2
	6	22.6	18.6	24.1	20.3	25.1	22.1	27.7
	9	24.8	20.2	26.2	21.8	29.8	24.1	32.4
	12	23.9	20.1	25.9	21.3	29.0	24.0	32.8
Pepsin 250 mg pH 1.8	3	15.9	12.3	17.7	14.6	19.3	16.4	23.2
	6	18.8	16.6	21.6	17.5	22.5	18.7	26.2
	9	23.9	20.2	25.6	21.1	26.6	21.4	29.8
	12	22.9	20.0	25.0	21.6	26.0	21.0	29.4
Papain 150 mg pH 6.5	3	15.7	12.1	17.2	14.1	19.4	16.1	20.6
	6	18.1	14.1	19.3	16.8	21.2	18.3	22.3
	9	19.6	15.2	20.2	18.6	24.0	20.0	27.8
	12	18.3	15.7	20.0	18.5	24.0	20.0	27.5

the seed cake. Further, the non-availability of allyl isothiocyanate in the meal and cake of the two varieties of mustard seeds appear to be due probably to the formation of complexes between the allyl isothiocyanate and other constituents of the meal and cake at high temperatures and drastic processing conditions. Similar observations had been made earlier also [13].

In Vitro *digestibility.* The effect of oil extraction technique on *in vitro* digestibility of RL-18 meal with trypsin, pepsin and papain is reported in Table 5. Maximum digestibility of enzymic detoxified RL-18 meal was noticed in the case of trypsin and minimum with papain. It was also observed that digestibility of the meal improved with the increase in time of incubations with different enzymes.

It is also evident from the Table that the digestibility of the meal is always more after single extraction than after double extraction. This decrease may be due to the destruction of heat labile amino acids or partial denaturation of proteins when heat treatment time or pressing time is increased [1–4].

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