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IMPROVEMENT IN THE NUTRITIVE VALUE OF MUSTARD AND RAPE SEED CAKES

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Protein, ash, crude fibre and allylisothiocyanate (AIT) contents of mustard and rape seed meals (defatted oilseed cake) varied from 40.9 to 45.1%, 7.0 to 9.1%, 10.7 to 13.5% and 0.78 to 1.22% respectively. Detoxification of the meals reduced the AIT content to traces. The detoxified meals showed a nitrogen solubility profile of 24.9 to 36.9% in water, 10% NaCl and 0.2% NaOH and a satisfactory growth promoting capacity for rats at the level of 10% dietary protein. NPU and PER increased from 45.8 to 65.8% and 0.83 to 2.12% respectively.

Key words: Glucosinolate, NPU, PER

INTRODUCTION

Pakistan produced 250,000 metric tons of mustard and rape seeds in 1985-86 [1] which is anticipated to increase to meet the present shortage of 50-60 metric tons of edible oils [2]. The increase in the production of oil seeds has augmented the production of seed cake which is a by-product of the edible oil industry. The seed cake has limited use in animal and poultry rations due to the presence of toxic glucosinolates and the anti-nutritive phytic acid [3-4]. The glucosinolates are hydrolysed by the endogenous enzyme myrosinase releasing goitrogenic and growth inhibiting compounds [5]. This explains why, despite its high protein content of about 35-40% [6] and with well balanced amino acid profile [7], the seed cake is not included in poultry rations. Consequently the importance of finding simple, low cost procedures for substantial reduction or complete removal of noxious compounds from mustard and rape seed cake is of paramount importance.

The object of the present studies was to detoxify mustard and rape seed cake available in large amounts as by-products of vegetable oil industry and small scale oilseeds crushing units. Although many procedures [8-11] have been reported in the literature to remove the toxic factors from mustard and rape seed cake/meal, yet the results obtained have remained unsatisfactory. The method suggested in the present communication is economical in energy consumption and gives a nutritionally better product free from toxic substances.

MATERIALS AND METHODS

Rapeseed cake and rapeseed meal were collected from market and a local vegetable oil mill respectively. Mustard seed cake was obtained by twice prepressing the RL-18 variety of mustard seeds in an oil expeller (Handle Model-510, Japan). The mustard and rape seed cakes were refluxed in a solvent extractor with *n*-hexane for 20 hr to reduce the oil content to minimum (2%) and kept at 60 ± 2° for 2 hr to evaporate the solvent in the meal. The rapeseed meal from local vegetable oil mill was not solvent extracted. All the samples were ground to 60 mesh size.

Detoxification. The detoxification of mustard and rape seed meals, i.e. the defatted cakes, was carried out according to the procedure reported elsewhere [12].

Quality evaluation. (i) *Nitrogen solubility profile :* 2 g of the detoxified mustard seed meal (80 mesh) were first extracted with 20 ml water and subsequently with 20 ml 10% NaCl followed by 20 ml 0.2% NaOH in a centrifuge tube with mechanical stirring for 2 hr at room temperature (30°). The slurries were centrifuged at 4,000 rpm for 20 min. and the soluble portion was separated from the sediment. 10 ml of the soluble portion were taken for nitrogen estimation by the micro-Kjeldhal method. The extracted nitrogen was expressed as the percentage of total meal nitrogen (N x 6.25). All experiments were conducted in triplicate.

(ii) *Biological evaluation.* The biological evaluation of detoxified mustard and rape seed meals was done by conducting feeding trials on albino rats. Five diets were prepared by replacing corn starch from non-proteinous diet-6 by 23.3, 24.9, 26.0, 23.0 and 11.3 g of untreated mustard seed meal (MSM), detoxified mustard seed meal (DMSM), detoxified rapeseed meal (DRSM-mill) and casein respectively. All diets were isonitrogenous, i.e. they contained 10% protein. Their detailed composition is given in Table 4.

(a) *Net Protein utilization (NPU).* NPU of the control and experimental diets was determined according to the procedure of Miller and Bender [15].

(b) *Protein efficiency ratio (PER).* PER of different experimental diets was determined from weight gain and protein intake ratio [16], i.e. PER = gain in weight/protein intake.

Analytical methods. Analytical methods for the estimation of moisture. ash, crude protein, crude fibre, fat and allylisothiocyanate have been reported elsewhere [17-18].

RESULTS AND DISCUSSION

The proximate composition and calorific contents of mustard and rape seed meals is presented in Table 1. The protein content varied from 40.9 to 45.1%, the maximum being in RSM (mill) followed by MSM and RSM (market) respectively. The high protein content of mustard and rape seed meals is in agreement with the values reported by other authors [11-12] and thus the meals represent a large potential of protein. The residual oil left after solvent extraction of cake varies between 1.8 to 3.1%. The amount of allylisothiocyanate (AIT) ranged from 0.78 to 1.22%, being maximum in MSM and minimum in RSM (market). RSM (market and mill) also contain other glucosinolates (19) which were not estimated, hence it is possible that a decrease in (AIT) may be accompanied by an increase in the other glucosinolates. Moisture, crude fibre and ash contents varied from 3.6 to 4.5%, 10.7 to 13.5% and 7.0 to 9.1% respectively. The calorific content of the meals ranged from 317 to 336 K. cal/100 g which are in accordance with the observations of Ballester *et al.* [19].

The effect of enzymic detoxification on the proximate composition of mustard and rape seed meals is shown in Table 2. The results indicated that enzymic detoxification reduced the AIT contents in all the meals to traces which is inaccordance with the findings of Shah *et al.* [12, 20]. Detoxification resulted in a decrease in protein contents from 24.1 to 26.7%, i.e. recovery of 73.3 to 75.9% protein but the increase in crude fibre and ash contents was mainly due to the loss of soluble fractions during treatment.

Nitrogenous substances soluble in water and sodium chloride are the protein fractions most easily assimilated by nonruminants [21]. Keeping this in view the nitrogen solubility profile of detoxified mustard and rape seed meals was determined (Table 3). Maximum solubility was found in 0.2% NaOH followed by water and 10% NaCl in all detoxified meals. Total soluble nitrogen compounds in water, 10% NaCl and 0.2% NaOH, varied from 24.9 to 36.9%, maximum being in DMSM and minimum in DRSM (market). Comparatively better nitrogen solubility profile in the case of DMSM and DRSM (mill) might be due to mill temperature conditions involved during oil extraction as reported earlier [19-20]. The lower nitrogen solubility profile shown by DRSM (market) might be due to oil extraction at higher temperature which denatured the protein, consequently resulting in decreased nitrogen solubility profile of the detoxified meal.

The effect of different diets supplemented with enzymic detoxified mustard and rape seed meals on the growth rate of albino rats is shown in Fig. 1. The group of four rats fed on diet No. 1 containing untreated MSM showed a weight gain of 16 g after 10 days. The minor weight gain indicated that the presence of toxic (AIT) producing glucosinolate i.e. sinigrin, highly suppressed the growth rate of rats fed on diet No. 1 [21]. Maximum weight gain (84.7 g) was observed in the case of diet No. 5 containing case in followed by diet No. 2 supplemented with DMSM which indicated the complete removal of (AIT). Comparatively lower weight gain, i.e. 35.2 and 48.3 g by rats fed on diets No. 3 and 4, might be due to the presence of glucosinolates gluconapin and progoitrin (22) other than sinigrin, which were not effectively eliminated by enzymic detoxification.

The average NPU of experimental and control diets ranged from 45.8 to 73.2% (Table 5), the maximum being

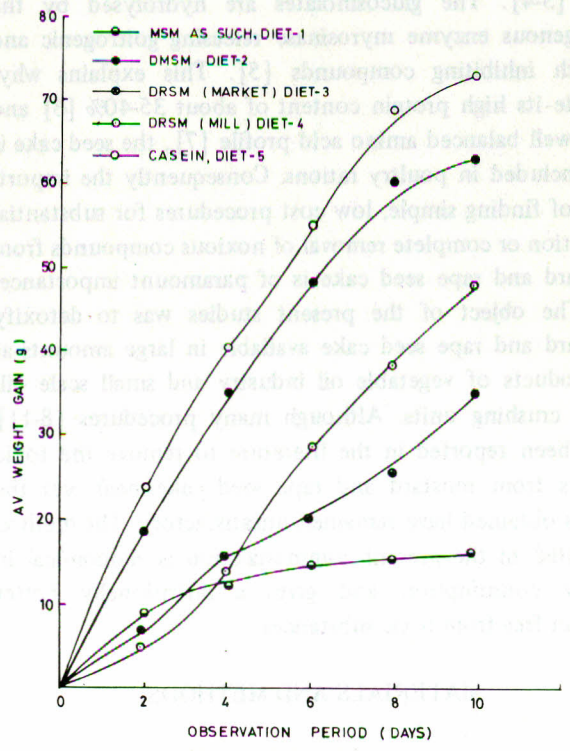

Fig 1. Effect of incorporation of detoxified mustard and rapeseed meals on growth of rats

Table 1. Proximate composition and caloric content of mustard and rape seed meals.

Source of oil seed cake	Moisture (%)	Protein (%)	Ash (%)	Crude fibre (%)	AIT** (%)	Fat (%)	NEF***	Caldric content K. cal/100g
Mustard seed cake*	3.9	43.0	7.0	10.7	1.22	2.3	35.8	336
Rapeseed cake* (Market)	4.5	40.9	9.1	13.5	0.78	2.1	33.6	317
Rapeseed meal (Mill)	3.6	45.1	7.4	11.8	1.08	1.8	32.8	328

* Extracted with *n*-hexane.
** Allylisothiocyanate.
*** Nitrogen free extract, calculated by difference.

Table 2. Proximate composition of enzymic detoxified mustard and rape seed meals.

Source	Moisture (%)	Protein (%)	Ash (%)	Crude fibre (%)	AIT (%)	Fat (%)	NFE*	Recovery (%) w/w basis	Recovery (%) Protein basis
Mustard seed meal	4.2	40.2	6.9	11.8	Traces	2.0	39.1	81.2	75.9
Rapeseed meal (market)	6.4	38.5	12.1	16.2	Traces	2.5	30.7	77.5	73.0
Rapeseed meal (mill)	4.8	43.9	8.8	12.8	Traces	1.5	33.0	75.3	73.3

* By Difference

Table 3. Solubility profile* of mustard and rape proteins.

Nitrogen soluble compounds in	Detoxified mustrard seed meal	Detoxified rapeseed meal (Market)	Detoxified rapeseed meal (Mill)
Water	10.8	6.2	8.6
10% NaCl	8.4	4.9	6.8
0.2% NaOH	17.7	13.8	16.2
Insoluble**	63.1	75.1	68.4

* Protein/Protein basis
** By difference

in the case of diet No. 5 containing case in and minimum in diet No. 1 containing untreated MSM. Detoxified mustard and rape seed meals showed improvement in NPU from 49.4 to 65.8%, which is in accordance with the findings of

Table 4. Composition of experimental diets.

Ingredients g/100g	Diets 1	2	3	4	5	6
Mustard seed meal untreated	23.3	–	–	–	–	–
Detoxified mustard seed meal	–	24.9	–	–	–	–
Detoxified rape seed meal (market)	–	–	26.0	–	–	–
Detoxified rapeseed meal (milled).	–	–	–	23.0	–	–
Casein	–	–	–	–	11.3	–
Corn starch	52.2	50.6	49.7	52.3	61.7	72.5
Glucose	9.5	9.5	9.3	9.7	10.0	10.0
Corn oil	10.0	10.0	10.0	10.0	10.0	10.0
Vitamin mixture (13)	1.0	1.0	1.0	1.0	1.0	1.0
Mineral mixture (14)	4.0	4.0	4.0	4.0	4.0	4.0
Cellulose	–	–	–	–	2.0	2.5
Proteins (by analysis)	9.0	10.2	9.9	10.1	10.0	0.34

Table 5. Effect of enzymic detoxification on biological quality of mustard and rape seed meals

Diet No.	Protein source	Protein (g)	Weight gain (g)	NPU (%)	PER
1.	Mustard seed meal (untreated)	19.2	16.0	45.8	0.83
2.	Detoxified mustard seed meal	30.5	64.6	65.8	2.12
3.	Detoxified rapeseed meal (market)	27.5	35.2	49.4	1.28
4.	Detoxified rapeseed meal (milled)	29.3	48.3	54.1	1.65
5.	Casein	33.6	84.7	73.2	2.52

other workers [12, 19]. The higher NPU (65.8%) of diet No. 2 supplemented with DMSM appeared to be due to complete elimination of (AIT). The average PER values of the diets No. 1-5 were 0.83, 2.12, 1.28, 1.65 and 2.52 respectively. PER of diet No. 2 supplemented with DMSM, was fairly high i.e. 2.12 which confirms the quality of mustard protein. The very low NPU and PER of DRSM (market) might be due to the presence of other glucosinolates [19] which were not completely eliminated by enzymic detoxification and the partial denaturation of proteins during oil extraction from seeds at higher temperature. Similar observations had been reported earlier [20, 23]. Niazi *et al.* [24] has reported that enzymic detoxified mustard seed meal showed total nitrogen solubility profile of 30.12% in water, 10% NaCl and 0.2% NaOH and *in vivo* digestibility of 75.51%. Thus, it can be safely concluded that prepassed and enzymic detoxified mustard/rape seed meal could be safely incorporated in the feed of non-ruminants and ruminants.

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