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Poultry Feed Supplement from Deoiled Mustard Cake

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1 Deoiled Mustard Cake

Three principal varieties of mustard are grown in this region - *sarson*, *toria* and *rai* while many more exist in the gene-pools¹. They differ significantly from the species and varieties grown in North America, in the plains of Europe and in China (*generally Brassica oleracea*, *B. rapa*, *B. napus*, *B. juncea*, *B. carinata*, *B. nigra* and *Sinapis alba*), in erucic acid² content and available quantity and variety of isothiocyanates³. The latter, together with sinapine, tannin, VOT⁴ and some anti-nutrient factors, are obstacles to large scale incorporation of deoiled mustard cake in poultry feed. When this is attempted, these substances are known to induce unpalatability, growth retardation, thyroid gland enlargement, low feed efficiency and reproductive problems.

Deoiled mustard cake is produced in large quantities in South Asia - significantly in the plains of India, semi-arid areas of Rajasthan and plains of Pakistan, and in Bangladesh from cultivated (and imported) seed. Together this region produces and consumes over 20% of the global mustard crop.

A variety of deoiled cakes needs to be incorporated into poultry feed to provide a balance of cost and nutrients. This, and the availability of large quantities of mustard oilseed cake in this region, point to the economic importance of a suitable technology to allow its largescale use in poultry feed formulations.

2 Available Research

Tangtaweewipat *et al*⁵, working at Chiang Mai University farm with untreated, dried mustard meal on Arbor Acres 707 DOC's reported in 2004 that it could be incorporated in broiler diet at 10% during 2-7 weeks of age or at 20% only in week 7 with no adverse effect on carcass quality, although there was some enlargement of the thyroid gland. This appears to set the upper level for inclusion of the untreated cake in poultry diets.

By adjusting heat and pressure to appropriate levels during the extraction of oil from mustard seed, Sakai and Ebisawa⁶ have shown that they are able to remove the pungency and fatty material from mustard seeds leaving mustard flour (ground from the defatted seed) which has a high protein content.

Hydamaka⁷, working at the Department of Food Science, University of Manitoba, showed that 40 minutes at a temperature of 40 deg C in the presence of ascorbic acid as catalyst and a 35% buffer, maximized the release of isothiocyanates from their glucosinolate conjugates - the form in which they are stored in the seeds. The isothiocyanates can then be easily stripped off by heating.

3 Crop Strategy Implications

Isothiocyanates are released enzymatically when the seed is crushed in the presence of water. Reaction duration, temperature, pH, buffer and catalyst, all affect this reaction. When the optimum mix of these factors is ultimately found, an industrial process would be available that would (a) produce an appropriate component for poultry meal and (b) improve the extraction economics further through recovery of isothiocyanates which have potential as important antifungal, or insect biocides. Biocides are high-value products. Currently there are no alternative products on the market and it is difficult to forecast how biocides will or can substitute other pest or weed control products in the future⁸.

Sinapis alba seed contains volatile isothiocyanates while *B. juncea* seed contains non-volatile isothiocyanates. These proportions vary according to species, varieties and agronomy. The nature and volatility of the enzyme-produced isothiocyanate of a variety or species of mustard is important in the strategy of making its cake useful in poultry feed. If you aim to use significant quantities of mustard cake in future, first examine the mustard variety grown in your area.

Certain varieties of mustard are high in erucic acid⁹ content. These (HEA) seeds bestow an important advantages in industrial use of their oil, especially as a substitute for petroleum products. USDA¹⁰ plans large acreages of HEA varieties in Kansas State as a substitute for petroleum derived lube oils and hydraulic fluids. This strategy differs from those of Canada and Europe where the varieties are grown mainly for edible purposes and so are low erucic acid types. Purely as an industrial oil crop, mustard is more important than soybean as it contains twice the amount of oil per Kg of seed. If successful, this move could divert large acreages from soybean to mustard in the US, with resultant impact in the global poultryfeed industry.

And if these efforts succeed, what is likely to happen in South Asia, with its high erucic acid content crop?



References

- ¹ National Research Centre on Rapeseed-Mustard (NRCRM), Bharatpur has notified 111 varieties and evaluated and characterized over 9000 Brassica germplasm varieties for morphological traits and biotic stresses. (<http://www.nrcrm.ernet.in/>)
- ² Erucic acid, CAS number 112-86-7, monounsaturated omega-9 fatty acid. German Directive 76/621/EC by the Erucic Acid Regulation of 24, May 1977 limits it to 5% for edible products. This is based on animal studies although effect on human health is considered benign, even helpful (ref Wikipedia). Indian mustard/rape oils can have erucic acid content as high as 50%. This concern has progressively modified the European crop to low erucic acid varieties as it is primarily meant for the edible oil/fats sector. In Canada a registered variety known as canola refers to cultivars of oilseed rape that produce seed oils with less than 2% erucic acid and meals with less than 30 mmol of aliphatic glucosinolates per gram. The development and subsequent release of the first canola-quality cultivars by plant breeding programs in Canada during the 1970s created a new, high-value oil and protein crop. (Ref Raymer, P.L. 2002. Canola: An emerging oilseed crop. p. 122–126. In: J. Janick and A. Whipkey (eds.), Trends in new crops and new uses. ASHS Press, Alexandria, VA)
- ³ Isothiocyanates are sulphur-containing phytochemicals with the general formula R-NCS and are present as glucosinolate conjugates in some plants. Different molecules belong to this group and those with the strongest anticancer properties are phenylethylisothiocyanate, benzylisothiocyanate and 3-phenylpropylisothiocyanate. As many as 12-15 different glucosinolate conjugates, each with its characteristic isothiocyanate component, occur naturally in significant proportions in cruciferous vegetables which include cauliflower, cabbage, turnip, mustard, radish, horseradish etc. These compounds are released through enzyme-mediation from the conjugates when the seeds are crushed in the presence of moisture. The characteristic pungency of these vegetables then becomes noticeable. For details refer <http://www.phytochemicals.info/>
- ⁴ 5 - vinyl -1 oxizolidine thione. Considered responsible for thyroid enlargement
- ⁵ The use of mustard meal as a protein source in broiler diets, Tangtaweewipat, S., *et al* - reporting in Vol. 26 No. 1 Jan.-Feb. 2004 30 of Songklanakarin J. Sci. Technol.
- ⁶ US Patent 4496598 - Process for preparing mustard flour - [Sakai, Shiro](#) and [Ebisawa, Etsuo](#)
<http://www.patentstorm.us/patents-by-date/1985/0129/1.html>
- ⁷ <http://www.gov.mb.ca/agriculture/research/ardi/projects/00-360>
- ⁸ SJFI – Working Paper no. 04/2001 Denmark. Søren Marcus Pedersen and Morten Gylling - The economics of producing quality oils, proteins and bioactive products for food and non-food purposes based on biorefining.
- ⁹ Erucic acid content of mustard seed has another interesting historical perspective. Around the First World War cultivation of mustard as an industrial oil was purposely encouraged because of its erucic acid content. This allowed the oil to be used as a lubricant in wet and hot conditions as prevailing in steam engines which then were, arguably, the most important prime movers
- ¹⁰ Rapeseed and Crambe, ISSN 0097-0484, Alternative Crops With Potential Industrial Uses, Bulletin 656, Agricultural Experiment Station • Kansas State University, Manhattan, Walter R. Woods, Director

