Background paper on quality improvement of rapeseed meal concerning the glucosinolate content

Summary

The increasing use of rapeseed meal as feedstuff for pigs and the development of the sales market for laying hens make a low content of glucosinolate an absolute necessity. Viewed in the light of the requirements of monogastric animals concerning the high digestibility of proteins and a high praecaecal digestibility of amino acids, stronger toasting in the oil mill process with the aim of accelerating the degradation of glucosinolate should strongly be rejected.

On the background and with consideration of the progress already made by plant breeders in securing low glucosinolate content* of modern and high-yielding winter rapeseed varieties, the target currently pursued in Germany and also on a European level is a reduction of the generally acceptable maximum glucosinolate concentration in rapeseed from 25 to 18 µmol/g (91 % DS) in 00 winter rapeseed crops. This implements a recommendation of the 11th international Rapeseed Congress in July 2003, which has the following wording to ensure high and stable quality of rapeseed meal and rapeseed cake in the European market (Röbbelen and Frauen 2003):

„The following maximum levels should apply to the glucosinolate content in market batches of rapeseed

a. *< 18 µmol/g seed according to the present quality standard in Europe,*
b. *< 15 µmol/g seed as the quality target desired for Europe,*
c. *< 12 µmol/g seed as present quality standard in Canada;*
d. *< 8 µmol/g seed as quality standard fort he future global development.*

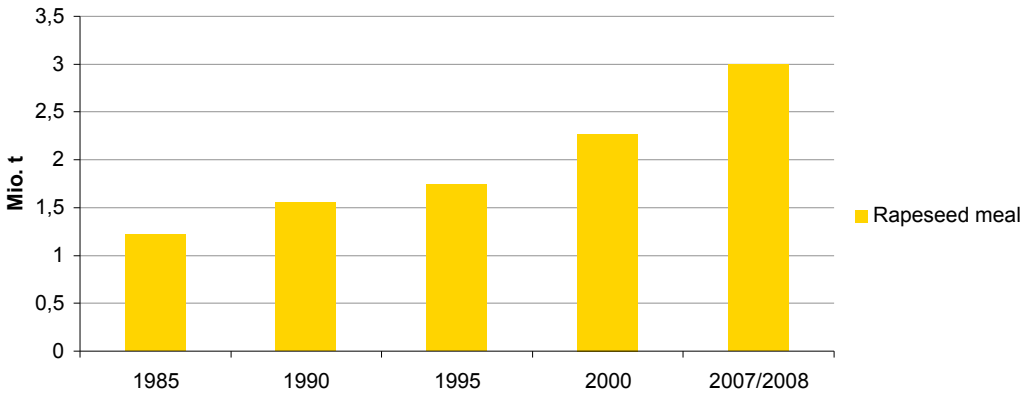
Further steps of quality improvement of rapeseed meal with the aim of the optimized use as commercial animal feedstuff will follow.

Notes on units:
*: The glucosinolate content is expressed as a function of the substance examined.
In the seed: µmol/g micromol per gram seed
in meal or cake: normally mmol/kg millimol per kilogram feedstuff
In addition, the dry substance related to the glucosinolate content must also be observed.

Present situation:

The consumption of rapeseed meal in commercial animal feeding in Germany more than doubled from 1.2 million tonnes in 1985 to approximately 3.0 million tonnes in 2007/2008 (Fig. 1). Accordingly, the share of rapeseed meal in all oil meal types for commercial animal feeding in Germany amounted to 35 % in 2007/2008 as compared with a mere 17 % in the EU-27. A precondition for this was, on the one hand, the introduction of first 00 quality rapeseed varieties in the cultivation year 1987/1988 which contain not more than 25 µmol glucosinolate/g seed (91 % DS) and, on the other hand, further progress in minimizing the glucosinolate level in new generations of winter rapeseed varieties. The Descriptive List of Varieties for 2008 published by the German Variety Certification Office proves that first high-yielding and healthy rapeseed varieties have reached glucosinolate content expression step 2 (6.0 – 11.9 µmol/g seed at 91 % DS) in the certification process for use of grain (BSA 2008).

Abb. 1: Rapeseed meal consumption in Germany 1985 – 2007/2008



Source: OVID 2008 (modified)

Development of the glucosinolate content since the introduction of the 00 quality rapeseed varieties:

Representative examinations of commercial rapeseed by SCHUMANN (Schumann 2005) in cooperation with private farming produce rural traders and cooperatives in the framework of a UFOP subsidized project yielded a mean level of 14.5 µmol/g at 91 % DS as early as in 2000, a mean of 12.9 µmol/g seed in 2001 and a mean of 12.7 µmol/g seed in 2002 (Table 1).

Table 1: Glucosinolate content in rapeseed from German sources
(samples obtained by rural collection trade, harvests 2000 to 2002)

Harvest year	Samples	GSL content (µmol/g 91 % DS)		Sample proportion (%)	
		Mean ± s	Range	> 18 µmol/g	> 25 µmol/g
2000	605	14.5 ± 3.8	0.5 – 30.6	15.2	1.2
2001	319	12.9 ± 4.3	4.0 – 36.0	8.8	2.5
2002	641	12.7 ± 3.4	2.7 – 28.3	6.4	0.3

Source: Schumann 2005

Analytical tests of consignments received by different oil mills showed that in the period under study all oil mills processed rapeseed with strongly glucosinolate concentrations that fluctuated very strongly. On average, the content was in the range of 12.5 to 15 µmol/g seed (91 % DS). There were no significant differences between the seed consignments received by the oil mills.

The examination of about 200 rapeseed oil meals from 10 industrial oil mills in the period 2000 - 2002 showed mean glucosinolate contents of 7 - 10 µmol/g (in DS) at the delivery end. All in all, German rapeseed meal was of good quality already at that time. Despite this, however, the glucosinolate content in the oil mal produced by different oil mills fluctuated. The fluctuations were mainly due to technological differences in rapeseed during processing, particularly toasting. The mean rates of degradation ranged from 33 % to 85 % of total glucosinolates in the years 2001 and 2002. The degradation rate was 60 % on average for all oil mills. This calculation assumed that 100% of all glucosinolates remained in the meal and the content in the meal increases 1.8 times that in the seed due to the removal of fat by milling.

Further examinations by SCHUMANN in the years 2000 - 2003 concerned rapeseed meal which was obtained directly from the feedstuff industry. Some 500 rapeseed meal samples from totally 32 mixed feed factories produced a mean glucosinolate content of 7.9 µmol/g (in DS). This was equal to the quality level found in the products delivered by the German oil mills. However, the frequency distribution of the glucosinolate levls showed that a number of samples had glucosinolate > 20 µmol/g (in DS). The sources of that material were not German oil mills at that time but came exclusively from imported meals with eastern European countries frequently mentioned as sources.

Continuing the projects initiated by SCHUMANN, the authorities on state level responsible for animal feedstuffs and the chambers of agriculture carry out a national rapeseed feedstuff monitoring with assistance of UFOP and OVID since 2005. One focus of the examinations is the analysis of the glucosinolate content of rapeseed oil meals and rapeseed cake. The results for 2005 and 2006 showed for rapeseed oil meal, on average, a glucosinolate level around 8.0 mmol/kg (89 % DS) with maximum glucosinolate content of 11.1 mmol/kg (89 % DS), which can be considered good quality. On the other hand, some batches identified by the monitoring in 2007 had glucosinolate contents as high as 17.1 mmol/kg (89 % DS), which started a heated debate of how the status quo of the glucosinolate content of rapeseed meal can be ensured and further improved and a clear signal for increased sales of rapeseed meal from German oil mills – especially for feeding to monogastric animals – can be sent (Table 2).

Table 2: Rapeseed meal monitoring, results 2005 – 2007

		2005	**2006**	**2007**
Samples	n	68	19	21
Dry substance	%	89,1	89,9	89,5
Content in 1000 g rapeseed meal of 89 % DS (range)				
Raw fat	g	28 (*10 - 64*)	31 (*14 - 40*)	37 (*18 - 48*)
Raw fiber	g	121 (*109 - 132*)	120 (*109 - 133*)	113 (*103 - 126*)
Raw protein	g	336 (*322 - 352*)	333 (*312 - 349*)	338 (*304 - 354*)
Raw ash	g	71 (*65 - 80*)	73 (*68 - 87*)	71 (*67 - 75*)
Glucosinolates	**mmol**	**8.1 *(4.4 – 11.1)***	**7.7 (4.4 – 11.0)**	**9.4 *(3.1 – 17.1)***
ME-S	MJ	10.2 (*9.8 – 11.0*)	10.3 (*9.6 – 10.8*)	10.6 (*9.8 – 11.0*)
NEL	MJ	6.4 (*6.2 – 6.8*)	6.4 (*6.3 – 6.5*)	6.5 (*6.3 – 6.6*)
nXP	g	208 (*204 - 212*)	207 (*199 - 211*)	196 (*185 - 200*)
RNB	g	20 (*15 - 23*)	20 (*18 - 23*)	**23** (*19 - 25*)

Source: Weber 2008

Increasing requirements on rapeseed feedstuff for feeding monogastric animals:

Whereas, in the past, rapeseed meal had successfully been tested and used widely in ruminant feeding, in particular, higher sales today are mainly on account of the use of the substance in pig feeding. Practical tests supported by UFOP in the years 2006 and 2007 provided compelling evidence of the possible animal and carcass performance which high rapeseed meal proportions of up to 15 % in pig fattening can achieve (Weiß 2007, Weiß and Schöne 2008). However, the concentration of glucosinolate in onefeed rations of pigs should not be substantially higher than 1.5 mmol/kg feed (corresponds to 10 mmol glucosinolates/kg rapeseed meal at 89 % DS and 15 % of the quantity fed).

Table 3: Pig fattening trials with rapeseed meal – practical tests 2nd run (10 % rapeseed meal in starting fattening ration and 15 % rapeseed meal in end fattening ration) – results of fattening

Trial organizer	Feeding technique	Ø feed uptake kg/head & day		Daily increase g/head		Total feed consumed kg/kg increase		Loss %	
		K	V	K	V	K	V	K	V
LK NRW	Liquid feeding	2.43	2.41	818	827	2.97	2.91	1	2
LK NRW	Sensor feeding	2.08	2.10	697	696	2.98	3.02	3	2.5
LLH Hessen	Automatic paste dispenser	2.26	2.22	836	818	2.71	2.73	3.1	2.1
LLH Hessen	Liquid feeding	2.13	2.06	703	706	3.03	2.92	3.8	5.1
ZTT Sachsen-Anhalt	Liquid feeding	2.30	2.34	711	713	2.85	2.81	1.8	2.3

Source: Weiß and Schöne 2008

SCHUMANN and SCHÖNE studied the quality of rapeseed oil meals after different levels of toasting in the oil mill process (Schumann and Schöne 2007). Totally 10 rapeseed meal samples obtained from rapeseed varieties with similar glucosinolate levels around 15 µmol/g (in DS) were examined. Die glucosinolate contents in the meals were greatly different due to the different intensity of toasting in the oil mills. More intensive toasting yielded over 11 µmol/g (in DS) lower glucosinolate content. To assess the protein quality, the rapeseed meal samples were analyzed for lysine content and available lysine (modified homoarginine method) and for usable protein (nXP) and rumen in ruminant feeding und protein flow through the rumen (UDP). With comparable raw protein concentration, the meals of the two

oil mills had significantly different lysine contents and lysine availability. These differences were to the disadvantage of the batches with lower glucosinolate, i.e., the products with stronger toasting (Table 4). Low-glucosinolate rapeseed oil meals exposed to higher heat load had 9 % lower lysine concentration and 4.5 % units less lysine availability. Summarily, the meals subjected to more heat had 2.5 g less available lysine per one kg rapeseed oil meal. This corresponds to a 14 % drop in available lysine related to 1 kg feedstuff. Standardized for 100 g raw protein, the lysine concentration of the rapeseed meal with more intensive toasting dropped by over than 10 %. Together with the lower lysine availability, the difference between meals with high and low glucosinolate content increased to 15 % reactive lysine.

Table 4: Quality of rapeseed oil meals* from two oil mills after toasting with different intensity (n = 10)

Parameter Toasting Glucosinolate content	Dimension µmol/g (in DS)	Oil mill stronger toasting 2.4 ± 0.8	Oil mill weaker toasting 13.8 ± 2.8
Raw protein	g/kg (in DS)	394 ± 12	387 ± 9
Lysine	g/kg (in DS) g/100 g raw protein	20.3 ± 0.8 5.15 ± 0.13	22.2 ± 0.8 5.74 ± 0.16
Available lysine	% g/kg (in DS) g/100 g raw protein	75.1 ± 3.2 15.2 ± 0.8 3.86 ± 0.18	79.6 ± 2.0 17.7 ± 0.7 4.56 ± 0.16
Useful lysine (nXP)	g/kg (in DS)	331 ± 16	298 ± 6
Non-degradable protein (UDP)		230 ± 20	192 ± 10

*except raw protein significance of differences in t test after STUDENT ($P < 0.05$)
Source: Schumann and Schöne 2007

It follows that more intensive toasting of the rapeseed oil meals in the oil mill process with the target of higher degradation of glucosinolate should strictly be rejected with a view to the required high protein digestibility / high praecaecal digestibility of amino acids by monogastric animals.

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