Very Low Glucosinolate and Yellow-Seeded Rapeseed : two genetic ways of increasing uses in animal feeding – an economic prospect

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Breeding and fast development of low glucosinolate content rapeseed in Europe has largely improved quality of meals and increased uses in animal feeding. In France, the present share of rapeseed in total meal consumption is reaching approximatively 15% vs 5% in 1981. So, rapeseed meal is becoming a good competitor to soybean meal, essentially for ruminants but also in pig production, where the price rate RSM/SBM rises between 60 and 70%.
Nevertheless, rapeseed utilization has not increased as high as expected and in 2000,a survey carried out by CEREOPA (a French institute for statistics and economics of feedstuffs and animal production) pointed out low and irregular inclusion levels of rapeseed meal in diets.
Moreover, the developing market of biodiesel in the next years will increase the availability of meal. A better marketing is a good way to increase utilizations of rapeseed meal by ruminants but efforts tending to improve nutritive values are probably necessary for extended uses essentially by pigs and poultry.
In fact, a significant progress in rapeseed utilization by animals is mainly dependent on two major quality improvements in seeds and meals :
- a further reduction of glucosinolate content through breeding (seeds) or crushing process (meals),
- an increase in energy value.
Concerning the glucosinolates, many studies have been done in many countries over the two last decades ; a background was presented at the 11th International Rapeseed Congress and some optional target levels were then proposed as the conclusions of a workshop (Gerhard Röbbelen, Göttingen and Martin Frauen, Hohenlieth, Germany).
Concerning the energy value of rapeseed, the dehulling technology perfected by CETIOM in the eighties had no industrial development and the genetic way (yellow-seeded rapeseed) is presently under investigation in several countries (Canada, Germany, France and Denmark).

A study was carried out by CETIOM and ONIDOL in 2003-2004 in order to evaluate the economic gain that can be expected by availability of rapeseed with very low glucosinolate content and/or yellow-seeded rapeseed on the market.

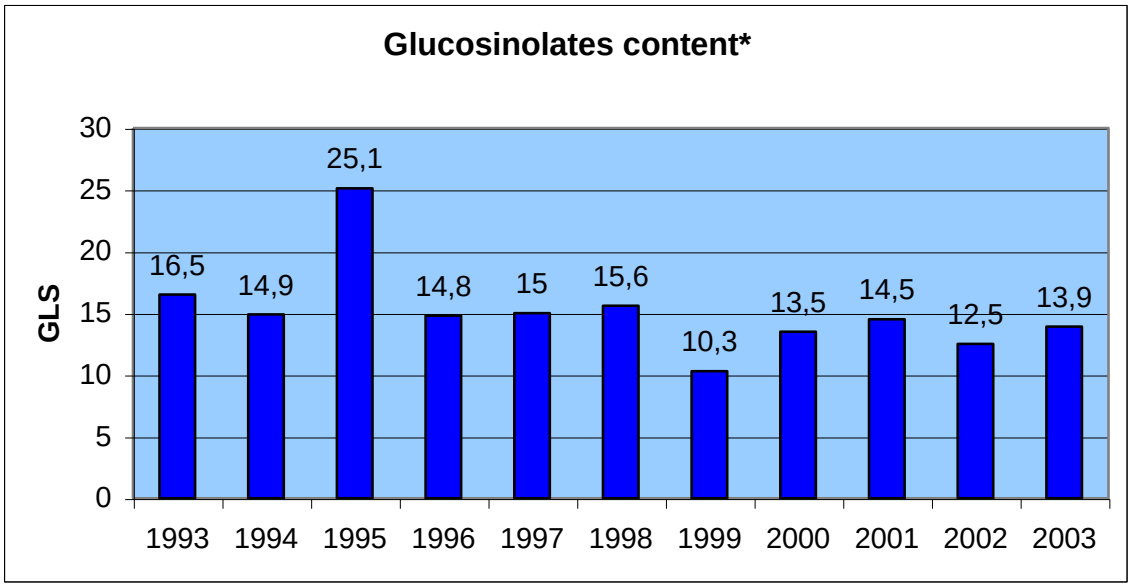
1. Today's utilizations of rapeseed in animal feeding

The French consumption of rapeseed meal in animal feeding amounts approximatively to 940 000 metric tons in 2004, - with 790 000 tons in feedstuffs and 150 000 tons by direct uses in farms. The main outlet is ruminants (Table 1).

Table 1 : Distribution of rapeseed meal consumption in French feedstuffs (2004)

1 000 T	Meal	Protected meal (formaldehyde)	Total
Ruminants	28	456	484 (61%)
Pigs	5	210	215 (27%)
Poultry	75	-	175 (10%)
Other	-	16	16 (2%)
Total	108	682	790

In 2000, a survey was carried out by CEREOPA with 11 companies involved in feed advice and 36 feed manufacturers, representing 16 millions/ tons of compound feed (more than 70% of French production).
The maximum inclusion levels of rapeseed (whole seeds) in diets ranged from 0 to 7% for fattening pigs, from 0 to 18% for broilers and 0 to 10% for dairy cows.
The maximum inclusion levels of rapeseed meal in diets ranged from 4 to 15% for fattening pigs, from 0 to 10% for broilers and from 0 to 50% for dairy cows.
These large variations in utilizations were essentially explained by a lack of palatability of rapeseed and anti-nutritional factors and it could be concluded that rapeseed with lower glucosinolate contents could be used to a larger extent.
In 2003, the average glucosinolate content of rapeseed crop was 13,9 µmoles/g (9% moisture). These values, determined by HPLC and X-fluorescence method, resulted from 228 samples for which the minimum level was 9,3 µmoles/g and the maximum level 23,3 µmoles/g (standard deviation : 2,3).



* µmoles/g of seeds (9% moisture)

2. Market perspectives through availability of rapeseed with very low glucosinolate content

A first simulation was done by CEREOPA to evaluate the increase in meal uses through availability of rapeseed with very low glucosinolate content.

Method

The study was done in the framework of three economic scenarios (Table 2) :

- Scenario "0", corresponding to average conditions registered in 2002/2003 for raw material prices and feedstuff uses,
- Scenario 2007 « low » : price conditions, raw material availability and feedstuff uses in a context of low price for protein sources (August 2002),
- Scenario 2007 « high » : price conditions, raw material availability and feedstuff uses in a context of high price for protein sources (December 2000).

Table 2 : Price scenarios for the main raw materials

Euros/t	Scenario "0"	Scenario 2007 "high"	Scenario 2007 "low"
Soyabean meal	212,1	272,0	201,0
Rapeseed meal	134,7	199,7	141,7
RSM/SBM	0,64	0,73	0,70
Sunflower meal	101,3	152,5	122,7
Pulse	139,2	162,2	145,9
Wheat	104,0	104,0	104,0
Corn	115,9	115,9	115,9

The model took the classical parameters used in France to calculate the feedstuff composition into account: analytical characteristics and nutritive value of raw materials, prices, cost of transportation, hypothesis for feedstuff utilization in 2007, present maximum inclusion levels applied to feedstuffs for ruminants and monogastrics (Table 3).

Table 3 : Maximum inclusion levels

Feedstuffs	%
Dairy cows	15
Steer	15-20
Pigs	6
Piglets	0
Sows	0
Broilers	8
Layers	0
Ducks	5
Lambs	5
Turkeys	4

Results

The reduction in glucosinolate content was expressed by the increase in maximum inclusion levels previously allowed in feedstuffs for ruminants and monogastrics. In this way, four increasing levels were tested : + 25%, + 50%, + 75% and + 100%.

In the case of the scenario "0" (Table 4), the result of a 100% increase in the maximum inclusion levels (which was equivalent to a 0 glucosinolate effect) was :

- an increase in rapeseed meal consumption : + 77%

- a decrease in pulse consumption : - 34%
- a decrease in sunflower meal consumption : - 17%
- a decrease in soyabean meal consumption : - 10%

Table 4 : Evolution of meal and pulse consumption by increasing maximum inclusion levels of rapeseed

Meal uses (1000 t)	**Scenario « 0 »**	**Increased maximum inclusion levels of rapeseed meal**				**Variation sc +100%/sc « 0 »**
		+ 25%	**+ 50%**	**+ 75%**	**+ 100%**	
Pulse	507	460	415	371	336	**-34%**
Soyabean	2 947	2 917	2 887	2 859	2 843	-4%
Protected soyabean	460	385	312	264	238	-48%
Total soyabean	***3 407***	***3 301***	***3 199***	***3 123***	***3 080***	**-10%**
Rapeseed	374	452	529	609	666	78%
Protected rapeseed	462	577	688	764	812	76%
Total rapeseed	***836***	***1 029***	***1 218***	***1 372***	***1 478***	**77%**
Sunflower 29	583	560	536	510	491	-16%
Sunflower 33	60	54	49	44	41	-32%
Total sunflower	***643***	***615***	***585***	***554***	***532***	**-17%**

The normal rapeseed meal was mainly valorised in pig feedstuffs and the protected rapeseed meal mainly valorised in ruminant feedstuffs.
The rapeseed meal consumption was increased by 54% in the case of the scenario 2007 "low", and by only 26% in the case of the scenario 2007 "high" in which the economic interest of rapeseed meal was low in comparison with soyabean meal.

3. Market perspective through availability of yellow-seeded rapeseed

A second simulation was done to evaluate the increase in meal uses through availability of yellow-seeded rapeseed. The same method was applied to rapeseeds from different origins : normal French rapeseed, yellow-seeded rapeseed AGAT (Denmark) and two *Brassica napus* canola lines (black-seeded line N89-53 and yellow-seeded line YN01-429) both produced at Saskatoon in 2003 and kindly supplied by Dr. Gerhard Rakow.

Table 5 : Composition of the different rapeseeds

	French Rapeseed (INRA-AFZ)	**Yellow-seeded AGAT**	**Black-seeded (line N89-53)**	**Yellow-seeded (line YN01-429)**
Dry matter (%)	92,3	92,8	94,8	95,2
Oil (%DM)	45,6	46,3	45,2	45,5
Crude protein (%DM)	20,6	23,1	29,3	28,6
Crude fiber (%DM defatted)	9,7	12,2	7,1	7,4
NDF (%DM defatted)	20,3	38,2	29	21,9
ADF (%DM defatted)	14,6	17,3	13,9	8,7
ADL (%DM defatted)	6,3	6,7	6,3	1,9
Ash (%DM defatted)	4,3	8,9	6,5	6,7

Glucosinolates *	15,7	5,8	14	9,9
Tanins (mg/kg)	-	1927	250	111
Walls** (g/100g)	18,9	16,5	18,3	16
Phosphorus (g/100g)	0,68	0,81	0,61	0,58
Calcium (g/100g)	0,49	0,50	0,26	0,24

*µmoles/g of seeds (9%moisture)
** Carré method (INRA)

The main interesting points concerning the Canadian lines were :
- their low fiber contents (7,1 and 7,4%),
- the low values of NDF, ADF and ADL for line YN01-429,
- the low glucosinolate content of the line YN01-429,
- and the good protein levels of the Canadian lines.

The meal compositions were calculated and the nutritional parameters (Gross Energy, ME for cockerels and broilers, DE and NE for pigs, UFL, UFV, DPIA, DPIN et DPIE for ruminants) determined through prediction equations presently used in France for formulation in animal feeding.

Results

In the case of the scenario 2007 "low", with the hypothesis of similar prices between standard rapeseed and yellow-seeded meal, the utilization levels of rapeseed meal YN01-429 would be as follows :

	Scenario 2007 "low" without yellow-seeded meal	**Scenario 2007 "low" with yellow-seeded meal**
Standard rapeseed meal	534 000 T	No more used
Yellow-seeded meal	-	1 417 000 T*

* among which 631 000 T of formaldehyde protected meal

The use of yellow-seeded meal would lead to a decrease in soyabean meal incorporation (- 890 000 T).

In the case of the scenario 2007 "high", still with the hypothesis of similar prices between standard rapeseed and yellow-seeded meal, the utilization levels of rapeseed meal YN01-429 would be as follows :

	Scenario 2007 "high" Without yellow-seeded meal	**Scenario 2007 "high" with yellow-seeded meal**
Standard rapeseed meal	63 000 T	No more used
Yellow-seeded meal	-	1 150 000 T*

* among which 626 000 T of formaldehyde protected meal

In this case, the use of yellow-seeded meal would lead to a reduction in soyabean meal incorporation (- 1 209 000 T).

The main outlets for yellow-seeded meal would be :

- in the scenario 2007 “low” : ruminants and pigs
- in the scenario 2007 “high” : essentially ruminants

Conclusion

This study demonstrated that a further reduction in rapeseed glucosinolates could lead to increase the maximum inclusion levels of rapeseed meal in feedstuffs,- which can only be effective when price rates between raw materials are in favour of rapeseed. A recent survey (2003-2004) in French crushing plants indicated glucosinolate values set between 5 and 36 µmoles/g (dry matter basis). So, it is necessary to clarify the specific part played by crushing parameters before taking decisions for new genetic programs.
The yellow-seeded rapeseed is a good raw material for animal feeding. The next step will be to validate the prediction equations established for standard rapeseed on yellow-seeded meal and to carry out animal tests to get an accurate determination of nutritional value of this new material.

Bibliography

Evrard J., Glucosinolates in rapeseed : must their content be further reduced ? Bulletin GCIRC, n°20
Krouti M., Merrien A., Le Dilosquer A., Quality of winter oilseed rape produced in France : an evaluation covering ten years, 11th International Rapeseed Congress, Copenhagen, 2003
Lapierre O., Pressenda F., Study on ways for improving rapeseed meal quality for animal feeding, juin 2004
Lapierre O., Pressenda F, A survey on utilization of raw materials in French feedstuffs, Cereopa, February 2000

Acknowledgments

This work received a financial support from Oniol and Onidol (the French organization for oilseeds development) in the framework of the national research plan (2002-2006) for oilseeds development in France.

Dr. Gehrard Rakow for supplying the canola *Brassica napus* lines.