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THE UTILIZATION OF RAPESEED MEAL IN ANIMAL FEEDING

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The poor palatability and goitrogenic activity of rapeseed meal resulting from the presence of ITC (isothiocyanates) and VTO (vinyl oxazolidinethiones) have led to a situation where this type of meal is hardly used in animal feeding in France.

The proportion of these compounds, ITC and VTO, in the meal depends largely on the manufacturing process. Various techniques are now applied, and the very purpose of one of them, toasting, is to eliminate volatile ITC.

We have, therefore, undertaken a series of studies concerning the influence of the manufacturing process.

For that purpose, we compared three meals from the same lot of seed, but prepared according to techniques whose characteristics are shown in Table I.

Thus, a comparison between processes A and C makes it possible to study the influence of toasting since the seed has been extracted under substantially the same conditions, and the comparison between processes A and B makes it possible to study the influence of heat conditioning of the seed before it goes to the press, since both meals were subsequently toasted.

The distribution as is and at will, of these three meals as well as the use of linseed meal as a control, has allowed us to assess palatability. The results (Table II) show the very definite influence of toasting on palatability, since the increase in the level of ingestion is of the order of 70% compared to the untoasted meal.

Toasting also makes it possible to ingest the meal more rapidly and shortens the adaptation period. However, we can also see the importance of heat conditioning the seed by comparing the consumption of meals A and B.

Following this test, we had to determine, for dairy cattle, at what rate the rapeseed meal could be incorporated into the concentrated feed, and also to find out whether the influence of toasting is just as pronounced when this meal is mixed with cereals.

TABLE I

TEMPERATURES (1) AND DURATION OF THE PASSAGE OF THE SEED AND OF THE MEAL AT THE DIFFERENT MANUFACTURING STAGES FOR THE THREE PROCESSES

	A		B		C	
Manufacturing stage	Duration of passage	Temperature at exit	Duration of passage	Temperature at exit	Duration of passage	Temperature at exit
Heating of the crushed seed	1st cooker: 26 mins. 2nd cooker: 26 mins. Conditioner: 3 mins.	68- 70°C 106-108°C 110°C	1st cooking : 15 mins.	35-40°C	Series of cookers 20 mins.	90°C
Continuous pressure in screw-press	about 10 mins.		1st pressing: 5 mins. 2nd cooking : 85 mins. 3rd pressing: 5 mins.	50-60°C	About 5 mins.	
Solvent extraction	Rotatory extractor about 2 hours		Horizontal extractor about 2 hours		Vertical extractor about 3 hours	
"Toasting" or drying	Toasting 4th tray: 45 mins. 3rd tray: 45 mins. 2nd tray: 45 mins. 1st tray: 45 mins.	65°C 92°C 108°C 116°C	Toasting 4th tray: 45 mins. 3rd tray: 45 mins. 2nd tray: 45 mins. 1st tray: 45 mins.	62°C 110°C 112°C 112°C	Drying in partial vacuum (a few cm of Hg)	105°C max

(1) The temperatures, as measured by means of industrial blade thermometers, must be considered with caution, because of the poor precision of these instruments.

TABLE II

QUANTITIES OF MEALS CONSUMED

AVERAGE VALUES BY TREATMENT AND BY PERIOD

(Kg of dry matter/animal/day)

Treatment	A 2.05 ** (B, C)	B 1.65 ** (C)	C 1.21	Linseed Meal 3.10 ** (A, B, C)
Period	1 1.60 *(2,3 & 4)	2 2.03	3 2.11	4 2.06

* Significant difference ($P<0.05$)
** Significant difference ($P<0.01$)

Accordingly, we compared for two successive years the palatability of four concentrated feeds containing 15% to 30% of each of the meals, toasted and untoasted.

The quantities of feed distributed were adjusted according to the requirements of the animals and the palatability was evaluated by the percentage rejected. The results (Table III) show major individual differences in consumption (0 to 70% rejected).

Also, the influence of toasting is much less evident when the meal is mixed with cereals. On the other hand, the rate of incorporation is very important since the percentage rejected is higher with 30% rapeseed meal, whatever the process.

With regard to the rapidity of ingestion, the feed containing toasted meal appears to be more quickly consumed, but the rate of incorporation has little effect.

Next we wanted to ascertain the maximum quantity of rapeseed meal which cows can ingest when concentrated feed is distributed at will. We studied two rates of incorporation, (30% and 40%), again comparing the two meals, ordinary and toasted. When providing the cows constantly with hay and concentrated feed, we observed very high consumption levels (Table IV), approaching 13 kg of dry matter of concentrated feed. Increasing the proportion of rapeseed from 30% to 45% caused a reduction in the quantity of feed ingested of about 2 kg, but at the same time, the consumption of rapeseed increased nearly 1 kg to reach 4.9 kg of dry matter with the

TABLE III

INFLUENCE OF THE TREATMENT AND OF THE PROPORTION OF RAPESEED MEAL IN THE CONCENTRATED FEED ON THE AMOUNTS INGESTED BY COWS AT THE BEGINNING OF LACTATION

(Test 2)

	1st year (4th-7th week of lactation)				2nd year (1st-4th week of lactation			
	Toasted 15%	Not Toasted 15%	Toasted 30%	Not Toasted 30%	Toasted 15%	Not Toasted 15%	Toasted 30%	Not Toasted 30%
Consumed concentrated feed (kg of dry matter)	5.47	5.21	2.81	4.52	6.56	5.76	6.04	5.17
$\frac{\text{Refused concentrated feed}}{\text{Offered concentrated feed}} \times 100$	5.0 (0-19.0)	1.5 (0-6.9)	31.2 (0.9-70.4)	20.0 (0.1-64.4)	2.0 (0-9.5)	3.6 (0-12.9)	1.7 (0-5.7)	6.4* (0-20.0)
$\frac{\text{Ingested meal}}{\text{Total ingested ration}} \times 100$	5.8	5.2	6.0	8.9	6.1	5.7	11.5	10.9
Duration of the consumption of the concentrated feed (mn/kg)	8.3	14.7	11.7	14.1				
Production of milk	19.4	19.6	18.5	21.3	22.4	20.3	20.4	18.1
Variation during the period (kg) (1st week - 4th week)	- 0.4	- 0.9	- 0.7	- 1.9	+7.4	+ 6.2	+ 5.7	+ 5.7
Fats (p.1000)	36.0	33.7	34.4	34.5	37.5	38.4	37.6	38.1
Nitrogenous matters (p.1000)	31.1	30.8	31.5	31.7	36.2	36.1	37.1	37.3

* Significant difference ($P < 0.05$)

TABLE IV

INFLUENCE OF PROCESSING AND OF THE PROPORTION OF RAPESEED MEAL IN THE CONCENTRATED FEED FED AD LIBITUM ON THE AMOUNTS INGESTED

(Test #3)

L O T S	I		II	
Concentrated Feed	Toasted Meal 30%	Non-Toasted Meal 45%	Non-Toasted Meal 30%	Non-Toasted Meal 45%
Ingested amounts (kg dry matter)				
Hay	4.78	4.67	4.93	5.06
Concentrated feed	12.97	10.99*	11.84	10.04**
$\frac{\text{Ingested concentrated feed}}{\text{Whole ingested ration}} \times 100$	73.0	70.1	70.5	66.7
Ingested rapeseed meal (kg dry matter)	3.89	4.95**	3.55	4.52**
$\frac{\text{Ingested rapeseed meal}}{\text{Whole ingested ration}} \times 100$	21.9	31.5**	21.2	30.0**

* Significant difference at $P < 0.05$ with 30% of meal

** Significant difference at $P < 0.01$ with 30% of meal

toasted meal, or 30% of the total ration.

Although the differences are not significant, there was a higher consumption of the toasted than of ordinary meal.

From these tests with dairy cattle one may draw the conclusion that an adaptation period seems to be necessary, if cattle is to consume large quantities of rapeseed meal, and a gradual increase in the quantity offered seems desirable.

Finally, as far as we can judge, since we did not have a control lot, rapeseed meal does not seem to have any harmful effects on the production and composition of milk.

However, while toasting seems to be generally effective in improving palatability, we must ascertain whether it does not change the nutritive value of the meal. We have observed that this process does not change the digestibility of the organic and nitrogenous matter when fed to sheep (Table V).

TABLE V

DIGESTIBILITY COEFFICIENTS DETERMINED IN SHEEP

	ORGANIC MATTER		NITROGENOUS MATTERS	
	% Dry Matter	Coefficient of Digestibility	% Dry Matter	Coefficient of Digestibility
"Toasted" Meal	92.3	81.3	44.1	86.1
Non-Toasted Meal	92.1	79.2	40.4	83.7

At the same time, we wanted to know whether toasting has any influence on the digestion of nitrogenous material in the rumen. It seems that it slightly reduces proteolysis, (Table VI), since the concentrations of ammonia in the rumen fluid and of urea in blood plasma are lower for toasted than for ordinary meal.

This leads us to think that toasting may allow a better utilization of nitrogenous matter, since this reduction in proteolysis is not accompanied by a reduction in the digestibility of the nitrogenous material.

TABLE VI

CONCENTRATION OF AMMONIA IN THE RUMEN FLUID
(Average of the 4 first hours after feeding)
AND OF UREA IN THE BLOOD PLASMA
(4 hours after feeding)
(expressed in mg N/100 ml)

	Cow 3061		Cow 4014	
Barley & Toasted Meal	17.2	30.7	9.6	23.0
Barley & Non-Toasted Meal	19.3	32.2	11.8	20.7

Finally, we compared the nutritional efficiency of these two meals in growing animals. Two lots of heifers receiving identical quantities of hay and concentrated feed containing 50% cereal and 50% of one of the two meals showed similar growth rates as indicated in Table VII.

While toasting makes it possible to eliminate part of the volatile mustard oils (isothiocyanates, ITC) without changing the nutritional value of the meal, this does not apply to the goitrin (VTO) which is not volatile and entirely remains in the meal. Up to now we have always thought that ruminants are not sensitive to this substance, because it has never shown to have any effect.

However, Canadian tests have shown that gestating sheep receiving a ration containing 20% rapeseed meal gave birth to significantly lighter lambs. In an experiment performed last year, we observed a similar phenomenon with rations containing no more than 10% of ordinary or toasted rapeseed meals, compared with linseed meal (Table VIII).

Moreover, the death rate during the first week after lambing was much higher in the two lots fed rapeseed meal. But it must be pointed out that the animals were in a shed at a temperature equal to that outside and that lambing took place during a severe cold spell. A repetition of the test this year did not seem to confirm the previous results.

Single lambs were lighter at birth in the rapeseed lot, but not significantly so, and twin lambs weighed as much as those of the control lot. On the other hand, out of 9 sheep from each lot slaughtered immediately after lambing, we observed that the

TABLE VII

COMPARISON OF THE NUTRITIONAL EFFICIENCY OF TWO NORMAL AND TOASTED RAPESEED MEALS ON GROWING HEIFERS

Periods		Lot I Toasted Meal	Lot II "Non-Toasted" Meal
	Ingested amounts (Kg D.M.)		
1	. Hay	5.52	5.53
6 Weeks	. Concentrated feed (50% corn - 50% meal)	2.67	2.66
	Daily average growth (g)	898	868
	Ingested amounts (Kg D.M.)		
2	. Hay	6.35	6.41
5 Weeks	. Concentrated feed (50% corn - 50% meal)	2.62	2.60
	Daily average growth (g)	944	960

TABLE VIII

INFLUENCE OF RAPESEED MEAL IN RATIONS FOR PREGNANT SHEEP ON THE WEIGHT OF LAMBS AT BIRTH

Lots		I	II	III
Diets		Toasted RSM	Normal RSM	Linseed Meal
Number of animals born:	Singles	23	17	18
	Doubles	14	22	20
	Total	37	39	38
Weight at birth (kg):	Singles	3.18	3.09	3.64*
	Doubles	2.61	2.62	2.83
Number of lambs dead during first week:				
	Singles	7	3	3
	Doubles	7	12	4
Average age (d) on 23/5:	Singles	51.9	48.5	50.5
	Doubles	55.6	54.1	49.1
Growth from birth to 23/5 (g/d):	Singles	203	176	211
	Doubles	166	147	145

* Significant difference at $P < 0.05$ with lots I and II.

thyroid glands of animals fed rapeseed meal were significantly heavier than those of the control lot: 6.75 and 4.49 grams respectively. In addition, a quick initial histological examination disclosed in the animals of the rapeseed lot a structural change in the gland: a higher epithelial cell count and high colloid content in resorption vacuoles. Thus contrary to our previous views, the goitrin also has an effect on ruminants at the thyroid level, but this is not always plainly visible and so far has been observed only in gestating sheep. It would no doubt be interesting to determine whether such a phenomenon also exists in cattle.

In conclusion, it would appear that toasting brings about the better utilization of rapeseed meal by improving its palatability. For meat production, which does not require an increased nitrogen content, this meal can no doubt constitute a major share of the complementary protein content of a ration made from forage and cereals.

However, with regard to dairy cattle and especially for heavy producers, there is no doubt that a limit of 20% rapeseed meal must be set for the total of concentrated feed. Otherwise, the animals will refuse to eat it. On the other hand, the percentage of rapeseed meal must be allowed to reach 40% in the case of a complementary nitrogen feed made from grains.

Finally, with regard to sheep, caution is essential and several tests are still required before we can set a definite guideline.