Long-term performances of mixed-parities sows fed with 10% regular rapeseed meal during gestation and lactation

Quiniou N.[1a]*, Crépon K.*[2]*, Quinsac A.*[3]*, Evrard J.*[3]*, Peyronnet C.*[2]*,*
Bourdillon A.[4]*, Royer E.*[1b]*, Etienne M.*[5]

1. IFIP - Institut du Porc, Pôle Techniques d'Elevage
a- BP35104, 35651 LE RHEU cedex, b- 34 bd de la Gare, 31000 Toulouse
2. ONIDOL, 12 av. George V, 75008 PARIS
3. CETIOM, Rue Monge, Parc Industriel, F-33600 Pessac
4. CYBELIA, 33 avenue du Maine, 75755 Paris cedex 15
5. INRA-UMR SENAH, Domaine de la Prise, 35690 SAINT-GILLES
nathalie.quiniou@ifip.asso.fr

INTRODUCTION

Due to the increase of bio-diesel production, the amount of rapeseed meal available as feedstuffs for animal production is expected to double between 2006 and 2010. Despite its nutritional qualities, rapeseed meal is not widely used in pig feed because of previously observed adverse effects of older, rich in glucosinolates (GSL) varieties (Etienne et al., 1987). However, thanks to the genetic breeding, very low GSL varieties (>18 µmol/g) are grown since the early 90s. Etienne et al. (1993) showed that this type of rapeseed meal could be incorporated for feeding primiparous sows at a rate according to a maximum level of 5 mmol GSL per day. In this late experiment, the rapeseed meal prepared in the CETIOM (France) pilot plant from the Tapidor cultivar, contained 9.3 µmol/g and was incorporated at 20 % in the feed.

The quality of the regular rapeseed meal currently produced in the industrial crushing plants in France has been monitored with a survey for several years. The GSL content was around 10 µmol/g with a significant variability (between 2 and 20 µmol/g) caused by the harvested seed content variability and especially the effect of the process (Dauguet et al., 2006). Beyond the development of varieties and the industrial crushing process since 1993, the specificity of this trial is based on the use of a regular industrial-type meal containing a relatively high level of GSL (about 15 mol/g) compared to the average of the production in France. Moreover, the study is conducted on the long-term (3 cycles of reproduction) with an important initial group of mixed-parities sows, the most sensitive stage in pigs.

1. MATERIAL AND METHODS

1.1 Experimental design

Four batches of crossbred Large White x Landrace sows from the IFIP Experimental Station (F-35850 Romillé) were used to study the effect of an introduction of 10 % of low content GSL rapeseed meal, on the prolificacy, the lactating and reproduction performances over three reproductive cycles. In addition to those animals, females, including gilts, were introduced during the two following cycles.

The sows were allocated between two treatments according to the parity, backfat thickness (BFT), live weight (LW) at weaning and the size of their previous litter. They received one of the two experimental feeds from weaning until the end of the study. Sows from the R treatment received feed containing 10% of rapeseed meal during the test period, whereas those from the C group were fed with diets that did not include rapeseed meal. Animals remained in the same treatment all along the trial.

1.2 Feeds and animal feeding

The batches of rapeseed meal used were obtained by hexane extraction following pressing in a high-capacity plant. For each lot, the GSL content was controlled by the CETIOM laboratory, (F-45160, Ardon). The GSL content was 14.5 µmol/g on average with a maximum value of 16.3 µmol/g (Table 1).

The main chemical characteristics of each feedstuff were determined before each dietary preparation. The rapeseed meal was substituted to soybean and sunflower meals and the formula for lactating and gestating feeds were adjusted, so that their net energy (NE) content was 9.0 and 9.6 MJ/kg and their digestible lysine content was 5.0 and 8.5 g/kg, respectively (Table 2). The diets were prepared and pelletized by Euronutrition (Sourches F-72240, Saint-Symphorien).

Table 1: Composition of the six rapeseed meals lots used for preparing the feed lots, in glucosinolates (µmol/g DM) precursors of goitrogenic compounds

Rapeseed meal lot number	Glucosinolates precursors of : Oxazolidine-2-thiones[1]	Isothiocyanates [2]	Thiocyanates ions[3]	Total GSL
500446	6.9	3.7	2.6	13.2
500650	9.7	4.4	2.1	16.2
600064	8.6	4.7	2.3	15.6
600407	7.3	4.1	2.7	14.1
600261	7.5	4.0	2.8	14.5
600563	7.4	4.0	2.0	13.4
Average	7.9	4.2	2.4	14.5
Standard deviation	1.1	0.4	0.3	1.2

[1]Progoitrin, epiprogoitrin and gluconapoleiferin, [2] gluconapin, glucobrassicanapin, glucoalyssin, [3]glucobrassicin, 4-hydroxyglucobrassicin

Table 2: Formulas of feeds and analysis for composition of the different manufactured lots (average and standard deviation)

Stage	Gestation				Lactation			
Diets	**G-R**		**G-C**		**L- R**		**L- C**	
Number of manufactured diets	9		9		7		6	
Incorporation rate g/kg[1]	**Formula**	**Analysis**	**Formula**	**Analysis**	**Formula**	**Analysis**	**Formula**	**Analysis**
Oilseed Meal	162 ± 14		156 ± 14		194 ± 10		187 ± 9	
of which rapeseed meal	**100**		**0**		**100**		**0**	
Cereals	694 ± 18		703 ± 18		696 ± 18		693 ± 24	
Amino acids premix	1 ± 1		1 ± 1		31 ± 4		28 ± 6	
Minerals-vitamins sources	27 ± 1		30 ± 1		29 ± 1		31 ±1	
Sugar beat pulp	95 ± 13		90 ± 14		12 ± 13		23 ± 30	
Sugar beat molasses	20		20		20		20	
Soybean oil	0		0		18 ± 3		18 ± 3	
Nutritional characteristics, /kg								
Crude protein, g	144 ± 1	139 ± 2	145 ± 11	139 ± 2	159 ± 5	154 ± 4	161 ± 5	155± 6
Lysine, g	6.5 ± 0.1	6.4 ± 0.1	6.3 ± 0.1	6.1 ± 0.1	9.8 ± 0	9.5 ± 0.3	9.6 ± 0.1	9.3 ± 0.2
Digestible lysine, g	5.0		5.0		8.5		8.5	
Starch, g	385 ± 12	407 ± 9	390 ± 111	409 ± 7	405 ±10	413 ± 12	400 ±18	409 ± 18
Fat, g	15 ± 1	13 ± 4	16 ± 11	15 ±1	33 ± 3	34 ± 3	33 ± 3	33± 3
Crude fibre, g	60 ± 3	64 ± 5	63 ± 13	65 ± 4	47 ± 2	52 ± 4	49 ± 2	52 ± 4
Ashes, g	55 ± 1	48 ± 2	56 ± 11	48 ± 2	58 ± 1	51 ± 1	59 ± 1	52 ±2
Digestible energy, kcal	3091 ± 24		3093 ± 124		3218 ± 10		3232 ± 18	
Net energy, MJ	9.0		9.0		9.6		9.6	

Oilseed meals: soybean, sunflower, rapeseed; Cereals: wheat, barley; Amino acids premix: 25 % lysine, 20 % methionine, 10 % threonine or 10 % tryptophan premix; minerals-vitamins sources: trace minerals and vitamins, salt, dicalcium phosphate, calcium carbonate.

Amounts of experimental feeds from weaning until the 9th day of gestation averaged 3.0 kg/d for the sows and 2.7 kg/d for the gilts. Thereafter, the dietary allowance was adjusted to the body condition of the sow at the beginning of gestation. From entering in the farrowing room to the farrowing, the sows were fed 3.5 kg/d and the gilts 3.2 kg/d. After the farrowing, they were restricted with a mixture of lactating and gestation feeds during four days and thereafter *ad libitum* with the lactating feed from the 5th day post-partum until the day before weaning that was performed on the 28th day. The day before weaning, the sows received an amount of feed corresponding to half of the quantity eaten the day before.

1.3 Management of animals in the farrowing room

Farrowing was induced on the 114th day. Within 24 hours after birth, piglets received routine care. Adoptions were carried out within 24-48 hours after birth in order to homogenize litter size. The dam and the nursing sow belonged to the same treatment

1.4 Measurements

On the 28th day of gestation, pregnancy was confirmed through ultrasonography. The sows were weighed and their BFT determined at weaning, at the beginning of the gestation, after farrowing and at the next weaning. Litter size at birth corresponded to the sum of born alive and stillborn piglets. The piglets were weighed at birth and at weaning or on the day of their eventual death. Sows were weaned on Thursday and checked for œstrus twice daily with a teaser boar from the 4th to the 21st days after weaning. The average daily feed intake (ADFI) during lactation was determined (Quiniou et al., 2006). In case of gestation failure (return to oestrus), abortion, or culling, date and causes were recorded. Blood samples were taken from the sows at the beginning of the pregnancy and at weaning and from two piglets per litter at birth and at weaning in order to determine thyroxin content (T4) in plasma using radioimmunoassay (CIS Bio International). For each type of feed and each batch of sow, samples were collected weekly for subsequent analysis.

1.5 Calculations and statistical analysis

The daily amount of GSL intake during pregnancy and lactation was calculated from the ADFI and the GSL content in the batch of rapeseed meal used for the used feed preparation. The size of the suckled litter took into account all weaned piglets and piglets that died before weaning as a proportion of the time they were present.
Statistical analysis was performed on all sows after completing one reproductive cycle in the trial (i.e. one gestation/lactation). The analysis of variance (proc GLM, SAS, 1990) included the treatment (T), the number of the reproductive cycle in the station (C), the batch (B) and the parity classified in four classes (R, 0, 1, 2 and 3, 4 and more) as main effects. The BFT at the beginning of the trial was also taken into account and categorised in three classes (E <15, 15-18, ≥18 mm). The multifactorial analysis of variance was performed from sows studied over more than one reproductive cycle (so-called thereafter "occurrence") in the trial, taking into account the same main effects as mentioned above and the number of occurrences (O), the interaction O × T and the sow (T) as the experimental unit. Depending on the criterion, either litter size at birth or suckled litter size was introduced as a covariate into the statistical model. The effect of the treatment on the number of stillborn and dead before weaning piglets was analyzed using Kruskal-Wallis nonparametric test (proc NPAR1WAY, SAS, 1990).

2. RESULTS

This paper focuses only on results obtained from sows that performed one or three occurrences during the trial.

2.1 Longevity

Over the three reproductive cycles, 175 and 192 sows were inseminated in the R and C treatments, respectively (Table 3), from which 52% and 56% of the sows initially present at the start of the trial remained at the start of the 3rd occurrence (χ^2, P>0.10).

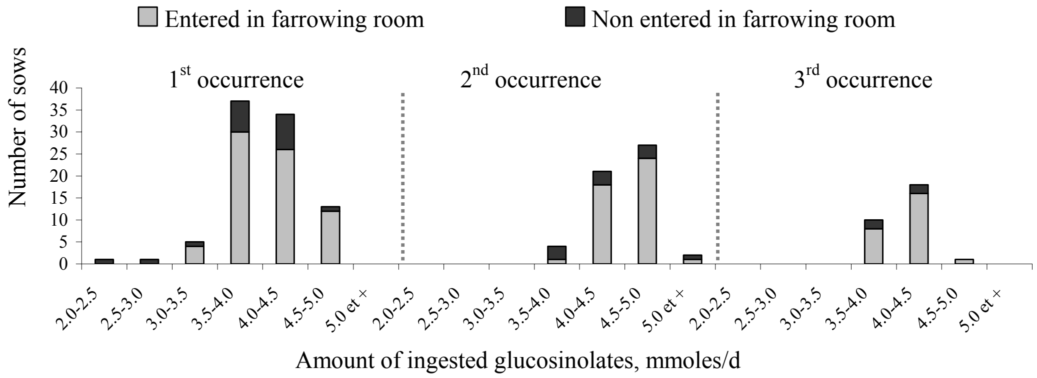

Figure 1 : Repartition of sows from the RAPESEED (R) batch according to their fate (entry or non-entry in farrowing room) after 1, 2 or 3 pregnancies and the amount of ingested glucosinolates

Return into oestrus frequency after insemination was not significantly affected by the treatment, nor the abortion rate was. Reproductive problems concerned 10 and 14% of inseminated sows in the R and C treatments, respectively (Table 3). During the 1st pregnancy, corresponding values were 10 and 17%, respectively (P> 0.10). Among sows that came back into oestrus beyond 28 days of gestation, 66% from the C group had been confirmed pregnant, whereas only 50% from the R group. One sow aborted after a strong fever and another was observed empty only when entering into the farrowing room. Except from these two sows, the average time of interruption of pregnancy was 46 days for both treatments. During gestation, only two sows ingested more than 5 mmol GSL per day. This level of consumption was reached during the 2nd occurrence of the test (Figure 1). One of these two sows entered the lactation (5.1 mmol/d), while the other one returned into oestrus on the 77th day of gestation, but after a non conclusive ultrasound control (5.3 mmol/d). Culling concerned 18 and 26% of sows from the R and C treatments, respectively (Table 3). Culling frequency and causes were not significantly influenced by the treatment. The main reason was related to the fact that more sows were inseminated that the number of available pens in the farrowing rooms, the second was related to leg weakness problems.

2.2 Short-term performance

During the 1st occurrence of the test, the number of farrowing was 71 in the R group and 69 in the C one. The average parity was 1.9 for both treatments. The litter size at birth was not significantly different between the two treatments: 13.9 and 14.2 total born piglets were obtained for the R and C groups respectively (Table 4). After cross-fostering, a higher litter size was obtained in the R treatment (P<0.01), taking into account lower early losses than in the C group. However, throughout the lactation, losses were similar for both treatments (3 piglets) and the litter size at weaning was not different. The weight of the litter or the heterogeneity among piglets within the litter was not significantly affected by the treatment, neither at birth nor at weaning. The proportion of sows that wasted feed during lactation did not differ significantly from one group to another (30 and 36% in R and C groups, respectively). The ADFI was 6.0 kg in the R group and 6.4 kg in the C one (P> 0.10). Sows' body weight and BFT changes during gestation and lactation were not different between the two groups (Table 5). The WEI averaged 4.5 days for both treatments.

Table 3: Evolution of the number of sows during the trial.

Treatment[1]	R	C	Statistics[2]
Number of sows at the beginning of the			
1st gestation	91	96	
2nd gestation	54	61	
3rd gestation	30	35	
Total	175	192	
Return in oestrus after insemination for the			
1st gestation in trial	9	16	
2nd gestation	7	10	
3rd gestation	1	1	
Total	17 (10%)	27 (14%)	χ^2 : ns
whose returned in oestrus after 28 days	9	6	
gestation confirmed at 28 days	3	4	
empty when entering the farrowing room	1	0	
aborted after vaccination	1	0	
were doubtfully diagnosed as gestating sow	4	2	
Culling			
Sows in excess	8	11	
Leg weakness	5	10	
Dead	0	2	
Others causes	3	2	
Total	16 (18%)	25 (26%)	χ^2 : ns

1. Treatments: R for diets that contained 10% of rapeseed meal, C for control diets without rapeseed meal.
2. Level of statistical significance : ***: P<0.001, **: P<0.01, *: P<0.05, ns: P>0,05

2.3 Long-term performance

Twenty-five sows from the R group and 27 from the C group went through three reproductive cycles. Their performances at the first occurrence of the test were similar to those of the full sample presented above. After three occurrences, the prolificacy of sows from the R treatment was not significantly different from that of the C treatment (14.7 and 14.2 total born piglets, respectively).

Table 4: Prolificacy and performances during lactation.

Duration considered	1 occurrence				3 occurrences					
Occurrence number					1st		3rd			Treatment & occurrence effects[3,5]
Treatments[1] and statistics	R	C	RSD	Treatment effect[2,5]	R	C	R	C	RSD	
Litter size										
Total born	13.9	14.2	3.7	T^{ns}	14.2	15.3	14.7	14.2	2.9	T^{ns}
Born alive	13.3	13.0	3.5	T^{ns}	13.6	14.2	13.4	14.0	2.6	T^{ns}
Alive at 24 hours	12.6	11.9	1.4	T^{**}	12.7	12.0	12.1	12.8	1.3	T×O*
Weaned at 28 days	11.3	11.0	1.4	T^{ns}	11.4	11.0	10.5	10.7	1.1	T^{ns}
Total losses[4]	2.7	3.2	-	T^{ns}	2.8	3.6	3.5	4.0	-	T^{ns}
Weight at birth										
kg/ litter	19.6	20.3	2.6	T^{ns}	21.0	21.8	21.8	22.7	1.7	T^{ns}
kg/ piglet	1.44	1.46	0.18	T^{ns}	1.51	1.45	15.51	1.52	0.13	T^{ns}
Within litter variability[5]	0.30	0.32	0.09	T^{ns}	0.31	0.34	0.34	0.36	0.07	T^{ns}
Weight at weaning										
kg/ litter	99	100	11	T^{ns}	107	102	100	101	9	T^{ns}
kg/ piglet	8.9	9.1	0.9	T^{ns}	9.43	9.23	9.50	9.50	0.72	T^{ns}
Average daily gain, kg/litter	2.99	3.01	0.32	T^{ns}	3.20	3.06	2.98	3.00	0.26	T^{ns}

1. Treatments: R for diets that contained 10% of rapeseed meal, C for control diets without rapeseed meal. Variance analysis with main effects: the treatment (T), the historical reproduction cycle in the station (H), the batch within-cycle (B), the initial backfat thickness (E) and parity (P).
2. Multifactorial analysis of variance with main effects T, H, B, P, the occurrence number (O), the interaction T×O, and the sow (S).
3. Sum of stillborn, early losses or losses after adoption, separately analysed for each occurrence by the non-parametric test of Kruskal-Wallis.
4. Standard error of the mean.
5. Level of statistical significance, see table 3.

Tableau 5: Body condition, average daily feed intake and post weaning reproduction performances.

Duration considered	1 occurrence				3 occurrences					
Occurrence number					1st		3rd			Treatment & occurrence effects
Treatments and statistics[1]	R	C	RSD	Treatment effect	R	C	R	C	RSD	
Number of sows										
At farrowing	71	69			25	27	25	27		
Lactating sows[2]	69	66								
Initial parity	1.9	1.8			2.3	2.0				
Daily feed intake, kg/d										
During gestation	3.0	3.1	0.1	T^{ns}	3.2	3.2	3.2	3.2	0.1	T^{ns}, O***
During lactation	6.0	6.4	0.8	T^{ns}	6.5	6.9	7.3	7.4	0.4	T^{ns}, O***
(nb. observations)	*48*	*42*			*15*	*16*	*13*	*15*		
Ingested GSL, mmol/d										
during gestation	4.0	-	0.2	-	4.2	-	4.0	-	0.3	O***
during lactation	7.4	-	0.9	T^{ns}	8.1	-	8.8	-	0.7	T^{ns}, O*
Live weight, kg										
At the beginning of the gestation	198	196	12	T^{ns}	205	199	243	238	10	T^{ns}, O***
After farrowing	251	252	13	T^{ns}	262	254	292	292	11	T^{ns}, O***
At weaning	226	226	15	T^{ns}	238	233	274	265	11	T^{ns}, O***
Backfat thickness, mm										
At the beginning of the gestation	16.5	16.3	1.0	T^{ns}	15.9	16.2	16.8	17.0	0.9	T^{ns}
After farrowing	19.9	19.9	2.3	T^{ns}	20.1	20.2	20.2	20.7	1.4	T^{ns}
At weaning	16.1	16.0	1.9	T^{ns}	16.6	16.5	17.4	16.8	1.1	T^{ns}, O*
Reproduction after weaning										
Number of sows	69	66			25	27	25	27		
Weaning-Estrus Interval, d	4.4	4.6	2.1	T^{ns}	4.2	4.0	4.0	5.4	1.8	T×O*
Next litter size	-	-	-	-	14.7	14.3	-	-	3.2	T^{ns}

1. See Tables 3 and 4.
2. Several sows were excluded from the analysis because of parturition or lactation problems independent of the trial

The difference in litter size noted the day after the first farrowing was not observed in the following births, resulting in a significant interaction between the lot and the number of occurrences. Whatever the number of occurrences, the losses before weaning did not differ between groups and averaged -3.2 and -3.7 piglets during the 1st and 3rd lactations, respectively. At the 3rd farrowing, piglets weighed 1.5 kg on average for both lots and the heterogeneity of litters remained similar. On average, 10.6 piglets weighing 9.5 kg were weaned per litter from sows from the two treatments. The ADFI during lactation was obtained from 13 to 16 sows according to the occurrence and the treatment. It increased with the age of the sows, from 6.7 kg/d during the 1st occurrence to 7.4 kg/d during the 3rd (P <0001) but without any difference between the treatments.

The body weight variation during the test was similar in the two lots (Table 5) and depended mostly on the parity (not presented) and occurrence number. The BFT averaged 20 mm at farrowing and 17 mm at weaning, whatever the treatment and the number of occurrences. While WEI was similar for both groups after the 1st and 2nd weaning, it was longer in the C one after the 3rd weaning. However, the delay was due to 3 sows coming into oestrus between 14 and 20 days after weaning.

2.6 T4 levels in plasma

The T4 levels in plasma of sows and piglets did not differ significantly between the two lots. The T4 content was significantly higher in sows before farrowing and in newborn piglets than at weaning. The occurrence number also influenced the T4 content. For piglets and sows, the highest values were observed during the 3rd and the 1st occurrences, respectively (Figure 2).

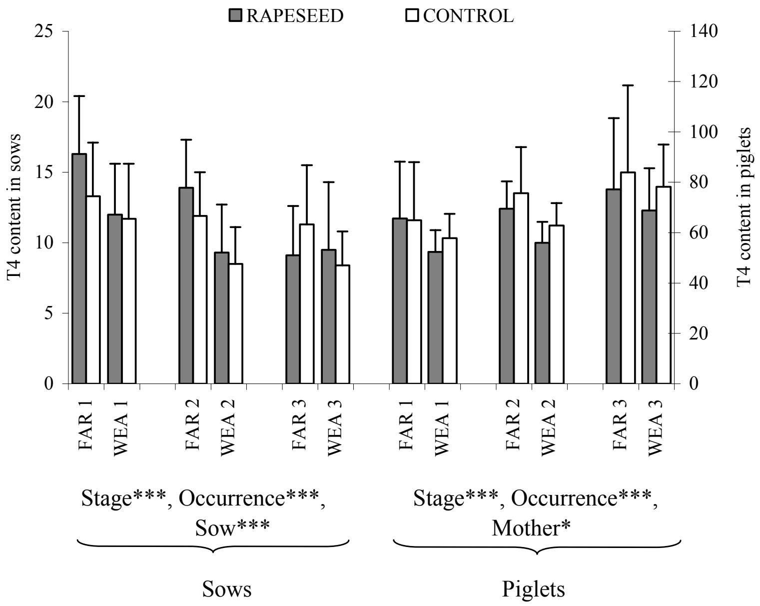

Figure 2 : Effect of the feed, the lactation stage (FAR : farrowing/ WEA: weaning) and the occurrence number on the T4 hormone content in plasma of sows and their piglets

3. DISCUSSION

To our knowledge, the effect of the incorporation of low-GSL rapeseed meal had never been studied on such an extended period on a herd level. In the literature, the longest periods studied concerned gilts studied during their growing period and heir first reproductive cycle. Thus, Opałka *et al.* (2003) showed no effect on reproductive performance when rapeseed meal was introduced at 12% during growth, 5% during pregnancy and 12% during lactation (0.8, 0.3 and 0.8 µmol GSL/g diet, respectively). Similarly, Etienne et al. (1993) reported no negative effects from the ingestion of up to 5 mmol GSL per day on the fertility of sows during their first gestation. Our long-term study provided results in agreement with these previous at the scale of a herd by the lack of significant difference on the frequency of return into oestrus, abortions and culling between the two lots.

In our trial, no difference in prolificacy was observed between sows that ingested or not rapeseed meal after 1, 2 or 3 gestations. At the end of the experiment, the sows observed on three occurrences farrowed on average 43.6 piglets in the R group and 44.8 piglets in the C one, without any significant difference. These results are consistent with those of Etienne et al. (1993) who reported similar ovulation rate and litter size in comparable GSL intake conditions. These criteria were not affected by using feed containing 2.6 to 7.4 µmol GSL/g (Etienne et al., 1990) or 1.2 to 1.8 µmol GSL/g (Opałka al., 2003). However, according to Etienne et al. (1987), prolificacy tended to be lower with feed containing 9.8 µmol/g of GSL.

According to the results of Etienne et al. (1993), the development of the foetus was not affected by the incorporation of rapeseed meal in the feed when the GSL intake did not exceed 5 mmol/d. The toxicity of rapeseed meal GSL is related to the goitrogenic effects of their degradation products: the vinyloxazolidine-2-thione (VOT) and thiocyanate ions. Synthesis of thyronine, precursor hormones T3 and T4, is impaired by the VOT (thiouracil type compound), and the thiocyanate ions compete with the iodine needed (Rabot, 1991). At the end of the gestation, Etienne et al. (1990) observed that the incorporation of rapeseed meal containing 37 µmol of GSL/g into the gestation feed was associated with a decrease in plasmatic T4 level and an increased weight of the foetus' thyroids. The higher the rapeseed meal incorporation rate was, the more important the effect on these criteria was. A significant decrease in T4 was also found with 20% of a meal containing only 9 µmol GSL/g, but the difference with the control group was extremely low and not biologically significant (Etienne et al., 1993). In the present study, not significantly different T4 plasmatic levels between groups of sows and piglets suggested that the thyroid function was not affected. This result confirms the absence of negative effect on sow performance and on their piglets of a 10% incorporation rate of regular rapeseed meal in the gestation and lactation diets. Thus, the survival of piglets from birth to weaning was not compromised, at either one or several occurrences during the experiment. Cumulative losses over three occurrences were 9.8 and 10.7 piglets in the R and C treatments, respectively (P> 0.10).

With iso-energetic diets provided *ad libitum*, no significant difference in ADFI was observed between the two treatments during lactation. No significant disadvantage was observed for the R group during the 1st occurrence (-0.4 to -0.6 kg), but that was not observed during the following lactations. With 10% of rapeseed meal containing on average 6 to 9 µmol GSL/g, the difference observed by Quiniou (2003) was only 0.13 kg. Within the range of GSL ingested, their possible impact on the appetite was small and transient as sows were already accustomed to receive this feedstuff in the gestation diet. However, with a lactation diet containing 2.1 µmol GSL/g, Schöne et al. (1999) observed that the ADFI tends to be 9% lower, whereas the appetite was reduced by 18% with a level of 4.2 µmol GSL/g (P<0.05).

In primiparous sows, whose potential for milk production was low, the incorporation of 12% of rapeseed meal (0.8 µmol GSL/g) in the lactation diet did not change significantly the piglets' body weight at weaning (Opałka et al., 2001). At higher levels of GSL intake, neither Etienne et al. (1987, 9.8 to 29.4 µmol GSL/g feed) nor Schöne et al. (1999, GSL 2.1 µmol/g feed) reported any effect on the growth rate of piglets during lactation. Our results, obtained with sows, which potential for milk production was very high, are in agreement with literature that indicates no effect on body weight at weaning when the diet contains low-GSL rapeseed meal.

The amount of GSL ingested during lactation averaged 8 mmol/d, with a maximum at 10 mmol/d. However, at the end of the 2nd and 3rd gestations, the litter size of sows from the R lot was not significantly different from that of the C one. This result indicates that, during lactation, ingestion of GSL beyond the 5 mmol/d recommended level during gestation, does not induce deterioration of the prolificacy at the next farrowing. As no information is available beyond 10 mmol GSL/d during lactation, this result only applies as ingestion level remains below this level.

Our results combined with those of the literature lead to calculate the rate of incorporation of rapeseed meal on the basis of a quantity of GSL ingested per day or a resultant GSL content in the feed depending on the feeding level during gestation. The maximum level of 5 mmol GSL/d was defined by Etienne et al. (1993) from rapeseed meal containing 9 µmol of GSL/g DM incorporated in the formula up to 20% and distributed to gilts (2.5 kg/d). This was equivalent to a dietary GSL content of 2 µmol/g. In our study, the average ration of 3.0 kg of feed with 10% rapeseed meal containing a maximum of 16.3 µmol GSL/g MS led to the ingestion of 4.4 mmol GSL/d (1.5 µmol GSL/g diet). Considering the BFT sows at weaning, higher feed allowance was sometimes applied. However, under such feeding conditions, the amount of ingested GSL remains below the limit of 5 mmol/d defined by Etienne et al. (1993).

In the present study, the GSL content of the rapeseed meal averaged 14.5 µmol/g DM, with a maximum value at 16.3 µmol/g DM. This low-GSL regular meal was chosen because it corresponded to the richest in GSL available on the market in France. In other words, the probability of using a meal with a higher GSL content than 14.5 µmol/g

MS is low. Nevertheless, this level may be over reached, especially with expeller cakes, but the risk induced by this type of product is limited because their high content of fat contributed to limit their incorporation rate in gestation diet. In lactation diet, which is more concentrated in energy, expeller cakes may be introduced to a higher rate. However, they currently represent only a marginal volume of rapeseed meal available in France.

CONCLUSION

This study confirms over a long-term period the results previously reported by Etienne et al.(1993), i.e. that the distribution of diets containing rapeseed meal does not influence the level of reproductive performance of the herd as long as the glucosinolate intake does not exceed 5 mmol per day during gestation. The results indicate also that the ingestion of a large quantity of glucosinolates during lactation, up to 10 mmol per day, does not affect reproductive performance after weaning or prolificacy at the next farrowing.

The rapeseed meal used in this study was produced by a high capacity crushing plant from rapeseed varieties grown in France and is representative of the majority of rapeseed meals used by feedstuff manufacturers in this country. Since the glucosinolates content of this rapeseed meal (14.5 mol/g DM) is much above the average content observed in the industrial rapeseed meal produced in France (~ 10 mol GSL/g DM), the results of this trial suggest that any batch of rapeseed meal from the French industry will induce no effect at a 10% incorporation rate in sow diets.

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