Effect of long-term feeding with regular rapeseed meal on the performances of reproduction of sows and growth of piglets.

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Introduction

Due to the increase of bio-diesel production, the amount of rapeseed meal (RSM) available as feedstuffs for animal production has been dramatically increased in France since 2008, and its wide availability has made it competitive for feeding pigs. Nevertheless, the long-term effects of the glucosinolates (GSL) from RSM on the reproduction and growing performances of swine were still a concern despite it was showed (Etienne et al., 1993) that RSM from double-low varieties could be used for feeding primiparous sows at a rate allowing a maximum level of 5 mmol GSL intake per day.

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 averages 10 µmol/g with an important variability (from 2 to 20 µmol/g) caused on the one hand by the harvested seed content variability and on the other hand by the process characteristics (Dauguet et al., 2011). It was then necessary to update and complete the literature data by taking into account the characteristics of the currently available rapeseed meal. Moreover, demonstration experiments were required at a large scale to evaluate the benefit of RSM inclusion in pig diets.

The aim of the following four experiments, carried out both in experimental stations and farms, was to evaluate the safe use of RSM for long-term feeding of sows and growing pigs by the measurement of their reproduction and growth performances, respectively.

Material and methods

Trial 1: Reproduction trial on sows in experimental station of IFIP (Romillé-Brittany)

Four batches of 24 LW×LD sows each were used to study the effects of either 0 or 10% incorporation of low GSL regular RSM in gestation and lactation diets on prolificacy, lactating performance and reproduction over three successive reproductive cycles. The GSL content averaged 14.5 µmol/g DM on average, with a maximum level at 16.3 µmol/g. The sows were allocated to one of the two treatments and fed the experimental diets from weaning onwards. At each physiological status, the two diets presented the same net energy and digestible amino acid contents. During the gestation, the GSL intake remained below 5 mmol GSL/d (except for two sows), whereas it averaged 8 mmol/d during the lactation (max. 10 mmol/d).

The body weight (BW) and back fat thickness variations, the average daily feed intake (ADFI), the date and causes for return to service, abortion, or culling, were recorded on sows. Litter size at birth and piglet's BW was determined. Blood samples were taken from sows and 3 piglets/litter in order to determine thyroxin content (T4) at the end of the gestation or birth and at weaning.

Trial 2: Test of RSM in large commercial farrowing units in Brittany and Auvergne

Two large commercial farrowing units from a private company (Sanders) with 600 and 700 sows located in Brittany and Auvergne regions in France tested the replacement of soybean meal by 10% of RSM in the commercial diet over two years (2008-2009). The RSM was provided on the market and was manufactured in a French crushing plant (Saipol or Cargill). The RSM and the other feedstuffs were analysed for the protein, crude fibre, minerals, and moisture and GSL contents. The GSL content in the gestation and lactation feed ranged from 0.5 to 1.2 µmol/g in the farrowing unit in Brittany and from 0.4 to1.4 µmol/g in the farrowing unit in Auvergne. Pigs were fed with a liquid system according

to a restricted feeding plan.

Growth performances of growing pigs in experimental station

Trial 3: This experiment was carried out in the experimental station of IFIP (Romillé) in Brittany, in order to study the consequence of the physiological stage at which rapeseed meal was incorporated in pigs' diets. Two batches of crossbred piglets issued from LW×PP sires and LW×LD sows fed with diets containing 0% (Control) or 10% rapeseed meal (R) were used. Within each batch, pigs were allocated to one of the four experimental treatments according to a factorial design 2×2 corresponding to incorporation rate of RSM (0%: C diets or 10%: R diets) in sows diets or in pig diets from 42 days of age until slaughter (the four groups of pigs were: CsCp, CsRp, RsCp, RsRp). The average content of GSL was 16.4 µmol/g RSM. Within each physiological stage, diets were formulated to be isoenergetic on a NE basis and presented the same digestible amino acid contents and pigs were fed ad libitum.

Trial 4: This trial was carried out in the experimental farm "Trinottières" of the "Chambre d'Agriculture des Pays de la Loire" (Maupertuis et al.2011). Three batches of 200 pigs from a similar crossbreeding, were obtained from sows fed with gestation and lactation diets containing 10% of RSM. Thereafter, they were all fed with 2nd age diets containing 12% of RSM and then fed with growing-finishing diets containing either 0% (treatment R-0) or 15% RSM (treatment R-15) . The RSM was incorporated in replacement of 10% soybean meal and 5%wheat. Subsequently, the total phosphorus (TP) was higher and the net energy (NE) lower in the diet at 15% RSM. The amino acid content of both diets was balanced using grade amino acids.. The average GLS content was 4.3 µmol/g RSM.

Results and discussion

Reproduction performances

In trial 1, Compared to the previous study of Etienne et al. (1993), and beyond the development of varieties and the industrial crushing process since 1993, the specificity of this trial was based on the use of a regular industrial-type meal containing a relatively high level of GSL (about 15 µmol/g) compared to the average value currently observed in France. Moreover, the study was performed on the long-term (three cycles of reproduction) with an important initial group of mixed-parities sows, the most sensitive stage in pigs.

Results (previously reported by Quiniou et al. 2008) showed that feed intake and prolificacy at farrowing and performance of sows after weaning, were similar among treatments: sows from the rapeseed treatment farrowed 43.6 piglets over the three reproductive cycles on average, vs. 44.8 in the control treatment ($P>0.10$). Similarly, survival and growth rate of piglets until weaning were not were affected. These results were supported by the similar thyroxin plasma levels in sows or piglets among treatments which suggested that GSL intake did not alter thyroid function.

In trial 2, the comparison of the 18 months periods before and after the beginning of the trial in the two farrowing units showed an improvement of the reproduction performances (more born alive and weaned piglets). However, this improvement results probably most from the continuous genetic selection of sows on the prolificacy over time than from the RSM incorporation.

Growth performances

In trial 3, whatever the physiological status considered, no difference in spontaneous ADFI was observed between treatments. Yet, over the post-weaning period, a lower ADFI was observed in pigs farrowed by sows fed with RSM that received also RSM from the second half of the post-weaning period (RsRp group) (table 1).

***Table 1**: Effect of the inclusion of rapeseed meal at 10% in the diet of sows or/and pigs*

Treatment[1]	CsCp	CsRp	RsCp	RsRp	RSD	Stat. effect[2]
Growing performances from 25 to 100 kg[2]						
Number of pigs[3]	105	106	106	106		
Number of pens	13	13	13	13		
Average daily feed intake[4] (kg/d)	2.45	2.38	2.4	2.36	0.1	ns
Average daily gain (g/d)	955	939	959	963	90	ns
From weaning until slaughter	*811*	*800*	*811*	*812*	*66*	*ns*
Feed conversion[4] (kg/kg)	2.58[a]	2.55[a]	2.52[ab]	2.46[b]	0.11	*
Carcass characteristics[5]						
Number of observations	67	72	71	71		
Hot carcass weight (kg)	88	87	88	87a	4	ns
Dressing[6] (%)	79.7[a]	79.4[ab]	79.3[ab]	78.9[b]	1.4	*
Back fat thickness[6] (mm)	16.3	15.1	15.9	16	2.9	ns
Muscle thickness[6] (mm)	58.2	57	56.8	57.4	5.3	ns
Lean meat content[6] (%)	58.6	59.4	58.8	58.8	2.1	ns

*1. CsCp: control diet (soybean meal) for sows and pigs; CsRp: control diet for sows and RSM diet for pigs; RsCp: RSM diet for sows and control diet for pigs; RsRp: RSM diet both for sows and pigs; 2. Multifactor analysis of variance. Only the effect of the treatment is reported. ***: P<0.001, **: P<0.01, *: P<0.05, ns: P>0.05; 3. Performances of alive pigs at the end of the finishing period; 4. Analysis of variance including the treatment and the replicate within batch as main effects; 5. Some data were missing (pigs dead during transportation to the slaughtering unit); 6. The hot carcass weight was introduced in the statistical model as a covariate.*

***Table 2**: Growth performance with 0% or 15% RSM in pig diets and 10% in sows diets.*

Treatment	R-0	R-15	RSD	Stat. effect
Growth performance from 37 to 119 kg				
No. pigs [3]	290	297		
No. pens	17	17		
Average daily intake[1] (kg/d)	2.22	2.20	0.10	ns
Average daily gain[2] (g /d)	876	857	40	**
Growing period	869	835	38	**
Finishing period	876	866	42	ns
Feed conversion ratio, kg/kg [1]	2.68	2.70	0.12	ns
Carcass characteristics				
Hot carcass weight[2] (kg)	94.1	93.6	2.2	ns
Back fat thickness[3] (G2, mm)	14.4	14.5	1.3	ns
Muscle thickness[3] (M2, mm)	59.9	59.2	1.9	ns
Lean meat content[3] (%)	60.4	60.2	1.5	ns

1 Model 1: Analysis of variance including the treatment and batch effects; 2. Model 2: Multifactorial analysis of variance including the effects of treatment (presented in the table), batch, sex as main effects and BW at the beginning of the fattening period as a covariate; 3. The hot carcass weight was introduced as a covariate in the model 2, instead of the initial BW.

As all the pigs were fed with the same creep feed at this time, an experimental artifact was suspected. Over the fattening period, no significant dietary effect was observed on ADG or on feed conversion ratio. Carcass leanness was not significantly influenced by the treatment. No significant interaction was observed between the diet allocated to the sows or to the pigs, which indicated no cumulated effect of RSM when it is incorporated both in sows and pigs diets up to 10%. Such a conclusion is in

agreement with the similar levels of T3 and T4 hormones obtained at the end of the fattening period in the four treatments (data not presented).

In trial 4, a lower average daily gain (ADG) was obtained in R-15 pigs, which could be explained by the lower NE content of the R-15 diet. However, the feed conversion ratio was not significantly different amongst treatments and no effect of RSM was observed on carcass characteristics (Table 2).

Conclusion

Data from trials 1 and 2, carried out in an experimental unit or in commercial farms, confirm 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 reproductive performance of the herd as long as the glucosinolate intake did not exceed 5 mmol per day during the gestation, respectively. The results also indicated that the ingestion of a large quantity of GSL during lactation, up to 10 mmol per day, did not affect reproductive performance after weaning or prolificacy at the next farrowing. Trials 3 and 4 showed that the RSM can be used successively both in sows and pigs diets without adverse and cumulative effect on the growing performances and the quality of the carcass, on the long term. Incorporation rates and GLS contents differed amongst both studies but daily GLS intake reminded below 5 mmol/d which may be empirically retained as the maximum intake also for growing pigs.

The rapeseed meal used in these trials was produced by high capacity crushing plants from rapeseed varieties grown in France. Since the GSL content in the rapeseed meal used in the four trial ranged from 4 to 16 µmol/g and could be considered as representative of the regular rapeseed meal produced in France (average ~ 10 µmol /g) and used by feedstuff manufacturers, it can be assumed that the use of rapeseed meal at such inclusion rates (10 % for sows and 15% for pigs) is safe on the long term, providing the maximum daily intake of GLS does not exceed 5 mmoles both during gestation and fattening periods.

Key words: Rapeseed meal, reproduction, sow, piglet, pig, long-term feeding, glucosinolate, growth, carcass quality.

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