

GRAIN LEGUMES, RAPESEED MEAL AND OIL SEEDS FOR WEANED PIGLETS AND GROWING/FINISHING PIGS.

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Abstract

The maximum inclusion rates of grain legumes, rapeseed meal and oil seeds in wheat-soybean meal basal diets have been studied at the ITP experimental unit in Villefranche de Rouergue (France) in several experiments using piglets or pigs.

Rapeseed meal and peas can be used respectively in the diets of the second period of post-weaning (after 12 kg – phase 2) at rates of 15 and 35 %, and in growing-finishing feeds at rates of 18 % and 40 %. Their association allows to reduce the soybean meal to 2 % and 0 % of growing and finishing diets containing respectively 32 and 35 % of peas, 15 and 18 % of rapeseed meal.

Maximum rates of 10 % of white (*Lupinus albus*) or blue (*Lupinus angustifolius*) sweet lupins in phase 2 diets seem advisable. The inclusion in phase 2 diets of 7 % of full-fat rapeseeds or sunflower seeds, or 15 % processed whole soybeans or 3 % rapeseed oil give similar weight gain and feed efficiency. The use of 8 % of oleic acid-rich sunflower seeds after 65kg body weight has no negative effect on carcass fat quality whereas 4 % of ordinary sunflower seeds have.

Key words : grain legumes, rapeseed meal, oil seeds, inclusion rates, piglets, pigs

Introduction

The inclusion rates of the feedstuffs are variable according to pig feed formulators, in relation to their personal experience and the practices of the group to which they belong (Cherrière and Rault, 2000; Pressenda, 2001). In consequence, for several years, operational limits - for each raw material and each physiological stage - have been advised in France by means of Tables written by the agricultural technical institutes (ITP et al., 2002). These limits relate especially to the maximum values and are primarily established on the basis of optimal performances observed in experiments.

Experimental programs on the incidence of the inclusion rates of the raw materials are carried out for many years by the various French research organizations. These experiments are conducted with amino acids balanced feeds, which was not always the case in the oldest tests. Concerning the Technical Institute for Pig (ITP), the work

carried out at the station of Villefranche de Rouergue was particularly based on the use of oilseeds, peas, lupins and rapeseed meal in post-weaning and growing-finishing pig feeds. This paper focuses on the contribution of these tests to the development of the Tables.

The use of full-fat oil-seeds, pulses (i.e. peas, faba beans, lupins) and rapeseed meal in pig diets encourages the reduction of the European protein deficit and frequently allows a reduction of the feed cost. But the recommended inclusion rates remained limited a long time because of factors restricting their use, especially their crude fibre content, their amino acids profile, their former high content in anti-nutritional factors. The development of the use of lupin (but also of faba bean not presented in this paper) justifies experimentation -in progress or to come - intended to improve knowledge on these two proteins sources.

MATERIALS AND METHODS

Between 1990 and 2002, 11 post weaning experiments and 7 growing-finishing experiments using a total of 3947 piglets and 1022 pigs were completed within the framework of 9 studies evaluating the use of grain legumes. Pigs were of both sex and crossbred ((LW x LD) x P76).

In the post-weaning tests, four dietary treatments were compared in the phase 2 period, corresponding to four inclusion rates or four samples of the same raw material, or to four formulas using various raw materials. Weaners were housed in an environmentally controlled nursery with an average number of 360 piglets (between 336 and 384), placed in 24 pens of 15 piglets each (14 - 16), with 6 pens per treatment. Piglets were randomly allotted after weaning at 28 days of age. For post-weaning experiments, performances related to the total growth stage between 7.5 and 26 kg were measured, but the experimental diets were distributed only after the average intake of 6 kg of phase 1 diet per piglet, adjusted according to weights at weaning. The total duration of post weaning phase was 5 or 6 weeks. The performances of the control groups ranged between 447 and 529 g/d of daily gain, and between 1,4 and 1,7 points of feed conversion ratio.

In the growing-finishing period, two or four treatments were compared. Experiments involved between 128 to 160 pigs, located into 20-24 pens of 5-6 pigs, except for 2 older tests where the animals were housed into 8 to 10 pens of 15-16 pigs. Initial weight averaged between 24 and 28 kg at the start of the experiments and pigs were slaughtered between 104 and 110 kg live weight. Performances of control animals ranged between 726 and 886 g/d of daily gain, and between 2,51 and 2,91 points of feed conversion ratio.

Responses measured were average feed and water daily intake, average daily gain, feed: gain ratio and slaughter data. All variable were subjected to variance analysis using STAT-ITCF or SAS.

The experimental feeds are produced on the ITP Villefranche's manufacturing unit since 1997 but were manufactured in a commercial feed mill before. In each experiment, the inclusion of the feedstuff to be tested was done by replacement of other ingredients: wheat, barley and soybean meal. Within each experiment, the diets were formulated to be isoenergetic (on net energy basis), isonitrogenous and to contain similar levels

of digestible amino acids. The formulas respected a rate of digestible lysine identical by unit of net energy according with the usual recommendations in France for the phase 2, growing and fattening periods. The minimum ratio(s) methionine, methionine + cystine, threonine and tryptophan on lysine were respected.

The feed was given, according to the tests, as pellets or meal for the post-weaning period. In fattening experiments, a dry form (meal or pellets) or liquid or dry/wet (delivering dry meal, then adding water [1:1]) was used. Pigs were provided at libitum during post-weaning period, and according to scale during growing-finishing period.

RESULTS AND DISCUSSION

The results of the studies are presented in table 1. Index performances of treatment groups have been calculated on the basis of the control group (basis 100). The maximum inclusion rates evaluated by the experiments are shown in table 2.

The **sunflower seeds** do not contain any anti-nutritional factor. However, its crude fibre content, 2 to 3 times higher than other oil-seeds, can explain the low number of studies concerning its use in post-weaning period. The 3 successive experiments carried out at Villefranche with 2 different samples of seeds showed that the inclusion of 7 % of sunflower seeds allows equivalent performances to those obtained with the 3 % rapeseed oil treatment (Albar et al., 1998 – Exp. 11-12-13). However, one of the seed batches had lower protein and fat content than the values given in feed tables, which could explain a significant degradation of the feed conversion ratio (+3%) in Exp. 12. During growing-finishing, we noted that an inclusion rate of 4 % sunflower seeds in a corn based diet did not modify performances (Courboulay and Massabie, 1994 – Exp. 17), in agreement with the results of Hartman et al. (1985) and Østerballe et al. (1990) for rates of respectively 10 % in a corn-soybean meal based diet and 12 % in a barley-soybean meal diet. Such a rate induced a strong increase in the linoleic acid (C18:2) content of the backfat (21 % of the total fatty acids against 14 % with the control treatment), exceeding the generally recommended level of 15 % above which technological defects of dry cured pork products can appear. Developed primarily for their industrial marketing, the oleic acid-rich sunflower varieties have a lower level of linoleic acid than conventional sunflower

(about 30-50 vs. 275 g/kg) and a higher one of oleic acid (280 vs. 90 g/kg). A Villefranche experiment has showed that this type of sunflower can be used without risk of negative effect on carcass fat quality at a rate of 8 % (Albar et al., 2000 – Exp. 18).

Authors indicate a satisfactory performance for piglets fed **full-fat soybeans** after a reduction of trypsin inhibitors by heat processing (Aumaitre and Bourdon, 1982; Burnham et al., 2000; Bertol et al., 2001). In our 3 tests, piglets were fed diets containing 15 % whole soybeans of good extrusion quality (trypsin-inhibiting activity of 3,4 TIU/mg DM) or insufficient extrusion quality (13,5 and 14,5 TIU/mg) in replacement of soybean meal and rapeseed oil (Albar et al., 1998 – Exp. 11-12-13). They had similar weight gain and feed efficiency to those obtained with the control treatment. In 3 further experiments (Royer et al., 2003 – Exp. 14-15-16), the effects of diets containing soybeans that had been processed with roasting, roasting followed by steam-flaking, or extrusion were tested at an incorporation rate of 15% for 12 lots provided by 7 commercial suppliers. Three lots of extruded seeds, including 2 coming from the same supplier and used in different experiments, presented trypsin-inhibiting activities higher than 6 TIU/mg (15.2, 10.2 and 8.9 TIU/mg). But this higher concentration resulted in significantly lower performances for the 2nd lot used in Exp. 15.

The trypsin inhibiting activity is one of the most reliable methods to evaluate the quality of beans. Taking into account the variability between beans and processing conditions, the process itself is not an important element of evaluation. However, Aumaitre (1985, quoted by Bourdon, 1990) observed better performances of 21 day old piglets receiving 25 % of soybeans with 5,0 TIU /mg submitted to a double extrusion, that with beans with 8,2 TIU /mg after a simple extrusion. The incidence of the treatment quality seems thus stronger when piglets are younger and when the beans are substituted in higher rates. However, taking into account their high price, soybeans are included only in the piglet's diets, and sometimes sow's diets, at incorporation rates lower than 15%. Lastly, low variations of feed: gain ratios in our study are coherent with the energy values indicated by the tables for various soybeans (NRC, 1998; INRA-AFZ, 2002) although a better energy value is sometimes given for extruded beans (Marty and Chavez, 1993; Barbosa et al., 1999; Kim et al., 2000a, 2000b).

Varieties with low contents of glucosinolates allow the inclusion of **full-fat rapeseeds** in pig diets but it is limited by a palatability factor and grinding problems. Few studies exist on their use, and authors often propose not to introduce them at levels higher than 10 % in piglet diets (Bureau and Evrard, 1993). A perfect control of the grinding conditions is the main requirement according to Bourdon (1990), who reports similarity of performances and digestibility values between diets containing high levels of extruded soybeans or rapeseeds, or fat-soybean meal based, in agreement with Reis de Souza et al. (1990). For the first two tests (Albar et al., 1998; – Exp. 11-12) in Villefranche at an inclusion rate of 7% of rapeseed in the weaning phase 2 diets, the in vitro crude fat availability of the diets indicated a poor grinding, corresponding to respectively 60 % then 15 % of seeds not correctly crushed. In Exp. 11, the growth performance obtained with the rapeseed treatment was significantly lower than the others showing an increase in the daily intake of 8 % and a degradation of the feed conversion ratio of 10%. In Exp. 12, with a feed conversion ratio degradation of 5%, the difference was reduced by half. The grinding of a mix of barley and rapeseeds for the Exp. 13, combined with a better quality of these seeds, allowed performances similar with those of the other treatments. The energy value of rapeseeds, 9 % lower than the values used for the formulation, can also partly explain the poor performances obtained in the first 2 tests, whereas the fat contents were in conformity with those of the tables for Exp. 13. Digestibility experiments undertaken later by Skiba et al. (1999, 2002) showed better performances and a higher energy value of rapeseed in a meal form when rolled vs. simply ground, but also that pelleting the feed compensated the differences for the simple grinding process and maximized the nutritional value of rapeseeds.

The inclusion of white (*Lupinus albus*) or blue (*Lupinus angustifolius*) sweet **lupin** at moderate rates of 10 % in piglet diets did not have negative effect in Villefranche on the daily feed intake (Cherrière et al., 2003 – Exp. 4-5-6). At higher rates, the incidence was variable according to varieties: no incidence for 15 % of blue Boltensia lupin, light incidence for the same rate of white Ares lupin (non significant), very marked incidence for the blue Bora lupin at the rate of 20 % (drop of 11 % of feed intake) and at the rate of 30 % (drop by 17 %). The alkaloid concentrations could explain the lower feed intake observed

Table 1. Influence of the feedstuff inclusion rates on piglets or pigs performances

Exp.	Feedstuff	rate %	weight (kg)	pigs /treatment	treatment to control index (1)				Formula & ingredients	Feeding system	Comments	Reference
					ADFI	ADG	FCR	lean meat				
1	Pea	25	24-105	32	100	99	101	103	wheat, soy meal	dry meal, to scale		Albar et al, 1992
2	Pea	25	24-105	32	101	100	101	97		liquid, to scale		
		25	25-105	32	101	100	103	98		pellets, to scale		
		25	25-105	32	103	101	101	101		liquid, to scale		
3	Pea	(35)	8-26	90	99	106***	94***		wheat, pea, soy meal	dry meal, <i>ad lib.</i>	Pea particle size 610 µm (2)	Albar et al, 2000
4	White ares lupin	5	8-25	84	102	99	102		wheat, corn, barley, soy meal	dry meal, <i>ad lib.</i>		Cherrière et al, 2003
5	Blue boltensia lupin	10	8-25	84	99	96	104					
		15	8-25	84	96	89***	108**					
		5	8-24	84	100	102	97					
		10	8-24	84	100	100	98					
6	Blue bora lupin	15	8-24	84	98	102	96					
		10	8-27	90	99	95***	96					
		20	8-27	90	89**	89***	92*					
		30	8-27	90	83**	79***	95					
7	Rapeseed meal	5	8-25	96	101	102	98		wheat, soy meal, pea (15%), cane molasses, oil	pellets, <i>ad lib.</i>		Albar et al, 2001
8	Rapeseed meal	10	8-25	96	99	101	97					
		15	8-25	96	98	99	97					
		6	27-105	40	99	100	99	100				
		12	27-105	40	99	101	98	102				
		18	33-103	40	99	99	100	102				
9	Pea /Rapeseed meal	32/15	29-107	72	101	100	101		wheat, (barley & soymeal for control only)	liquid, to scale	Pea/rapeseed meal 35/ 18 % in finishing diets :	Albar et al, unpublished
10	Pea /Rapeseed meal	32/15		72	100	97	103					
11	Sunflower seed	7	8-26.5	90	100	101	99		wheat, barley, soy meal, pea, (rapeseed oil)	dry meal, <i>ad lib.</i>	poor in fat poor in fat -, 60% not ground 13.5 TIU/mg poor in fat poor in fat, 15% not ground 14.5 TIU/mg good grinding 3.4 TIU/mg	Albar et al, 1998
12	Rapeseed	7	8-26.5	90	108**	97*	89**					
	Extruded soybean	15	8-26.5	90	99	101	98					
	Sunflower seed	7	8-26.5	90	99	97	103*					
	Rapeseed	7	8-26.5	90	99	94***	105***					
13	Extruded soybean	15	8-26.5	90	99	99	100					
	Sunflower seed	7	8-26.5	90	101	100	102					
	Rapeseed	7	8-26.5	90	103	100	101					
	Extruded soybean	15	8-26.5	90	100	99	101					
14	Roasted & flaked soybean	(15)	7.4-25	90	105	103	102		wheat, soy meal, control = 15 % roasted soybean from A plant; 3 batches of respectively 3.0, 5.6, 3.0 TIU/mg	dry meal, <i>ad lib.</i>	B plant, 1 st batch, 3.5 TIU/mg D plant, 1 st batch, 3.5 TIU/mg E plant, 1 st batch, 15.2 TIU/mg B plant, 2 nd batch, 3.2 TIU/mg D plant, 2 nd batch, 2.6 TIU/mg E plant, 2 nd batch, 10.2 TIU/mg C plant, 4.2 TIU/mg F plant, 9.0 TIU/mg G plant, 5.6 TIU/mg	Royer et al, 2003
15	Extruded soybean	(15)	7.4-25	90	100	101	99					
	Extruded soybean	(15)	7.4-25	90	103	100	103					
	Roasted & flaked soybean	(15)	7.4-25	90	101	101	100					
	Extruded soybean	(15)	7.4-25	90	100	101	99					
16	Extruded soybean	(15)	7.4-25	90	96	94**	102					
	roasted & flaked soybean	(15)	7.7-27	90	99	102	96					
	Extruded soybean	(15)	7.7-27	90	98	102	96					
	Extruded soybean	(15)	7.7-27	90	99	102	96					
17	Sunflower seed	4	23-104	32	100	103	97	99	wheat, (barley), pea, soy meal, rapeseed meal, molasses	pellets, to scale	C18:2 = 21,1 % (3)	Courboulay & Massabie, 1994
	Sunflower seed	4	24-107	47	100	100	100	101				
18	Sunflower seed	4	25-110	40	100	102	98	100	wheat, (barley), pea (20%), soy meal	dry/wet meal, to scale	C18:2 = 15,5 % (3) C18:2 = 8,4% C18:2 = 8,5 %	Albar et al, 2000
	Oleic sunflower seed	4	25-110	40	100	101	99	101				
	Oleic sunflower seed	8	25-110	40	100	102	98	101				

(1) performances of control group = 100 ; ADFI : average daily feed intake; ADG : average daily gain; FCR : feed conversion ratio; * (p<0.05), ** (p<0.01), *** (p<0.001) means significantly differs from control

(2) average pea particle size of control = 1020 µm

(3) linoleic acid in backfat (% of identified fatty acids)

with the Bora blue variety, whose alkaloid contents were high compared to the two other lupins and to the Tables. It is thus advisable to moderate the sometimes announced advantage of the blue lupin. The lower intake noted for the high rates of lupin was reflected directly on the growths, without worsening of the feed conversion ratio. This was probably due to a palatability problem related to the lupin, in agreement with the reports of Castaing et al. (1982) and Quemere et al. (1984) for sweet white Kalina lupins.

The significant deterioration of the feed: gain ratio observed at the rate of 15 % of white Ares lupin indicates that for this feedstuff, the growth decrease is not only related to the intake fall. It could be explained, in agreement with the bibliography (Cerning-Beroard and Filiatre-Verel, 1980), by the higher content of total alpha-galactosides in white lupins, and by a higher stachyose content compared to other

alpha-galactosides. However, other studies connected the problem of flatulence to the stachyose and verbascose contents, raffinose having little effect. In conclusion, prudence is essential concerning the risks of intake decrease. Maximum rates of 10 % of blue lupin are for the moment recommended in post-weaning, and by extrapolation in growing-finishing, due to the variability of the alkaloids content. However our results with Boltensia agreed to those obtained with Gungurru (Noblet et al., 1998) and Sonet (Richter et al., 2002) and showed that rates of 15 % could be considered for these varieties of blue lupin. The rate of 10 % appears to be accepted in post-weaning for the white lupin. However, it cannot be recommended for the moment in growing-finishing without complementary experimentation, taking into account important risks of flatulence.

Table 2 . Inclusion rates for pulses oilseeds and oilseeds meal/cakes for piglets, pigs and sows⁽¹⁾.

	Phase 1 weaners	Phase 2 piglets	Growers-finishers	Gilts	Pregnant sows	Lactating sows
Peas	0	30	<i>nl</i>	<i>nl</i>	<i>nl</i>	<i>nl</i>
Faba beans	0	15	15	10	10	10
White lupin	0	10	5			
Blue lupin	0	10	10			
Full-fat rapeseed	0	7	5	5	5	5
Full-fat sunflower seed	0	7	4	5	8	8
Processed f.soybeans	10	15	10	10	10	10
Rapeseed meal	0	10	15	10	10	10
Sunflower meal	0	0	5	5	10	5
Soybean meal	20	<i>nl</i>	<i>nl</i>	<i>nl</i>	<i>nl</i>	<i>nl</i>

(1) We indicate here, on a purely informative basis, the limits for gilts and sows.

nl : non limited

Adapted from *Tables d'alimentation pour les porcs 2002*, ITP et al. (ed), Paris

The lysine content of **peas** (*Pisum sativum*) is relatively high, but sulphur amino acids, threonine and tryptophan contents are low. When associated with corn, peas require a supplementation with amino acids (Castaing et al., 1993). Peas are a perfect addition for rapeseed meal because they complementarily balance in amino acids (Albar et al., 2001). In growing-finishing, the incorporation of peas is not limited. Diets containing 25 to 45 % can be used whatever the feeding system (Gatel et al., 1989, Quemere, 1990; Albar et al., 1992). It was shown that phase 2 diets well balanced in

all limiting amino acids containing up to 40 % of peas allows performances identical to those obtained without peas (Grosjean et al., 1991; Van Cauwenberghe et al., 1997; Grosjean et al., 1997).

A study carried out in Villefranche on the effect of the dietary particle size on the performances showed that a fine size (610 µm) compared to a medium (750) or coarse (1020 µm) size of peas significantly improves growth and feed conversion ratio of weaned piglets fed in phase 2 period with 35% of peas (Albar et al., 2000 – Exp. 3). The micro-grinding of the

pea (25 µm) enhanced the real digestibility by about 10 points compared to grinding with a 2,4 mm screen (Hess et al., 1998) but this improvement certainly knows a limit (Creveieu, 1999). It seems that the problem of low palatability sometimes observed doesn't result from the pea itself. The effect on the feed intake of a new diet with a high percentage of peas was variable but stayed equivalent to the control for the total 4 days of transition (Gatel and Grosjean, 1986; ITCF, 1992). In fact, the presence of pea has an effect on feeding behaviour of fattening pigs (increase of the eating act duration, reduction of the number of visits per day), without consequence on total intake or growth, but it is advisable to take this phenomenon into account for strong competition situations between animals (Mathe et al., 2003). Finally, an imbalance in tryptophan can indeed explain observed problems of low palatability.

In two post-weaning and growing-finishing experiments (Albar et al., 2001 – Exp. 7-8), we increased the levels of **rapeseed meal** resulting from seeds of the "00" type, with low concentrations in glucosinolates (12,4 and 10,4 µmol /g) and erucic acid. Inclusion levels of 15 % for piglets and 18 % for growers-finishers have had no significant incidence on daily intake, growth, feed:gain ratio, neither reduction in appetite, regularly cited in the literature. In both experiments, the diets, containing corn, pea and soybean meal, were formulated to contain the same amount of net energy and digestible amino acids, since amino acids digestibility for rapeseed is lower compared to soybean. Following these results, the maximum rate of 5 %, suggested in the former French tables was re-examined with a rise at a level of 10 %. The acceptable maximum rate of 15 % in growing-finishing, identical to the Danish recommendations (Landsuvalget for svin, 1996), was confirmed. These results were confirmed by two other experiments comparing growers and finishers formulas containing corn, pea and rapeseed meal to corn, barley, soybean meal diets (unpublished data; Exp. 9-10). These experiments showed the possibilities of suppressing all the soybean meal in growing-finishing, replacing it by a pea – rapeseed meal association. In spite of the good quality of the rapeseed meals available in the European Union, the image of this feedstuff remains negative in feed industry (Pressenda, 2001). It is thus important to maintain the efforts of reduction of the glucosinolates content, independently of the requirements related to the payments of the EU's Common

Agricultural Policy. A work group of the 11th Rapeseed Congress held in July 2003 in Copenhagen thus recommends to reduce in the future the maximum content of glucosinolates in commercial grains from <18 µmoles /g (present standard in Europe) to <15 µmoles /g or even <8 µmoles /g, but also to declare the quality characteristics of the rapeseed cakes when being sold (Röbbelen and Frauen, 2003).

Conclusion

The experiments carried out at ITP-Villefranche research station allowed us to propose to the French formulators new inclusion limits for the main alternatives proteins sources.

For a same lipid content in feed, similar performances can be obtained with various oilseeds, taking into account their respective oil contents. The sunflower seeds and rapeseeds have the positive feature of a direct use without preliminary industrial heat treatment. Their use in phase 2 diets was experimented at the rate of 7 % but can be considered at the rate of 10 % for correctly ground rapeseeds. In growing-finishing, their inclusion is permitted by the restriction in linoleic acid in the diet (1.7 % /DM maximum) and will depend on other included raw materials. The rate will generally be lower than 5 %, but can reach 10 % in the case of sunflower seeds of the oleic type. The full-fat soybeans require a good cooking quality, but their frequent high price limits their use only in piglets and sometimes sows diets at levels lower than 15 %.

The incorporation rate of pulses depends on their contents in anti-nutritional factors. Reduction of the trypsin inhibitors concentration in new varieties of peas allows to obtain satisfactory results with a 30 % inclusion rate in phase 2 diets and to have no other limits in growing-finishing diets than the balance in amino acids and the economic benefit. The situation is different for lupins. Maximum rates of 10 % of blue lupin can be considered in post weaning and growing-finishing diets, and can be increased for certain varieties. For white lupin, rates of 10 % appear possible in post-weaning but seem to have to be excluded in growing-finishing. The utilization of increasing rates of faba beans is the subject of on-going studies in France.

The association of several pulses (peas, faba beans, lupins) in the same formula generally results in imposing a limiting rate for the total of the raw materials of this family. The evaluation of these rates requires complementary studies. The reduction of the

glucosinolates concentration in rapeseeds has allowed to introduce higher rates of rapeseeds meal into pig feed, and to stop the mistrust expressed about this raw material. The amino acid balance of peas and rapeseeds meal appears complementary and the association of these two raw materials allows to reduce the inclusion of soybean meal. Maximum inclusion limits being known, the final choice and the inclusion level of the raw materials depends on the formulation goals (least expensive net energy, well balanced in digestible amino acids), but takes also into account the supplying and storage difficulties, as well as the conservation and the quality of these feedstuffs.

Utilisation des oléagineux, du tourteau de colza et des protéagineux chez les porcelets et porcs charcutiers.

Le taux maximum d'incorporation des oléagineux, du tourteau de colza et des protéagineux en

remplacement du tourteau de soja dans des régimes à base de blé a été étudié à la station ITP de Villefranche de Rouergue lors de plusieurs essais sur porcelets et porcs charcutiers.

Le tourteau de colza et le pois protéagineux peuvent être utilisés respectivement à 15 et 35 % en 2ème âge, à 18 % et 40 % en engraissement. Leur association permet de limiter le tourteau de soja à 2 et 0 % dans des aliments croissance et finition contenant respectivement 32 et 35 % de pois, 15 et 18 % de tourteau de colza. Des taux maximum de 10 % de lupin blanc (*Lupinus albus*) ou bleu (*Lupinus angustifolius*) en 2ème âge apparaissent prudents. Les apports dans l'aliment 2ème âge de 7 % de graines entières de colza ou de tournesol, ou de 15 % de graines de soja extrudées ou de 3 % d'huile donnent des résultats comparables. L'emploi en engraissement de 8 % de graines de tournesol oléique ne dégrade pas la qualité des gras alors que cela est le cas dès 4 % avec le tournesol classique.

References :

- ALBAR J., CHAUVEL J., GRANIER R., 1992. [About the use of spring field peas in dry or wet feeding for fattening pigs]. Journées Rech. Porcine en France, 24, 179-186.
- ALBAR J., DOUMAYZEL S., GRANIER R., SERIN J.F., 1998. [Oilseeds for weaned piglets : rapeseed, sunflower seeds and extruded full fat soybeans]. Journées Rech. Porcine en France, 1998, 30, 281-288.
- ALBAR J., SKIBA F., ROYER E., GRANIER R., 2000. [Effects of the particle size of barley, wheat, corn or pea based diets on the growth performance of weaned piglets and on nutrient digestibility]. Journées Rech. Porcine en France, 32, 193-200.
- ALBAR J., ROYER E., MASSABIE P., MOUROT J., VENDEUVRE J.L., 2000. [The use of oleic acid-rich sunflower seed in diets for growing pigs : effects on backfat quality]. Journées Rech. Porcine en France, 32, 297-303.
- ALBAR J., CHAUVEL J., GRANIER R., 2001. [Effects of the level of rapeseed meal on performances in the post-weaning and the growing/finishing periods]. Journées Rech. Porcine en France, 33, 197-203.
- AUMAITRE A., BOURDON D., 1982. Sur l'intérêt nutritionnel des graines de soja entières extrudées dans l'alimentation des porcelets. Journées Rech. Porcine en France, 14, 319-324.
- BARBOSA H.P., TRINIDADE NETO M.A. da, SORDI I.M.P. de, SOTO W.L.C., 1999. [Digestibility coefficients and energy values of several feeds for swine]. Boletim de Industria Animal, 56, 47-52.
- BERTOL T.M., MORES N., LUDKE J.V., FRANKE M.R., 2001. [Soybean proteins processed by different forms in diets for weaned piglets]. Rev. Brasileira Zootecnia, 30, 150-157.
- BOURDON D., 1990. Intérêt des traitements technologiques appliqués aux graines entières d'oléo-protéagineux pour les porcs. In « Symposium qualité des céréales, oléagineux et des protéagineux français », 6 juillet 1990, Toulouse, 75-84, ITCF éd, Paris, 95 p.
- BUREAU J., EVRARD J., 1993. Utilisation des graines entières de colza en alimentation animale, Oléoscope n°13, CETIOM (ed), Paris.
- BURNHAM L.L., KIM I.H., KANG J.O., RHEE H.W., HANCOCK J.D., 2000. Effects of sodium sulfite and extrusion on the nutritional value of soybean products for nursery pigs. Asian-Australasian J. Anim. Sci, 13, 1584-1592.
- CASTAING J., COUDURE R., FEKETE J., GROSJEAN F., LEUILLET M., 1982. Utilisation de la graine de lupin doux Kalina chez le porcelet sevré et le porc en croissance. Journées Rech. Porcine en France, 14, 307-318.
- CASTAING J., CAZAUX J.G., COUDURE R., 1993. [Spring field peas in diets based on moist grain maize for growing finishing pigs]. Journées Rech. Porcine en France, 25, 137-142.
- CERNING-BEROARD J., FILIATRE-VEREL A., 1980. Lebensm. Unters-Forsch, 171, 281-285.
- CHERRIERE K., RAULT S., 2000. Peas for pig feed: contrasting practices in Europe. Grains legumes, 29.
- CHERRIERE K., ALBAR J., NOBLET J., SKIBA F., GRANIER R., PEYRONNET C., 2003. Utilisation of white (*Lupinus albus*) or blue (*Lupinus angustifolius*) sweet lupins in weaned piglet diets. Journées Rech. Porcine en France, 35, 97-104.
- COURBOULAY V., MASSABIE P., 1994. [Use of sunflower seeds in diets for growing pigs : effect on performance quality and backfat quality]. Journées Rech. Porcine en France, 26, 207-212.
- CREVIEU-GABRIEL I., 1999. [Protein digestion of leguminous in monogastrics. Pea proteins as an example]. Prod. Anim., 12 (2), 147-161.
- GATEL F., GROSJEAN F., 1986. Influence d'un changement de matières premières dans le régime sur les performances du porc charcutier. Journées Rech. Porcine en France, 18, 121-126.
- GATEL F., GROSJEAN F., CASTAING J., 1989. Utilisation par le porc charcutier de régimes à teneur élevée en pois de printemps (plus de 40 p. cent). Journées Rech. Porcine en France, 21, 69-74.
- GROSJEAN F., BOURDON D., KIENER T., CASTAING J., GATEL F., 1991. [Feeding value of French and imported peas for pigs]. Journées Rech. Porcine en France, 23, 53-60.

- GROSJEAN F., JONDREVILLE C., BOGAERT C., BOURDILLON A., PEYRONNET C., LE GUEN M.P., WILLIATE I., 1997. [Utilization of feeds for weaned piglets containing 40% peas]. Journées Rech. Porcine en France, 29, 197-204.
- HARTMAN A.D., COSTELLO W.J., LIBAL G.W., WAHLSTROM R.C., 1985. Effect of sunflower seeds on performance, carcass quality, fatty acids, and acceptability of pork. J. Anim. Sci., 60 (1), 212-219.
- HESS V., THIBAUT J.N., DUC G., MELCION J.P., VAN EYS J., SEVE B., 1998. [Influence of variety and micro-grinding on pea nitrogen and amino acids ileal digestibility. Real nitrogen digestibility and specific endogenous losses]. Journées Rech. Porcine en France, 30, 223-229.
- INRA, AFZ, 2002. Tables de composition et de valeurs nutritives des matières premières destinées aux animaux d'élevage : porcs, volailles, bovins, caprins, lapins, chevaux, poissons. Sauvant D., Perez J.M. et Tran G. eds, INRA Editions, Versailles, 304 p.
- ITCF, 1992. Effet de l'incorporation de quantités élevées de pois dans le régime sur l'appétence chez le porc charcutier. In : Rapport annuel valorisation animale, ITCF (éd.), Paris, 34-35.
- ITP – ITCF – ADAESO – UNIP – CETIOM, 2002, Tables d'alimentation pour les porcs. ITP éd., Paris, 40 p.
- KIM I.H., HANCOCK J.D., HINES R.D., 2000. Influence of processing method on ileal digestibility of nutrients from soybeans in growing and finishing pigs. Asian-Australasian J. Anim. Sci, 13, 192-199.
- KIM I.H., HANCOCK J.D., HINES R.D., GUGLE T.L., 2000. Roasting and extruding affect nutrient utilization from soybeans in 5 and 10 kg nursery pigs. Asian-Australasian J. Anim. Sci, 13, 200-206.
- LANDSUDVALGET FOR SVIN, 1996. Fodersoffer til svin, Danske slageterier (ed), Copenhagen.
- MARTY B.J., CHAVEZ E.R., 1993. Effects of heat processing on digestible energy and other nutrient digestibilities of full-fat soybeans fed to weaner, grower and finishing pigs. Can. J. Anim. Sci., 73, 411-419.
- MATHE D., MONEGER R., GUILLOU D., 2003. [Effects of peas on growth and eating behaviour of fattening pigs during dietary transitions]. Journées Rech. Porcine en France, 35, 127-132.
- NOBLET J., MANCUSO M., BOURDON D., VAN BARNEVELD R., 1998. [Energy value of lupin (*Lupinus angustifolius*) in growing pig and adult sow]. Journées Rech. Porcine en France, 30, 239-243.
- NRC, 1998, Nutrient Requirements of swine, 10th revised ed, Nat. Acad. Press éd, Washington, DC.
- ØSTERBALLE R., MADSEN A., MORTENSEN H.P., BEJERHOLM C., BARTON P., 1990. [The influence of feeds on meat quality of growing pigs . 2. Linoleic acid/ linolenic acid and sunflower seed.] Beretning fra Statens Husdyrbrugsforsøg, n° 685, 58 pp.
- PRESENDA F., 2001. Utilisation des matières premières domestiques en alimentation animale. Panorama des pratiques de formulation. In "Valoriscop", AFTAA (ed), Paris, 53-66.
- QUEMERE P., FEKETE J., LEUILLET M., WILLEQUET F., 1984. Utilisation de la graine de lupin doux "Kalina" par le porcelet sevré. Journées Rech. Porcine en France, 16, 409-414.
- QUEMERE P., 1990. [A review of French and foreign experimental results concerning the utilization of peas in pig diets]. Journées Rech. Porcine en France, 22, 133-150.
- REIS DE SOUZA, MELCION J.P., BOURDON D., GIBOULOT G., PEINIAU J., AUMAITRE A., 1990. [Raw vs extruded whole rapeseed : a raw source of energy and protein in the diet for weaned piglets]. Journées Rech. Porcine en France, 22, 151-158.
- RÖBBELEN G., FRAUEN M., 2003. Low glucosinolate rapeseed meal - a high quality protein feed, from European production., non published.
- ROYER E., ALBAR J., GRANIER R., 2003. [Effects of processing whole soybeans in phase 2 diets of weaned piglets]. Journées Rech. Porcine en France, 35, 89-96.
- RICHTER C., WESTENDARP H., BERK A., 2002. Austausch von Sojaextraktionsschroten gegen Lupinen bei Absatzferkeln. Schweinezeitung und Schweinemast Leserservice, http://www.susonline.de/inhalt/dateien_lesers/VBOsnabueck0302.pdf, 5 p.
- SKIBA F., CASTAING J., ÉVRARD J., MELCION J.P., HAZOUARD I., F. GÂTEL F., 1999. [Effect of technological treatments on the feeding value of full fat rapeseed and rapeseed meal for weaned pigs]. Journées Rech. Porcine en France, 31, 215-221.
- SKIBA F., NOBLET J., CALLU P., EVRARD J., MELCION J.P., 2002. [Effects of grinding process and pelleting on nutritional value of full-fat rapeseed for growing pigs]. Journées Rech. Porcine en France, 34, 67-73.
- VAN CAUWENBERGHE S., JONDREVILLE C., BEAUX M.F., GROSJEAN F., PEYRONNET C., LE GUEN M.P., WILLIATE I., GATEL F., 1997. [Post weaned piglet growth performance with diets containing pea and cassava]. Journées Rech. Porcine en France, 29, 189-196.