

Effect of Graded Levels of Tallow in the Diet on Performance, Digestibility of Fat, Lipogenesis and Body Lipid Deposition of the Weaned Piglet

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ABSTRACT : Thirty piglets weaned at 24.5 d of age (6.9 ± 0.5 kg) randomly allotted to 3 treatments were used to investigate the effect of dietary tallow on average performance, digestibility of nutrients, metabolic utilization of energy and body composition at 25 kg. Weaned piglets respond to increasing levels of dietary tallow from 0 to 4% and 8% by digestive and metabolic adaptation. Apparent fecal digestibility of fat (AFDf) was highly correlated with the level of dietary tallow (X as % of fat extracted after HCl hydrolysis) by the following curvilinear equation of regression: $AFDf = 33.8 + 6.9X - 0.3X^2$. Feed intake expressed as DE was only significantly increased at the higher inclusion level of tallow. But neither average daily gain, nor feed conversion was affected by the addition of fat. On the other hand, body composition at 25 kg was equally affected, by both levels of supplementary fat; dry matter and energy content in the body were significantly higher ($p < 0.01$) in piglets receiving tallow. As a consequence, the energy cost of the live weight gain was also increased from 23 to 24.7 MJ DE/kg ($p < 0.02$) and the efficiency of energy deposition was decreased from 3.2 to 2.8 MJ DE/MJ deposited energy ($p < 0.01$) in the presence of dietary tallow. An increase in the level of fat stimulated the activity of pancreatic lipase up to a constant value of 22 ± 1.4 IU/mg protein but conversely depressed the activity of amylase from 300 to 100 IU/mg of protein. The activity of liver acetyl CoA carboxylase and malic enzyme in the perirenal fat were low and not affected by dietary fat; the activity of glucose-6-phosphate dehydrogenase was high. Opposite to that, the activity of acetyl CoA carboxylase and malic enzyme in the perirenal and backfat were higher than in the liver and both were significantly reduced by the inclusion of fat in the diet. A direct deposition of dietary fat has been demonstrated by increasing the energy and lipid content of the empty body weight gain between 7 and 25 kg of live weight, and decreasing the efficiency of digestible energy utilization. (*Asian-Aus. J. Anim. Sci.* 2000. Vol. 13, No. 4 : 497-505)

Key Words : Dietary Fat, Digestibility, Pancreas, Lipogenesis, Piglet

INTRODUCTION

Addition of fat in the diet for the early weaned pigs has been recommended on the basis of several studies indicating the ability of the young animals to digest milk fat (Peo et al., 1957; Kelly et al., 1991). Increasing the level of dietary fat at low cost in case of a supply of tallow has no marked effect on the adipose tissue lipogenesis (Allee et al., 1971a, b) but increased GE content of feed is supposed to improve feed efficiency in the piglet (Endres et al., 1988). Apparent faecal digestibility of fat (AFDf) depends upon the level of dietary fat. In the growing pig, a curvilinear relation between the AFDf and the level of dietary tallow is reported by Just (1982). In the piglet, data are conflicting because conclusions of the authors are mainly based on growth performance and apparent fecal digestibility of ether extract (Eusebio et al., 1965; Leibbrandt et al., 1975; Endres et al., 1988; Eeckhout and De Paepe, 1988). The optimum level of

fat in the starter could be physiologically associated with a high level of energy intake and a maximum value for the apparent digestibility. In addition, the activity of pancreatic lipase could be related to the AFDf according to the hypothesis raised by Cera et al. (1988). In the pig as in other monogastric animals, the activity of pancreatic enzymes are related to the composition of the diet (Corring, 1980). Thus, an increase in the activity of the pancreatic lipase has been demonstrated in the growing pig fed a diet containing 25% peanut oil compared to a control group receiving a diet containing only 5% (Mourot and Corring, 1979).

It was commonly accepted that an increase in the level of dietary fat stimulated early body fat deposition when an increase in protein level supported protein deposition (Allee et al., 1971a; Leibbrandt et al., 1975). In addition, lipogenesis generally considered as a *de novo* synthesis of fatty acids in different tissues is only particularly active in adipose tissues of the weaned pig (Fenton et al., 1985). Acetyl CoA carboxylase (ACX, EC 6.4.1.2), glucose-6-phosphate dehydrogenase (G6PDH, EC 1.1.1.49) and malic enzyme (EC 1.1.1.38) are certainly involved in lipogenesis in the pig (Allee et al., 1971a), but their respective effects have not been clearly identified. High levels of dietary fat were reported to decrease

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the rate of lipogenesis estimated *in vitro* by the incorporation of glucose-U ¹⁴C in adipose cells by Allee et al. (1971a, b). A decrease in the specific activity of the malic enzyme and G6PDH was also observed but the effect of dietary fat on the activity of ACX was not shown. In addition, the relationship between the level of dietary fat and the activity of lipogenic enzymes, and further between body lipid deposition and the activity of lipogenic enzymes were also not demonstrated in the piglet. Moreover, the effect of dietary fat on the composition of empty body weight gain and on the efficiency of energy utilisation for energy and protein deposition have not been intensively investigated in the piglet.

The main objectives of the present study were to measure the digestive and the metabolic consequences of the introduction of graded levels of tallow in the starter diet of the weaned piglet. The relation between fat digestibility and pancreatic lipase activity, and between the level of fat and the activities of lipogenic enzymes in the liver, backfat and perirenal fat have been simultaneously investigated. Thus, the consequences of an increase in the level of fat on the digestive and metabolic utilisation of dietary energy have been investigated. The effect of dietary tallow on the body composition at 25 kg and on the fat deposition in the empty body weight gain were also measured in the piglet.

MATERIALS AND METHODS

Experimental treatments and diets

Thirty Large White piglets, 15 castrated males and 15 females were selected from five litters with 3 pigs of each sex in each litter. After weaning at 24.5 days of age (6.9 ± 0.5 kg), they were randomly assigned on the basis of litter origin, sex and weight to one of the three experimental diets containing 0, 4% or 8% tallow. They were housed individually in a nursery house where the environmental temperature was set at $25 \pm 1^\circ\text{C}$. Feed was pellets of 2.5 mm diameter and water were available *ad libitum*. The experiment was conducted in two phases (P); P1 from weaning to 49 days of age, and P2 from 49 days to approximately 25 kg of live weight. The experimental diets were based on wheat, manioc, and soybean meal fortified with adequate levels of lysine, methionine, minerals and vitamins to meet the nutritional requirements of animals of these ages (INRA, 1985). They were formulated to provide 24% and 23% CP in the DM in P1 and P2, respectively. Chromic oxide was incorporated in the starter at the level of 0.5%, (table 1). Tallow was substituted for an equivalent amount of manioc, leading to an increase in the energy/protein ratio as the level of tallow was increased. At the end of the experiment, only the 15 castrated males were

slaughtered for tissue sampling and for the determination of the body composition.

Table 1. Chemical composition of the diets (%)

Treatment	Tallow in diet (%) ³		
	0	4	8
Starter diet ¹ , 21-49 d			
Dry matter	909	911	916
Protein (N × 6.25) as DM	241	241	240
HCl-fat	25	65	108
Starch	423	392	359
Gross energy (MJ/kg DM)	16.03	16.60	17.80
Piglet diet ² , 49 d, 25 kg			
Dry matter	907	909	915
Protein (N × 6.25) as DM	231	228	225
HCl-fat	25	64	109
Starch	463	432	395
Gross energy (MJ/kg DM)	16.07	16.95	17.86

¹ Control diet contained as %: Wheat 54.69; Soybean meal 32.36; manioc 8.0; minerals, vitamins and trace elements 4.45; Chromium oxide 0.5; Minerals and trace elements: Bengala Freire et al. (1991).

² Control diet contained : Wheat 61.23; Soybean meal 26.38; Manioc 8.0; minerals, vitamins and trace elements 4.39.

³ Supplied at the expense of manioc.

Measures of performance and digestibility of dietary components

Animals were weighed weekly; feed was continuously supplied *ad libitum*, then feed consumption was recorded each week. After an adaptation period of 14 d to the diet after weaning, the apparent digestibilities of nitrogen, fat and energy were measured between 35 and 42 d of age using chromic oxide as indigestible marker. During the collection period, fresh samples of feces (50 g/piglet) were daily collected after the morning meal, placed in plastic bags and frozen. The pooled samples of feces from each piglet were freeze-dried and ground. Feeds and freeze-dried samples were analysed for nitrogen by the macro-Kjeldahl method and for gross energy using an adiabatic bomb calorimeter. Fat in feed and feces was extracted after hydrolysis with 3N HCl through filtration and washing of the sample by diethyl ether in a Soxtech apparatus (Soxtech, Hogönas, Sweden) and drying according to Eeckhout and De Paepe (1988). Chromic oxide in feed and feces was measured by the method of Bolin (1952). Digestible energy and protein during the experimental period were expressed on the basis of feed intake, and digestible energy and protein of feeds measured on 10 piglets per diet.

Tissue sampling and determination of body composition

In each treatment, five castrated animals of similar age and weight were slaughtered at approximately 25 kg of live weight after an overnight fast, as recommended by Mersmann et al. (1981). Immediately after electric stunning, a sample of 5 g of backfat was taken at the level of the last rib. Thereafter, a 2 g sample of perirenal fat, liver and pancreas was collected after bleeding and opening the animals through a laparotomy. All samples were taken within minutes after death, weighed and frozen in liquid nitrogen then maintained at -65°C until analysed. Animals were eviscerated and the digestive tract was carefully emptied and weighed. The empty body weight (EBW) was determined as the live weight minus the weight of the digestive tract content. The carcass was split into 2 halves and weighed. The body components of each pig were divided into two composites as follows: the right half carcass and viscera including blood, the head, the tail, the emptied digestive tract, the liver and emptied bladder and gall bladder and other organs. It was assumed that the two halves carcass have the same composition. The composites were deep frozen at -20°C then minced successively in a Hobart RF 15 mincer then a Hobart chopper T4346 (Hobart, Troy, Ohio, USA). Representative samples of each composite were taken, freeze-dried, homogenised and analysed for dry matter, ash, nitrogen and gross energy content. The lipid contents were determined on a sample of fresh tissues using a chloroform/methanol mixture (2/1: vol/vol) as a solvent according to Folch et al. (1957).

The comparative slaughter technique was used to determine crude protein, lipid and energy content of the body and the amount of nutrients retained in piglets. According to the previous results of Noblet and Etienne (1987), it was assumed that animals of the same age, weight and breed contained on average at weaning 112.6 g lipids, 143.8 g protein and 8.331 MJ Energy/kg. Empty body weight gain (EBWG) was calculated as the difference between final and initial values. Empty body weight gain composition was estimated from the EBWG and the composition of initial and final EBW.

Digestive and metabolic enzyme determination

The substrate concentration and incubation conditions used for amylase and lipase determinations were those described by Bengala Freire et al. (1991). The activity of pancreatic amylase (*EC 3.2.1.1*) and lipase (*EC 3.1.1.3*) were measured using 1 g of frozen pancreatic tissue homogenised in distilled water at 4°C with a Polytron homogenizer (Polytron, 3000 Zürich CH) for 1 minute. The activity of amylase was expressed as international units (IU) per mg of tissue protein. The

activity of lipase was expressed as micromoles of fatty acids released per minute per mg of protein. Measurements were performed on the five castrated males slaughtered for the determination of body composition at 25 kg of live weight. The activity of lipogenic enzymes, acetyl CoA carboxylase (ACX, *EC 6.4.1.2*) was assayed by the H^{14}CO_3 -fixation method of Chang et al. (1967) modified by Chakrabarty and Leveille (1969), and activity expressed as bicarbonate incorporated /min/mg protein. Malic enzyme activity (*EC 1.1.1.38*) was determined by the method of Hsu and Hardy (1968). Glucose-6-phosphate dehydrogenase (G6PDH, *EC 1.1.1.49*) activity was measured by the method of Ficht et al. (1959) modified by Gandemer et al. (1983). The amount of NADPH released was measured at 340nm. Activities of malic enzyme and G6PDH were expressed in nmoles NADPH released/min/mg of tissue protein at 25°C . The protein content of the pancreas extract and in the microsomal fraction of the supernatant of adipose and liver tissue extract were determined using the method described by Lowry et al. (1951).

Statistical analysis

All data were treated statistically, linear and quadratic effects of dietary tallow were analysed by the Statistical Analysis System (SAS, 1987). The differences in mean values were analysed using one way ANOVA between control and each treatment. Only 5 castrated males per treatment were slaughtered for the determination of enzymatic activities, and for the measurements of body composition. Energy balance was further expressed for 10 piglets in each treatment, assuming that body composition at 25 kg was independent of the sex of animals (Aumaitre et al., 1964; Leibbrandt et al., 1975).

RESULTS

Performance and apparent faecal digestibility

Age at weaning was 24.5 d and the corresponding average weight was 6.9 ± 0.5 kg at starting. The effect of level of tallow on the overall performance and digestibility of fat, nitrogen and energy are shown in table 2. There was no effect of the level of dietary fat on growth rate (figure 1) and feed conversion ratio. Level of fat had also no significant effect on feed intake but there was a significant increase in GE and in DE intake only at the higher level of fat. There was a quadratic effect ($p < 0.001$) of the level of fat mostly supplied as tallow on AFDf. Thus the regression between AFDf and the level of dietary tallow (X) was more accurately expressed by a curvilinear equation: $\text{ADFDf} = 33.8 + 6.9X - 0.3X^2$, ($R^2 = 0.81$), (table 2). Opposed to that, the linear equation had a lower statistical significance ($R^2 = 0.645$).

Table 2. Influence of the level of dietary tallow on average performance and fecal apparent digestibility of fat, nitrogen and energy (n=10 piglets per treatment)

Treatment	Tallow (%) in diet			Statistical significance	
	0	4	8	SEM	Effect of treatment
Average daily performance ¹					
Feed intake (g/d)	697	687	671	30	NS
Gross energy intake (MJ/d)	11.18 ^a	11.55 ^a	11.95 ^b	0.48	p<0.01
Digestible energy intake (MJ/d)	9.44 ^a	9.28 ^a	9.81 ^b	0.40	p=0.04
Weight gain (g/d)	411	396	397	24	NS
Feed conversion ratio	1.71	1.75	1.70	0.10	NS
Apparent digestibility (%)					
Fat ²	48.9 ^a	64.2 ^b	68.0 ^b	5.4	p<0.001
Nitrogen	76.3	72.6	74.9	3.5	NS
Energy	84.5 ^a	80.4 ^b	82.1 ^b	2.1	p<0.01

¹ Between weaning and 25 kg of live weight approximately.

² Between 6-7 weeks of age: AFD of fat as per cent = $33.8 + 6.9X - 0.33X^2$ (for X as %, $R^2 = 0.81$).

^{a,b} Values with different superscript letters in a row were significantly different; NS=not significant.

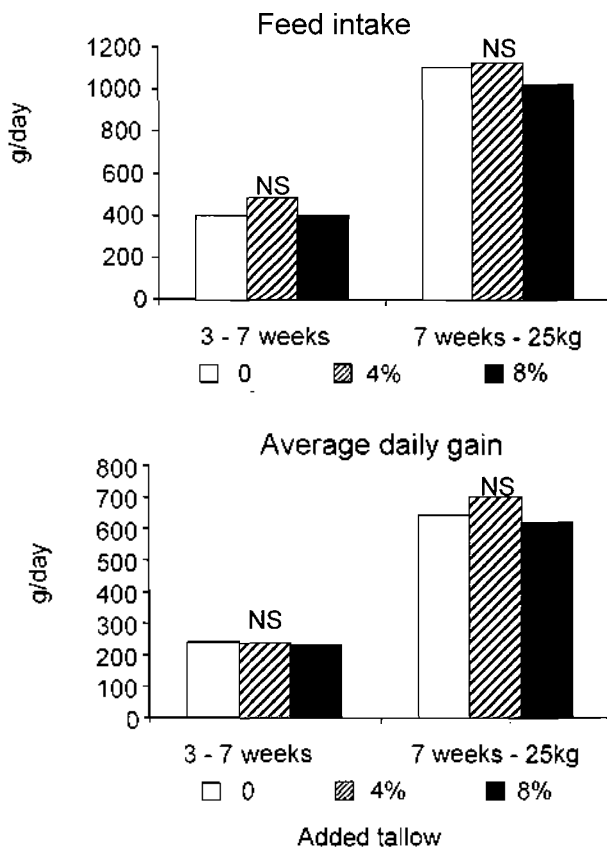


Figure 1. Effect of the level of dietary tallow on feed intake and average daily gain (NS indicates that the differences between treatment were not statistically significant within each period)

Enzymatic activities

The specific activity of pancreatic lipase increased in a quadratic response to the level of dietary tallow,

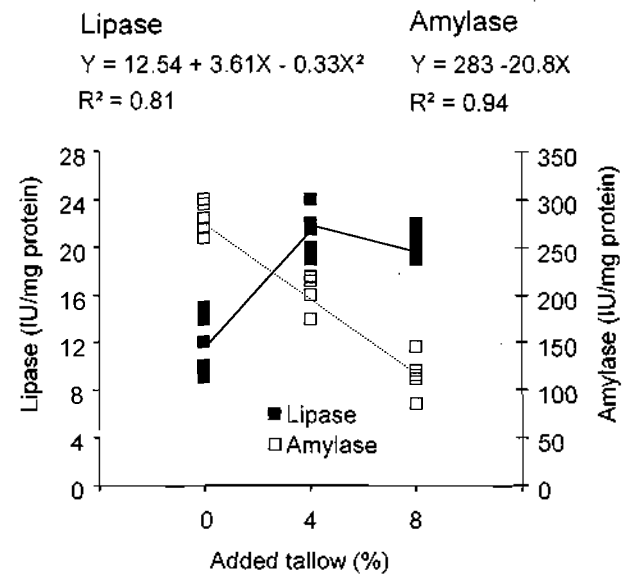


Figure 2. Influence of the level of dietary tallow on α -amylase (EC 3.2.1.1) and lipase (EC3.1.1.3) specific activity in the pancreas

($p < 0.01$) while activity of amylase was linearly depressed (figure 2, $p < 0.01$).

The effect of level of tallow on the activity of lipogenic enzymes of selected tissues are shown in figure 3. Increasing level of tallow induces a linear decrease in the activities of ACX in the perirenal fat while a significant decrease was only found at the highest level in backfat ($p < 0.001$). No effect was observed for ACX in the liver. Activity of malic enzyme was similar in perirenal fat and in backfat and were approximately 3 times higher than in the liver

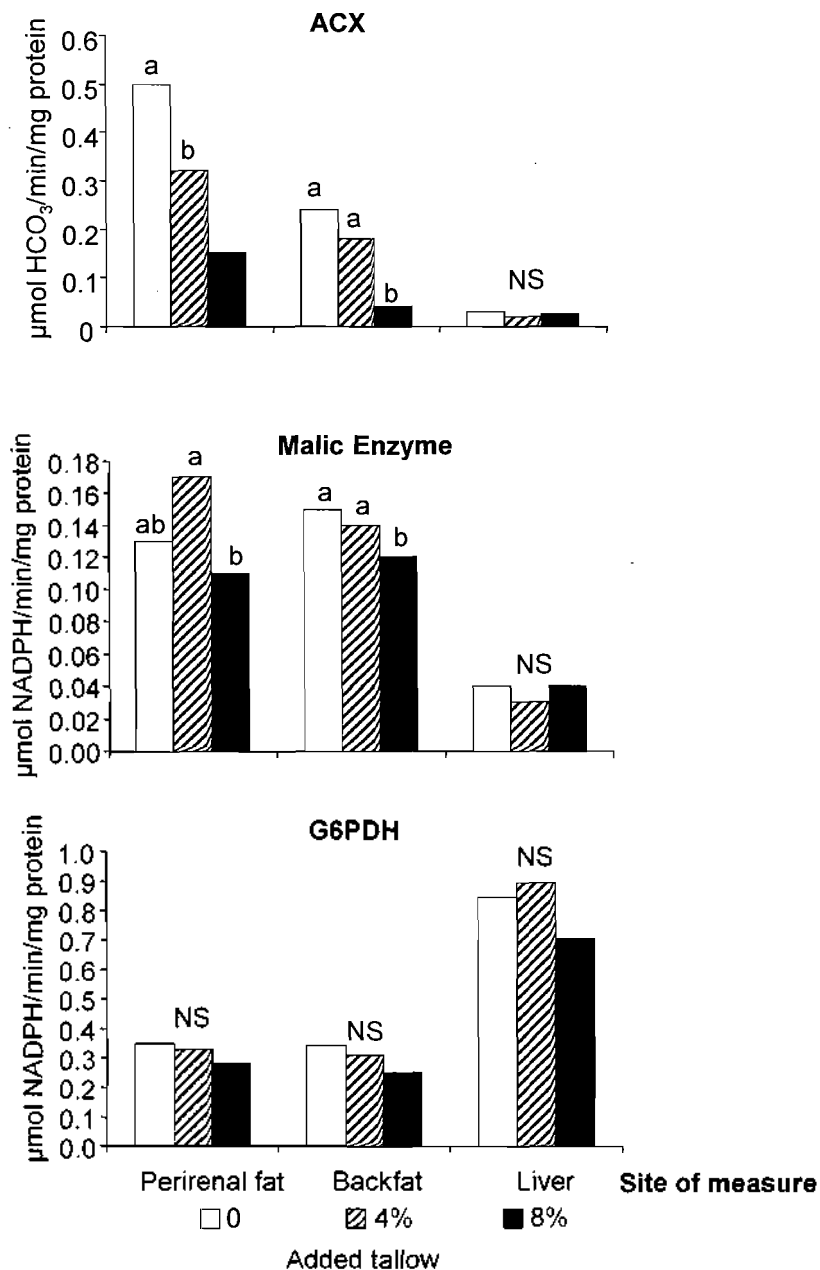


Figure 3. Effect of dietary tallow on the specific activity of acetyl CoA carboxylase (*EC 6.4.1.2*), ACX, malic enzyme (*EC 1.1.1.38*) and glucose-6-phosphate dehydrogenase (*EC 6.4.1.2*), G6PDH (a, b, c, indicates significant differences between treatments within a site of measurement)

($p < 0.001$). In both adipose tissues, the activity was reduced ($p < 0.01$) at the highest level of tallow but no effect was observed in the liver. The activity of G6PDH was higher in the liver than in both adipose tissues but there was no effect of the treatment in the three tissues.

Body composition and utilisation of energy

Slaughter performance and data on carcass and empty body weight composition and body reserves were presented in table 3. The initial body weight of

the castrated males was 7.6 ± 0.4 kg. At the end of the experiment, carcass and EBW of pigs fed diets containing fat had higher content in dry matter, and energy ($p < 0.01$ and $p < 0.001$, respectively) than control animals, but the difference in fat content was not statistically significant. As a consequence, energy stored in body reserves was significantly increased in the presence of dietary fat ($p < 0.01$). Data on the chemical composition of the two composites (carcass and other body components) showed that energy and fat stores were mainly deposited in the carcass

Table 3. Influence of the level of dietary tallow on average body composition of the piglets at 25 kg live weight (n=5 castrated males/treatment)

Treatment	Tallow in diet (%)			Statistical significance	
	0	4	8	SEM	Effect of treatment
Slaughter performance¹					
Age at slaughter (d)	69.7	70.5	69.8	2.3	NS
Live weight (kg)	25.9	25.5	25.3	1.2	NS
Empty body weight (kg)	24.8	24.0	24.8	1.2	NS
Carcass (kg)	16.8	16.0	15.6	1.0	NS
Chemical composition¹					
Carcass					
DM (%)	33.2 ^a	36.1 ^b	35.8 ^b	1.2	p<0.01
Lipids (%)	12.7	14.3	14.6	1.6	p=0.24
Protein (%)	17.3	16.6	16.7	1.0	NS
Ash (%)	2.8	2.9	2.9	0.4	NS
Energy (MJ/kg)	8.49 ^a	9.80 ^b	9.93 ^b	0.30	p<0.01
Final empty body composition²					
DM (%)	30.8 ^a	33.0 ^b	32.8 ^b	1.0	p<0.01
Lipids (%)	11.2	12.3	12.5	1.2	p=0.30
Protein (%)	16.2	16.1	16.2	0.9	NS
Ash (%)	2.7	2.9	2.9	0.4	NS
Energy (MJ/kg)	7.79 ^a	8.82 ^b	8.96 ^b	0.33	p<0.001
Body reserves at slaughter					
Energy (MJ)	193.19	211.68 ^b	222.20 ^b	14.7	p<0.01
Lipids (g)	2,777	2,952	3,100	161.7	p=0.15
Protein (g)	4,116	3,864	4,018	127.0	p=0.09

¹ On a fresh weight basis.² Reconstituted on the basis of analysis of the two composites.^{a,b} Values with different superscript letters in a row were significantly different; NS=not significant.**Table 4.** Effect of level of tallow on the utilisation of dietary energy by the piglet between weaning and 25 kg of live weight (n=10 piglets/treatment)

Treatment	Tallow in diet (%)			Statistical significance	
	0	4	8	SEM	Effect of treatment
Weaning to 25 kg					
Daily composition of:					
Energy (MJ/day)	2.94 ^a	3.33 ^b	3.56 ^b	0.2	p<0.001
Lipids (g/day)	44.23 ^a	47.62 ^b	50.90 ^b	3.3	p=0.01
Protein (g/day)	68.57 ^a	62.15 ^b	65.52 ^b	3.2	p<0.01
Composition of EBW gain					
Energy (MJ/kg)	7.45 ^a	8.91 ^b	9.11 ^b	0.18	p<0.001
Lipids (%)	11.17 ^a	12.76 ^b	13.04 ^b	0.36	p=0.05
Protein (%)	17.32	16.65	16.79	0.45	NS
Efficiency of energy utilisation					
Live weight gain (MJ DE/kg)	22.97 ^a	23.43 ^a	24.70 ^b	1.26	p<0.02
Energy deposited (MJ DE/MJ)	3.213 ^a	2.787 ^b	2.756 ^b	0.84	p<0.001
Protein deposited (MJ DE/kg)	137.8 ^a	149.4 ^b	149.7 ^b	11.72	p<0.01

^{a,b} Values with unlike superscript letters in a row were significantly different; NS=not significant.

fraction, at the expense of water. Opposite to that, the protein and ash content was not affected by the treatment. Results on daily deposition of nutrients, composition of EBW gain and efficiency of energy

utilisation by the piglets are presented in table 4. At approximately 25 kg of live weight, and for a relatively constant empty body weight, energy reserves were significantly increased by the addition of dietary

fat, whatever the level of supply. Daily deposition of body fat and energy were linearly increased while the deposition of protein decreased significantly in the presence of fat in the diet. The energy cost of live weight gain was also increased and the efficiency of energy deposition was decreased by the presence of dietary fat, ($p < 0.02$ and $p < 0.001$, respectively).

DISCUSSION

Data observed in the present experiment demonstrated clearly that the addition of tallow to the starter diet was not efficient way to stimulate growth rate of piglets, as already suggested by Leibbrandt et al. (1975) and Tokach et al. (1995). No substantial increase in digestible energy intake has been observed by increasing the level of dietary tallow. Thus, the energy underfeeding associated with weaning was not overcome by an increase in the dietary tallow in agreement with our previous data (Aumaitre et al., 1964). Chemical composition at 25 kg of live weight was significantly modified by the treatment in that the addition of dietary fat increased dry matter and energy content of the total EBW and empty body weight gain (EBWG). These data agreed with the increase in backfat thickness of piglets fed a diet with a high energy/protein ratio as observed by Aumaitre et al. (1964), but are in contrast with data observed at 20 kg by Endres et al. (1988) who used another breed of animals. These authors suggested that feeding a high level of fat to castrated males in particular, altered the body composition even though the level of fat had no significant influence on daily gain or feed conversion. Similar conclusions could be drawn in this study from the calculations showing a significant increase in the energy reserves at a similar live body weight or an increase in the energy and lipid content of the empty body weight gain of piglets fed diets supplied with tallow.

Moderate dietary inclusion of fat (4%) resulted in a significant improvement in the AFDf which is in good agreement with data of Eusebio et al. (1965), Frobish et al. (1971) and Li et al. (1989). But AFDf remained rather constant at a higher level. Such a plateau in AFDf observed with the increase of dietary fat level was also observed in the growing pig by Just (1982) and in the piglet by Wiseman and Cole, (1987) and Eeckhout and De Paepe (1988). It was also reported in the case of addition of tributyrin (Frobish et al., 1971) but not clearly apparent in the case of vegetable fat (Cera et al., 1988). These data extended the hypothesis of Corring et al. (1978) concerning the ability of the pancreas of the growing pig to adapt its pancreatic secretion to the composition of the diet. Nevertheless, the limited response of the level of pancreatic lipase observed in the piglet at 25 kg, as

was also found by Lindemann et al. (1986), suggested a limited capacity of the animal to utilise large amounts of fat as efficiently as suckled piglets (Corring et al., 1978). The linear decrease in the activity of pancreatic amylase concomitant with an increase of lipase activity in the presence of graded levels of fat could be a weakness of the pig weaned on a high fat starter diet for a further adaptation to a starch rich diet traditionally fed during the growing phase.

The activity of ACX is closely dependent on the tissue which agreed with results observed on growing pigs by Anderson et al. (1972) and Lefaucheur et al. (1991), reaching a maximum in the perirenal fat. The linear decrease of the activity of ACX in the perirenal fat consecutive to an increase in the level of dietary fat is of interest in the piglet. Ingestion of fat could contribute to a decrease in fatty acid synthesis generally fuelled by dietary starch (Allee et al., 1971a). But the level of added tallow should be increased over 4% to reduce significantly the activity of ACX or malic enzyme involved in lipogenesis. The activity of malic enzyme in the liver is low, which is in agreement with Mersmann et al. (1973). As a consequence, it is suggested that the liver contributed only marginally to fat synthesis in the pig after weaning (Fenton et al., 1985). However, malic enzyme activity in adipose tissue of the pig was not affected by dietary fat (Allee et al., 1971a, b). The activity of G6PDH in fatty tissues decreased at higher level of fat supply, but not significantly. The low level of unsaturated fatty acids in the tallow used in the present experiment could not be responsible for an inhibition of the enzymatic activities involved in the fatty acid synthesis as it was usually observed (Mersmann et al., 1981). Other mechanisms such as insulin resistance of liver could be involved in pigs fed high fat diets as demonstrated by Smith et al. (1996).

No relationship between the activity of enzymes involved in the lipogenesis process and the amount of energy and possibly lipids deposited in the weight gain have been observed. Thus, dietary lipids, when incorporated at a high level were directly deposited in the adipose tissues of the carcass of the piglet as suggested by Allee et al. (1971b). The efficiency of utilisation of DE for growth was decreased with increasing dietary fat level. Such results were similar to the data observed by Seve (1983) on animals of the same age at the same weight fed *ad libitum*, but are in contrast with the results of Allee et al. (1971a) and Just (1982) found in older pigs. The increase in the energy/protein ratio resulting from the addition of a too high level of fat and the subsequent significant reduction of daily protein deposition could be involved in the explanation.

In conclusion, the present results emphasise the limited capacity of the weaned piglet to digest and utilise high levels of fat as tallow in its starter diet opposed to an efficient use of milk fat during the suckling period. The digestive response of the pancreas and metabolic data concerning the liver or fatty tissues could be useful physiological basis in the formulation of diets for the young weaned piglet. The high risk of boosting early energy and probably lipid deposition in the body by adding increasing amounts of dietary animal fat should also be considered in the feeding strategy of the weaned pig.

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