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Performance, chemical body composition, and energy balance of 70-kg pigs as affected by dietary restriction in young age

G. Skiba, H. Fandrejewski, St. Raj and D. Weremko

The Kielanowski Institute of Animal Physiology and Nutrition,
Polish Academy of Sciences
05-110 Jabłonna, Poland

ABSTRACT

The study was carried out on 20 gilts from 15 to 70 kg. From 15 to 25 kg the animals were fed a starter diet at three feeding levels: group C, 100; group D1, 85; D2, 60% of intake. From 25 to 70 kg the animals were fed a grower diet at the standard feeding level. During restriction, the D1 and D2 pigs grew slower than the C pigs (382, 240 vs 512 g/day) and reached 25 kg 8 and 23 days later, respectively. During realimentation, both D1 and D2 pigs utilized feed more efficiently and grew faster than controls. Overall performance (15-70 kg) indicates that D1 pigs grew at similar rate and D2 significantly slower than the C pigs (670, 677, 565 g/day) but both previously restricted pigs utilized protein more efficiently. The D1 group showed a full compensatory response.

KEY WORDS: pigs, compensatory growth, protein utilization, energy utilization

INTRODUCTION

Temporarily underfed animals can grow faster during subsequent stages of their growth (Donker et al., 1986; Stamataris et al., 1991; Bikker, 1994). However, this response depends on many factors (Ryan, 1989) and sometimes animals are unable to fully compensate for age and weight lost during underfeeding (e.g. Campbell and Biden, 1978).

The aim of this study was to test the hypothesis that the compensatory response of previously underfed pigs is connected with better protein deposition as well as protein and energy utilization.

MATERIAL AND METHODS

A study was carried out on 20 Polish Landrace gilts growing from 15 to 70 kg. At 15 kg the pigs were divided to three groups and up to 25 kg (*restriction phase*) fed the same diet: the C (control) nearly *ad libitum*, group D1, 85% and group D2, 60 % of the intake of the C pigs. From 25 to 70 kg (*realimentation phase*) all pigs were fed at the standard feeding level (1.44 MJ ME/kg$^{0.75}$).

The starter diet used during the restriction phase contained 12.9 MJ ME and 9.9 g of lysine per kg and comprised (%): protein concentrate, 20; cereals, 77; and mineral components, 3; The grower diet fed to animals during realimentation was based (%) on rapeseed meal as the main source of protein, 25.0; cereals, 71.6; mineral components, 3; and synthetic lysine, 0.4; and contained 12.4 MJ ME and 11 g of crude lysine. Apparent digestibility (indirect method with Cr_2O_3) of nutrients was determined on animals in the middle of each phase of the study.

At 15 kg four pigs were slaughtered as the "zero" group, the rest at 70 kg. The pigs were slaughtered after 16 h of fasting. After slaughter, the body were analyzed for protein and fat content (AOAC, 1994). Daily deposition of protein and fat was established from the difference between the final and initial content of these body components.

Statistical analyses were performed by one-way analysis of variance ANOVA using Statgraphics version 6.0 Plus software.

RESULTS

The performance of the pigs during the subsequent growth period is given in Table 1. Decreasing the feed consumed by animals inhibited the growth rate of the D1 and D2 pigs as compared with the control pigs (382 and 240 vs 512 g/day) and worsened their feed conversion ratio as well (29.4, 35.0 vs 26.9 MJ ME/kg gain). Consequently, these pigs reached 25 kg 8 days (group D1) and 23 days (group D2) later than the control (C) pigs. Protein digestibility was not affected by the severity of the restriction and amounted on average to 79.6%.

During growth from 25 to 70 kg, the D1 and D2 pigs utilized energy more efficiently than the C pigs (29.3, 33.3 vs 35.6 MJ ME/kg gain), however, a significant difference ($P<0.01$) was detected only between the D1 and C pigs. The growth rate of the D2 and D1 pigs was faster as compared with the C pigs (886 and 780 vs 732 g/day, respectively). The severity of the previous restriction did not influence the apparent protein digestibility of the diet (on average 75.3%).

During the overall period of growth (15-70 kg), the gain of the D1 and C pigs was similar (670 and 677 g/day, respectively), but the D2 pigs gained more slowly (565 g/day, $P<0.01$). The feed conversion ratio in the D1 and D2 pigs was better

TABLE 1

Performance of the pigs

Item	C (n=6)	D1 (n=5)	D2 (n=5)	s.e
		15-25 kg		
Average daily gain, g	512^{C}	382^{B}	240^{A}	8.50
Feed conversion ratio, MJ ME/kg gain	26.9^{B}	29.4^{B}	35.0^{C}	1.99
Age at 25 kg	80^{A}	88^{B}	103^{C}	1.36
		25-70 kg		
Average daily gain, g	732^{A}	886^{C}	780^{B}	10.06
Feed conversion ratio, MJ ME/kg gain	35.6^{B}	29.3^{A}	33.3^{AB}	1.75
		15-70 kg		
Average daily gain, g	677^{B}	670^{B}	565^{A}	7.60
Feed conversion ratio, MJ ME/kg gain	34.0^{B}	31.9^{AB}	26.5^{A}	1.75
Age at 70 kg	141^{A}	144^{AB}	159^{C}	1.49

^{A,B,C} – P<0.01

than in C (31.9, 26.5 vs 34.0 MJ ME/kg gain), but a significant difference was detected only between the D2 and C pigs. When the final age of the pigs was compared it was found that the D1 pigs were only slightly older than the C (144 vs 141 days, difference insignificant)) while the D2 pigs were significantly (P<0.01) older (159 days).

The final protein content in the body did not differ significantly between groups (Table 2). However, the D1 and D2 pigs had even less fat compared with the C pigs (11.15 and 11.60 vs 12.97 kg), but a significant (P<0.05) difference was detected between the D1 and C pigs only. A tendency (P<0.07) to improve the protein:fat ratio in the body of the D1 and D2 pigs as compared with the control animals was detected (0.97 and 0.92 vs 0.80, respectively).

TABLE 2

Protein and fat content in the body of the pigs at 70 kg

	C n=6	D1 n=5	D2 n=5	s.e
Protein, kg	10.40	10.76	10.62	0.08
Fat, kg	12.97^{b}	11.15^{a}	11.60^{ab}	0.27
Protein:fat	0.80	0.97	0.92	0.02

initial protein and fat content at 15 kg BW: 2.12 kg protein and 1.47 kg fat

$^{a, b, c}$ – P<0.05

The C and D1 pigs deposited a similar amount of protein daily (102 and 105 g, respectively) and significantly more (P<0.01) than the D2 pigs (87 g), (Table 3). However, the efficiency of digestible protein (protein consumed/protein deposited) was the best in the D1 pigs (50.7 %), slightly worse in the D2 pigs (47.2 %) and the worst in the C pigs (43.7%) but a significant difference (P<0.01) was detected only between the C and D1 pigs.

TABLE 3

Daily protein and energy balance from 15 to 70 kg

	C n=6	D1 n=5	D2 n=5	s.e
Protein balance, g				
digestible protein intake	232^{C}	208^{B}	185^{C}	0.86
protein deposition	102^{B}	105^{B}	87^{A}	1.58
digestible protein efficiency, %	43.7^{A}	50.7^{B}	47.2^{AB}	0.35
Energy balance, MJ				
metabolizable energy intake	23.0^{C}	21.3^{B}	18.7^{A}	0.09
energy retention as protein	2.4^{B}	2.5^{B}	2.1^{A}	0.06
energy retention as fat	5.6^{B}	4.7^{A}	4.2^{A}	0.10
energy retention/metabolizable energy intake, %	34.1	33.8	33.6	0.36

^{A,B,C} – P<0.01

Daily energy intake (Table 3) by the pigs varied from 23.0 MJ (the C), 21.3 MJ (the D1) to 18.7 (the D2). The C and D1 pigs deposited a similar amount of energy as protein and significantly more than the D2 pigs (2.4 and 2.5 vs 2.1 MJ/day). However, the D1 and D2 pigs deposited less (P<0.01) energy as fat compared with the C pigs (4.7 and 4.2 vs 5.6 MJ/day) but no differences between groups of pigs in energy utilization were detected.

DISCUSSION

Decreasing the energy intake inhibited the growth rate of animals to the same extent as in a previous study on compensatory growth, in which feed intake had been decreased to a comparable extent (e.g., Campbell et al., 1983). Positive growth of the most severely underfed pigs during the restriction phase indicates that young animals have a great adaptive capacity to temporary nutritional deficiency, which is connected with a reduction in their maintenance requirements due to the smaller size of internal organs (Koong et al., 1982).

Similarly to the results of our study, significantly higher growth rates of pigs previously underfed in terms of energy intake had been observed in the studies by Donker et al. (1986), Stamataris et al. (1991) and Bikker (1994). However, only a few studies have been carried out on sheep (e.g., Winter, 1976; Thornton et al., 1979). In them, animals recovered their weight and age lost during the restriction phase similarly to the D1 pigs in our study. Data concerning the growth rate of the D2 pigs showed a decrease of their daily gain during the subsequent four weeks of realimentation, which might have resulted from the intensive recovery of the size of their alimentary tract, which usually takes place in the first period after the change from restriction to realimentation (Ryan, 1989). Intensive recovery of metabolically active organs increases protein turnover and, as a consequence, the maintenance requirement of animals (Koong et al., 1985) therefore, less energy can be assigned for growth.

The energy balance of the pigs during growth from 15 to 70 kg indicates that previously underfed pigs deposited more energy as protein and less as fat and that the energy efficiency in such growing pigs is not significantly worse than in the pigs fed adequately throughout their growth period.

The severity of the restriction of the D2 pigs was too high and those pigs grew significantly more slowly, but utilized protein slightly better than controls. These findings agree with those presented by Stamataris et al. (1991) and Bikker (1994) who applied a similar severity of the restriction but used animals at a different age. It should be pointed out that from 15 to 70 kg, previously weakly underfed pigs grew at similar rates and deposited similar amounts of protein despite lower energy intake, but protein utilization was even better than in the control animals. The similar average protein deposition of the previously weakly underfed and control pigs indicates that during the realimentation phase, previously weakly underfed pigs must have deposited a greater amount of protein in the body as compared with the control (Stamataris et al., 1991; Bikker, 1994).

CONCLUSIONS

Temporary underfeeding of young pigs increased their growth rate during the subsequent stage of growth and influenced their overall performance. Temporarily underfed pigs are able to show compensatory growth (recovering weight-for-age) but this response is influenced by the severity of the previous underfeeding.

Overall performance of previously underfed pigs indicates that the compensatory response can be connected with higher protein deposition and better protein utilization.

REFERENCES

AOAC, 1994. Association of Official Analytical Chemists. Officials Methods of Analysis. 15th Edition. Washington, DC

Bikker P., 1994. Protein and lipid accretion body components of growing pigs: effects of body weight and nutrient intake. PhD Thesis, Wegeningen University, Wegeningen, pp. 1-203

Campbell R.G., Biden R.S., 1978. The effect of protein nutrition between 5.5 and 20 kg live weight on the subsequent performance and carcass quality of pigs. Anim. Prod. 27, 223-230

Campbell R.G., Taverner M.R., Curic D.M., 1983. Effects of feeding level from 20-45 kg on the performance and carcass composition of pigs grown to 90 kg live weight. Livest. Prod. Sci. 10, 265-270

Donker R.A., den Hartog L.A., Brascamp W.W., Merks J.W.M., Noordewier G.J., Buiting G.A.J., 1986. Restriction of feed intake to optimise the several performance and composition of pigs. Livest. Prod. Sci. 15, 353-358

Koong L.J., Nienaber J.A., Peaks J.C., Yen J.T., 1982. Effects of plane of nutrition on organ size and fasting heat production in pigs. J. Nutr. 112, 1638-1646

Koong L.J, Nienaber J.A., Mersmann H.J., 1985. Effects of plane of nutrition on organ size and fasting heat production genetically obese and lean pigs. J. Nutr. 113, 1626-1634

Ryan W.J., 1989. Compensatory growth in cattle and sheep. Nutr. Abstr. Rev., Ser B 60, 651-656

Stamataris C., Kyriazakis I., Emmans G.C., 1991. The performance and body composition of young pigs following a period of growth retardation by food restriction. Anim. Prod. 53, 373-381

Thornton R.F., Hood J.D., Jones P.N., 1979. Compensatory growth in sheep. Aust. J. Agr. Res. 30, 135-142

Winter W.H., Tulloh N.M., Murray D.M., 1976. The effect of compensatory growth in sheep on empty body weight, carcass weight, and the weight of some offal. J. Agr. Sci. 87, 433-440

STRESZCZENIE

Wpływ pobrania energii przez młode świnie na ich wyniki przyżyciowe, skład chemiczny ciała oraz bilans energii w późniejszym okresie wzrostu

Badania przeprowadzono na loszkach, które w okresie wzrostu od 15 do 25 kg (restrykcja) żywiono paszą typu starter, stosując trzy poziomy żywienia: grupa C-100, grupa D1-85 i D2-60% pobrania paszy przez grupę kontrolną. Od 25 do 70 kg (realimentacja) zwierzęta żywiono systemem dawkowanym paszą typu grower. W okresie restrykcyjnym świnie grup D1 i D2 rosły wolniej niż kontrolne (382, 240 vs 512 g/day). W okresie realimentacji świnie grup D1 i D2 wykorzystywały pasze lepiej i rosły szybciej niż kontrolne. Wyniki badań za cały okres wzrostu (15-70 kg) wskazują, że świnie grupy D1 przyrastały podobnie, a grupy D2 istotnie wolniej niż zwierzęta kontrolne, ale świnie obydwóch grup okresowo niedożywianych (D1 i D2) wykorzystywały białko lepiej ($P<0,01$) niż świnie grupy kontrolnej. Ponadto zwierzęta grupy D1 osiągnęły 70 kg w podobnym wieku jak świnie kontrolne, co wskazuje na wystąpienie zjawiska wzrostu kompensacyjnego.