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Grass utilization in growing finishing Bísaro pigs (85-107 kg). Performance and carcass composition

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SUMMARY – The aim of this work was to study the effects of grass utilization in the diets on performance of finishing Bísaro pigs. A total of 22 pigs (16 castrated males and 6 females) was housed outdoors and fed ad libitum (37-85 kg live weight) on a growing diet and then transferred to an indoor system (with free access to an outdoor area) for 49 days, according to 3 different treatments: 100% concentrate (C), 75% concentrate + *ad libitum* grass (CE75), 50% concentrate + *ad libitum* grass (CE50). The grass was supplied and its intake registered on a daily basis. Every 14 days, the pigs were weighted and their backfat (P_2 *in vivo*) measured. After slaughter (average weight of 107 kg LW), yield and 1/2 left carcass characteristics were controlled. During the outdoor growing phase, the ADG was 513 g/day. During the indoor finishing phase, the increase was proportional to the reduction of concentrate in the diet. The ADG (g) and the fat deposition (P_2 cm) were significantly different (P<0.05) in the 3 treatments (ADG: C=641; CE75=467; CE50=356 and: C=11.4; CE75=+9.5; CE50=+6.2). The empty body weight (kg) was also proportional to the intake of concentrate (C=116.2; CE75=107.7; CE50=102.2). Comparatively to the weight of the body parts, pigs that had higher intake of grass and lower of concentrate showed a higher % of shoulder (P<0.05; C=20.4; CE75=21.7; CE50=22.2) and the pH 45min of CE carcasses was significantly higher (P<0.05). As a conclusion, concentrate substitution for grass showed a slower growing rate, thinner carcasses and a high technological quality.

Keywords: Grass, intake, finishing, growth, carcasses, meat, Bísaro, pig.

RESUME – *"Utilisation de l'herbe par des porcs Bísaro en finition (85-107 kg). Performances et composition de la carcasse". Le but de ce travail était d'étudier les effets de l'utilisation de l'herbe dans le régime alimentaire des porcs Bísaro en finition. Vingt-deux porcs (16 mâles castrés et 6 femelles) étaient élevés à l'extérieur et nourris ad libitum de 37 à 85 kg de poids vif, puis transférés dans un bâtiment avec accès libre à l'extérieur pendant 49 jours, avec 3 régimes alimentaires différents : 100% concentré (régime C), 75% concentré avec herbe* ad libitum *(régime CE75) et 50% concentré avec herbe* ad libitum *(CE50). L'herbe était fournie et la quantité ingérée mesurée quotidiennement. Tous les 14 jours, les porcs étaient pesés et l'épaisseur de gras dorsal (P_2* in vivo*) mesurée. Après abattage à un poids vif moyen de 107 kg, le rendement et la composition de la carcasse étaient contrôlés. Pendant la phase d'élevage à l'extérieur, le GMQ était de 513 g/j. Pendant la phase d'élevage à l'intérieur, la croissance était proportionnelle à la réduction de la part du concentré dans le régime. Le GMQ (en g) et le dépôt de gras (P_2 en mm) étaient significativement différents dans les 3 traitements (GMQ : C = 641 ; CE75 = 467 ; CE50 = 356 et P_2 : C=11,4 ; CE75 = +9,5 ; CE50 = +6,2). Le poids vif vide (en kg) était également proportionnel à l'ingestion de concentré (C = 116,2 ; CE75 = 107,7 ; CE50 = 102,2). Les porcs qui recevaient le plus d'herbe et le moins de concentré avaient un % d'épaule supérieur (P<0,05 ; C = 20,4, CE75 = 21,7, CE50 = 22,2) et le pH 45min des carcasses CE était plus élevé (P<0,05). En conclusion, La substitution de l'aliment concentré par de l'herbe entraînait une croissance plus lente, des carcasses plus maigres et une meilleure qualité technologique.*

Mots-clés : *Herbe, ingestion, finition, croissance, viande, Bísaro, porc.*

Introduction

The use of different quantities of vegetables, forages or fresh grass as fodder for growing-finishing pigs is an important factor of the northern Portugal traditional system. The increasing development of swine production in outdoor systems, extensive and biological ones, turns to upcoming natural diets, in which grass performs a significant part. With regard to this, some investigation has been made concerning the use of fibre-rich feed ingredients in pig nutrition. Metabolic effects of its ingestion are analysed concerning different sights (economical, social, environmental and physiological ones). From the physiological point of view, the physical properties of fibre, in combination with its chemical composition, determine the effects of digestion and metabolism in swine (Gerrits *et al.*, 2003). Fibrous feed utilization and value are quite complex, as affected by numerous factors, which interconnect: availability (in pasture or supplied), nutritional composition, fibre content, fibre source (cellulose, hemicellulose, lignin), intake capacity, digestibility, season, clime, botanical varieties and genotype (Edwards, 2003).

Soluble diet fibre can increase viscosity in the upper part of gastro-intestinal tract, thus reducing passage rate, whereas insoluble fibre contributes to energy supply (short-chain fatty acids) and to increase passage rate in the large intestine by physical stimulation and increase of bulk (Gerris *et al.*, 2003). Digestibility rates of dry matter, plant cell wall components, energy and protein decreased when big amounts of fibre feeds were added to control diets (Etienne, 1987). Fernandez and Jorgensen (1986) have studied 246 diets e 257 feed, intending to establishprediction equations ofgross energy digestibility, and reported that carbohydrate simple fraction (crude fibre or NDF) is the main reason forup to 70% of diet digestibility variation and 85% of plain feeds digestibility variation. In growing pigs, fibre digestibility coefficients may vary from 0.40-0.50 (even reaching zero when lignin is present in large quantities, e.g. straw) to 0.80-0.90 in fibre sources high in pectin (e.g. sugar beet pulp). In adult sows, ingestion and digestibility are a little higher. Lignin is indigestible, pectin is almost completely digestible and hemicellulose tends to be more digestible than cellulose. When partially digested, they supply insignificant quantities of digestible or metabolizable energy for growth, once increased loss of endogenous protein and fat is observed, besides other negative interactions with other components of the diet (Noblet and Le Goff, 2001). Concerning animal health, while positive effects are claimed by most authors on the stability of intestinal microflora, reduction of stomach ulcers, improvement of gut transit and enhanced well-being of animals (Wenk, 2001), others report negative effects on disease resistance (Gerris *et al.*, 2003).

Other behavioural aspects of pigs related to fibrous diets are: reduced restlessness, aggressiveness and physical and locomotor activity, have been pointed out as improvers of animal welfare (Meunier-Salaün *et al.*, 2001); animals' lower needs of maintenance (Schrama *et al.*, 1998) and consequently more available energy, or higher efficiency, of its utilization to productive functions (growth, breed) are also frequently related to these kind of feeds. Nevertheless, these effects will only be clear if nutrient ingestion from fibrous diets fulfil the nutritional needs, according to desired production levels and regarding all economical factors (Meunier-Salaün *et al.*, 2001). In case of adult sows, empty or during the first two thirds of gestation, the amount of grass consumed in pasture, together with concentrate fed restrictedly, may contribute up to 50% of maintenance energetic needs, supplying high proportions of amino acids and minerals (Edwards, 2003).

Regarding the effects of fibrous diets on performances of growing pigs, there are a few works in this area. Danielsen *et al.* (1999) restrained concentrate feed to 70% of daily needs, supplying fresh and ensiled clover ad libitum, achieving a forage intake between 20 and 30% of the total dry matter ingested, equivalent to just 5-6% of total energy consumption, and obtained a response of less than 10-16% in average daily gain and an increase of 1 a 2% in the percentage of lean carcass.

The purpose of the present study, integrated in a wider project of investigation and development of fattening feed systems for Bísaro pigs recurring to fibrous diets (AGRO 339), was to investigate the effects of grass utilization on finishing and carcass performances of the latter breed.

Material and methods

Animals, husbandry system, feed and treatments

In this experiment, 22 Bísaro pigs were used (16 barrows and 6 females). They were born in an outdoor system, in October 2003. After weaning, at 45 days of age, pigs remained in the same place and system, and the first growth control occurred at about 37 kg BW. Growing phase (phase 1) took place in an outdoor paddock (220 m^2/animal) provided with two huts (3 x 3 x 1,2 m), and the animals were fed ad libitum with a commercial concentrate, which was provided until 80 kg BW. Next, the pigs were moved to stables (4m2/pig) with free access to an outdoor area (granite pavement, 5m^2/pig) to start the finishing phase, after a 15 days preliminary period. This second phase lasted 49 days, when a medium slaughter weight of 107 kg BW was obtained. The feeding regimen consisted of concentrate and grass in 3 different proportions. These 3 treatments (Table 1) were: (C) 100% concentrate (2.700 kg animal/day), (CE75) 75% concentrate + grass *ad libitum*, (CE50) 50% concentrate + grass *ad libitum.* The grass, proceeding from a commercial mixture (*Avena sativa* * *Vicia villosa* * *Trifolium suaveolens* * *Lolium perenne*) was supplied and its intake registered on a daily basis.

Table 1. Feeding treatments supplied during finishing phase (49 days; 85 to 107 kg BW)

Phase 2	2 Allotments		2 Allotments		2 Allotments	
Treatment	C	C	CE75	CE75	CE50	CE50
N	3	3	4	4	4	4
Supply/day/animal	2.700 kg	2.700 kg	C 1.800 kg Grass *ad libitum*	C 1.800 kg Grass *ad libitum*	C 1.500 kg Grass *ad libitum*	C 1.500 kg Grass *ad libitum*

In January 2004 a study of growing pigs started:

– Phase 1. Growing pigs in an outdoor system (Vairão), till 80 kg BW.

– Phase 2. Finishing pigs according to the 3 feeding treatments.

Concentrate with 13,02 MJ of digestible Energy (ED/kg DM), and 16% of Crude Protein was administrated once a day, in the morning, after cleaning the feed box and the rejected grass registered. Grass chemical composition is presented on Table 2.

Table 2. Grass chemical composition (%DM)†

	Value†
DM %	20.5
Crude fibre (CF)	29.8
NDF g/kg DM	615
Digestible energy (DE) MJ /kg MS††	7.56
Crude protein (CP)	9.9
Calcium (Ca)	0.71
Phosphorus (P)	0.21

† "Tabelas de Valor alimentar das Éspecies Forrageiras" (Magalhães Oliveira, 2004).

†† ED (MJ/kg MS) =17,4-0,016NDF (Witthemore, 1996).

Feed intake and performances

During the finishing period (49 days), feed consumption (grass and concentrate) was registered on a daily basis. Every 14 days, animals were weighted, measuring, simultaneously, fat evolution (P_2 *in vivo*). Throughout this phase, ADG, FCR, subcutaneous fat deposition development and feed consumption were evaluated. Slaughter took place when pigs reached the medium BW 107 kg, in a private slaughterhouse (Landeiro).

Carcass and meat quality

After slaughter, carcass weights were taken and from 1/2 left carcass of each pig the following parameters were determined: fresh and cold (24 hours) carcass weight, pH at 45 and at 60 minutes *post mortem* and pH ultime (24 h) in *Semimembranosus* (SM) and *Longissimus dorsi* (LD) muscles. Muscle and backfat thickness areas (between 13th and 14th vertebras in D, P_1, P_2 e P_3 spots, 24 hours after slaughter) were also determined. All carcasses were stored for 24 hours in a refrigerated chamber, at approximately 4℃. According to the Portuguese traditional carving method, also used in Ponte de Lima (Minho Fumeiro), the different resulting body parts of the 1/2 carcass (shoulder, ham, boned loin, belly e head) were weighted and, at the same time, samples were taken of *Longissimus dorsi* muscle, with its respective subcutaneous fat for further determinations of meet and fat quality parameters.

Statistical analysis

The results of the performance test and of the carcass parameters were submitted to a variance analysis (JMP programme, ANOVA) considering the fixed effect (treatment). The medium values found were compared to control group (C).

Results and discussion

Phase 1 – Describing the system and pigs' growth at open air (37-80 kg)

Animals were born in an outdoor system, in October 2003 and weaned at 45 days of age in December and remained in the same system during the growing phase. This period, beginning in January (day 7), extending up to middle March (day 11). The pigs weights increased from 37 ± 8.9 kg till 80 ± 7.8 BW, with a ponderal medium weight of 513 g ± 123 g/day. Considering that piglets' growth occurred outdoor, during Winter time, we can classify these values as very satisfactory, since in former experiences the achieved average daily gains (ADG), in similar conditions, were lower (Santos e Silva *et al.*, 2003). The less severe climate conditions registered *in situ* (milder temperature, lower precipitation and reduced thermal amplitudes), which is a littoral area, relatively to the conditions of previous experiences (confined), can explain the good growth observed, as well as the lower heading and the better soil conditions, also observed (reduced soaking and better vegetable soil covering).

Phase II – Finishing pigs recurring to different levels of grass. Feed consumption and growth

On Table 3 the medium intakes are presented in terms of dry matter (DM) and digestible energy (DE) of the animals groups concerning each treatment. As observed on Table 3, differences between treatments existed, in concentrate and grass (fresh) quantities consumed per animal. However, if we consider total DM consumed (CE50= 90.2 kg > CE75= 115.6 kg > C= 113.8 kg), differences are not so big, and so we suggest that animals with available grass (CE75 and CE50) were close to its maximum ingestion capacity, about 3.2 kg DM at the end of the period (Fig. 1).

Table 3. Feed consumption and energy/animal during finishing (49 days)

	Treatments		
	C	CE75	CE50
N	6	8	8
Concentrate (kg DM/animal)†	113.8	75.9	37.9
Energy consumed DE (MJ)	1481.8 (100%)	988.3	493.5
Grass (kg DM/animal)††	0	39.7	52.2
Energy consumed DE MJ	0	300.1	394.6
Total DM ingested (kg /animal)	113.8	115.6	90.2
Energy consumed DE (MJ)	1481.8	1288.4 (-13%)	888.1 (-40%)

† Concentrate DE (MJ/kg DM) =13.02
†† Grass DE (MJ/kg de DM) =7.56

To the lower concentrate intake corresponded a higher grass consumption per animal taken *ad libitum* (CE50= 52.2 kg of DM > CE75= 39.7 kg de MS > C= 0) and therefore the total energy quantities were lower compared to the control group (CE50= 888.1 MJ (-40%) > CE75= 1288.4 (-13%) > C= 1481.8). The differences in the energy consumption between the treatments CE50 and CE75 (400.3 MJ/animal) are due to the different consumption of concentrate. In CE50 groups, 58% of total DM ingested proceeds from the grass contributing with 44% of the digestible energy, and in CE75 these values are respectively 34% of DM and 23% of total DE ingestion.

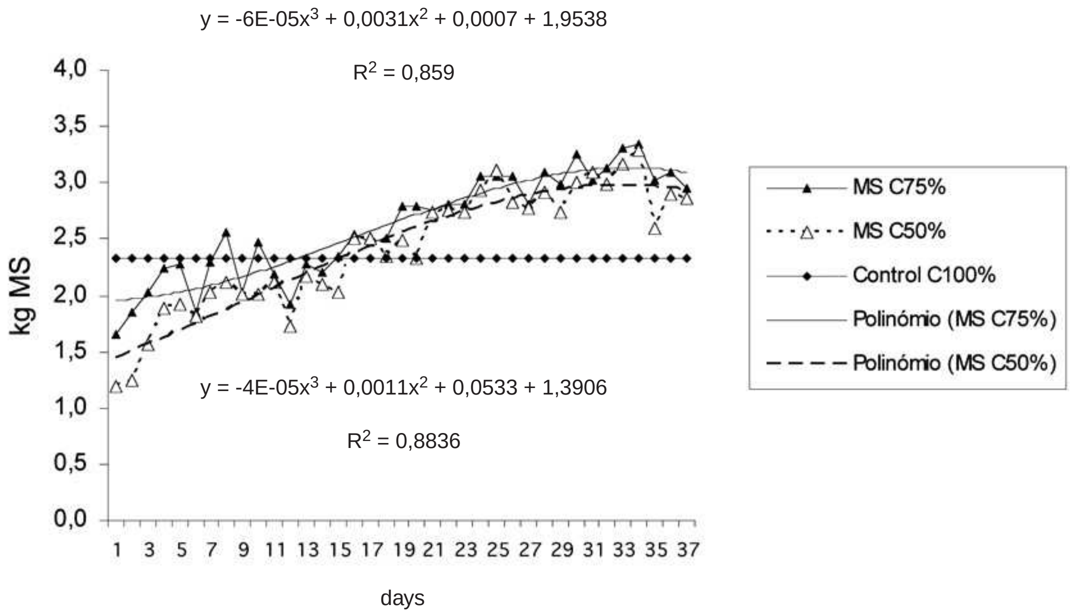

Fig. 1. Induced lipid oxidation of *Longissimus dorsi* samples from different Iberian crossbreeds fed on different diets.

Consequently, group C animals – Control group were largely beneficed in the total energy intake, since the total dry matter consumption proceed only from concentrate (a total of 1481.8 MJ DE/animal). On the whole, the increase of grass ingestion verified as a response to the lower consumption of concentrate, was not compensated, in terms of energy. This may be confirmed by the differences noticed on the growth between the three treatments (Table 4).

Table 4. Summary of the growth results obtained per treatment (49 days of finishing phase)

	Treatment			P-value
	C	C75	C50	
N	6		8	
Initial weight (kg)	84.9	84.5	84.9	NS
Final weight (kg)	116.2	107.7	102.2	*
ADG (g)	641	467(-27%)	356(-45%)	*
Fat development P_2 (mm)	+11.4	+9.1	+6.2	0.08
FCR DM (kg/kg)	3.6	5.0	5.2	

The average daily gain (GMD g) was significantly different (P <0.05) in the three treatments (C=641 > CE75=467 > CE50=356), as well as the carcass weights (kg) (C=116.2; CE75=107.7; CE50=102.2). These two last parameters were also directly proportional to the concentrate and energy quantities consumed. Analysing data from another point of view, the ADG from C75 and C50 treatments when compared to C allotment suffered a loss of 27% and 45%, respectively.

Concerning the *in vivo* fat deposition (Table 4, P_2 mm), this was also significantly different (P <0.08) in three treatments (C=11.4; CE75=9.1; CE50=6.2), showing that the carcasses of the animals fed with grass were thinner (+2.2% in CE75 and +3.1% in CE50) and that CE50 animals had a higher loin area (Table 5). The lower energy and protein consumption in these diets regarding control group may explain the differences found. These results are in accordance with former experiences, in which diets with restricted concentrate and *ad libitum* fibrous feed, corn silage and apples (Santos Silva *et al.*, 2003) and clover (Danielsen *et al.*, 2000) grew less and lodged a lower fat percentage.

Table 5. Summary of the carcass results per treatment (49 days of finishing phase)

	Treatment			P-value
	C	C75	C50	
N	6	8	8	
Weight of cold carcass, kg	90.2	81.6	76.3	*
Carcass yield, kg	77.6	75.9	74.7	*
% Lean meat	46.3	48.5	49.4	NS
P_1 cm	33.0	23.7	22.0	0.08
P_2 cm	31.0	24.1	21.9	NS
P_3 cm	34.7	25.3	22.5	NS
Loin area, cm^2	39.5	40.0	35.9	0.1
Cutted pieces:				
Head %	7.9	8.0	8.1	NS
Loin %	26.0	23.4	24.6	NS
Ham %	28.7	29.9	29.9	NS
Shoulder %	20.4	21.7	22.2	**
Belly %	16.9	17.1	15.2	0.07
pH 45 minutes	6.04	6.23	6.34	*
pH ultimate	5.32	5.37	5.38	NS

Carcass

Live weight (kg) at slaughter was directly proportional to ADG and to the concentrate intake (C=116,2; CE75=107,7; CE50=102,2). Cold carcass weight and its yield varied in the same direction, with a quantitative advantage ($P < 0,05$) in treatments with higher concentrate ingestion (table 5). In relation to the carcass weight distribution (evaluated from the cut pieces weight), animals with higher grass intake and lower of concentrate presented a higher % of shoulder weight ($P < 0,05$; C=20,4, CE75=21,7, CE50=22,2), no differences have been found between the other cut pieces. It is not easy to explain this change, yet it suggests that this anatomical region presents, in the studied breed, a differential and primary growth than the other regions. It was also noticed that with lower levels of nutritional intake (treatments CE75 e CE50) the growth of the remaining carcass parts is inferior, comparing to the fore members.

Regarding the qualitative carcass aspects, the deposition of subcutaneous fat increased together with the concentrate quantities consumed and decreased with grass consumption ($P<0.05$; C=33.0; CE75= 23.7; CE50= 22.0), contributing to fatter carcass. When comparing fat/lean tissue ratio (P_2/loin area), we verified that C and CE75 treatments have similar loin area (40 cm^2), but C has gained more fat (C=31, CE75=24). In our opinion, this suggests that, in terms of nutrition, the energy and protein intakes by the control group have exceeded the maximum potential of nitrogen retention and of muscle growth. So, it seems that in Bísaro breed the nutritional requirements are lower than that of the standard genotypes. These results are in accordance with others obtained in previous studies, namely, the utilization of apple and of corn silages in growing-finishing pigs (Santos e Silva *et al.*, 2003).

Comparatively to the velocity drop in pH 45min, it decreased with lower concentrate intake, and increased with higher grass intake ($P<0.05$), suggesting a higher carcass technological ability from grass finishing animals.

Growth and carcass heterogeneity

Variability (CV %) of the productive parameters at the end of this study were higher in the treatments that included grass: live weight (C=10.5%; C75=10.7%; C50=14.3%), ADG (C=24%; C75=37%, C50=42%), and final fat (P_2: C=37%; C75=32%, C50=52%). These values suggest that the utilization of fibrous feeds in growing-finishing swine may be one of the possible explanations of the more heterogeneous products and carcasses found in the traditional or extensive systems, common users of fibrous feeds in the carcass finishing phase.

Conclusions

From the obtained results we are allowed to conclude that, facing the different levels of concentrate and grass used in this work, the consumed concentrate amount is a decisive factor of growth and carcass rates in swine. Grass, although contributing with values from 34 to 58% of total DM intake and from 23 to 44% of DE, causes drops from 27 to 45% in ADG, and this fact is dewed in part to the limited ingestion capacity and to the diminution of metabolic efficiency. On the other side, replacing grass for concentrate led to thinner carcasses (1 to 2%) and better pH post-mortem kinetic rates, predicting a higher technological quality.

In practice, the use of fibrous feed in swine finishing adapts perfectly to extensive systems (outdoor, biological and natural ones), but its viability will depend on proper handling and on the leading objectives of these kind of productive systems seeking the improvement of meat quality.

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