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SUMMARY – During the first half of the last century, production of the Mediterranean pig was very important considering both the farm and the general economy. The production was based on natural resources (grass, acorns and chestnuts) eaten by hogs of local breeds. In Portugal, the Alentejano pig breed represented almost 50% of the total pigs raised in the country. Intensification of agricultural systems and livestock management caused a strong decrease of pig herds fattened in extensive systems. In 1986, autochthonous pigs represented about 2% of the total pig population in Portugal. Progressive demand for high graded products, like hams and dried sausages, protected by PDO or IGP rules, resulted in a new stage of development of pig production under traditional open systems. These high quality products provide added value by valorising its originality linked to the traditional production system in oak or chestnut woodlands. The CAP together with a progressive environmental concern also helped to restore, in a sustainable way, the system of finishing pigs with acorns (montanheira) or chestnuts. This means fattening hogs aged 14 to 18 months grazing in oak stands, during autumn and winter. The late fattening performed with a starch rich diet produces heavy carcasses, from 120 kg to 140 kg, with a high percentage of fat and an important level of intramuscular infiltration of fat. In order to make recommendations for proper livestock management systems, which optimize carcass and meat characteristics using natural resources, it is necessary to know, objectively, natural feedstuff resources, the specific physiology of local breeds, physical and chemical characteristics and sensorial characteristics of traditional products, as well as fresh meat parameters.

Keywords: Swine, carcass, extensive system, livestock management.

RESUME – *"Gestion de l'élevage pour optimiser les caractéristiques de la carcasse et de la viande dans des systèmes d'élevage utilisant les ressources naturelles". Durant la première moitié du siècle dernier, l'élevage du porc méditerranéen était très important pour l'économie fermière comme pour l'économie en général. Elle reposait sur l'usage des ressources naturelles végétales (herbe, glands et châtaignes) par les porcs de races locales. Au Portugal, la race porcine d'Alentejo représentait presque 50% de l'effectif porcin portugais. Avec l'innovation technologique dans les systèmes agricoles et d'élevage comme dans l'industrie agroalimentaire, la filière, qui reposait sur des systèmes extensifs et sur des ateliers artisanaux, connut une longue agonie. En 1986, elle ne représentait plus que 2% de l'effectif porcin portugais. Une nouvelle étape de la production porcine extensive a démarré à cause d'une demande progressive de produits de haut de gamme en charcuterie sèche, protégés par des appellations d'origine (AOP) et des indications géographiques (IGP) dont les cahiers des charges renvoient au terroir et à la tradition. Les produits de haut de gamme peuvent faire valoir une originalité liée aux systèmes d'élevage traditionnel. L'évolution de la PAC et une prise de conscience environnementale progressive ont aidé aussi à la reprise durable de la finition en "Montanheira" et en châtaigneraie. Cela veut dire l'engraissement pendant l'automne et l'hiver de porcs locaux âgés de 14 à 18 mois, dans les forêts de chênes ou en châtaigneraie. Cette finition fortement amylacée produit des carcasses lourdes de 120 à 140 kg, avec une forte adiposité et des infiltrations graisseuses intramusculaires caractéristiques. Pour choisir la conduite d'élevage en vue d'optimiser les caractéristiques de la carcasse et de la viande dans des systèmes de production utilisant des ressources naturelles, il faut bien connaître, de façon objective, les ressources alimentaires, la physiologie particulière des races locales et les caractéristiques physico-chimiques et organoleptiques des produits traditionnels et de la viande fraîche.*

Mots-clés : *Porc, carcasse, élevage extensif.*

Introduction

South Europe influenced by Mediterranean climate still preserves particular animal and plant resources, which undertake an evolution, along the years, that allowed the sustainable preservation of fragile agro systems. Swine production has been for centuries, based on local breeds fed on natural resources, particularly during the late fattening phase, between October and February. Acorns from both green and cork oaks (*Quercus rotundifolia* and *Q. suber*) and chestnuts (*Castanea sativa*) together with different amounts of grass, have been considered the main and more important feedstuffs to finish pigs of different Mediterranean breeds, under extensive systems.

Agricultural revolution after the Second World War strongly affected the roles of traditional marginal areas pig production systems and, it was not taken into account how important those roles were to maintain marginal areas alive and populated. Complete chains development involved: (i) preservation of oak and chestnut forests: oaks and chestnuts forests are cultivated (not natural groves) and have been considered as the equilibrium point between forests and desert (Castó, 1987); (ii) preservation of wild and domestic animal germplasm; (iii) maintenance of social links and cultural know-how; and (iv) development of local skills to foresee adequate transference of technologies and marketing strategies.

To advise a proper livestock management to optimise the carcass and meat characteristics in farming systems using natural resources, is a difficult task for any one but it seems to be a good challenge for all of us. Based on a recent bibliographic review, relevant data available will be presented. By comparing foreign studies and our studies you can expect an opinion but, quite far from an optional management.

Productive environment

Oak forests take the name of "Chênaies" in France, "Montados" in Portugal and "Dehesas arboladas" in Spain. Oak trees are very well adapted to poor and acidic soils and to the semi-arid Mediterranean climate. Sunshine and the long vegetative period favoured special productions as a result of intense chemical and reproductive activities such as resin, tannins, cork and obviously fruits (Pavari, *cit. in* Tirapicos Nunes, 1993). Acorn season starts on late October and ends in the beginning of March. Iberian and Alentejano pig management have been developed based on oaks fruits dehiscence, comparable pig fattening can be observed under chestnuts forests also in fall and winter period.

Acorns chemical composition is presented in Tables 1 and 2, evidencing a poor protein content and high starch content.

Table 1. Chemical composition of acorns (as % of shelled fruit)

Authors	I.Grasa Sevilla	Vieira	Vidal	Varela	Cuenca		Aparicio Macarro			
Year		1966	1969	1965	1965	1964	1965	1969	1969	1969
C. protein	6.80	6.20	3.60	5.10	4.60	7.20	8.30	6.60	8.40	7.50
Fat	10.40	8.30	10.70	11.00	6.00	7.40	8.50	13.70	7.00	5.40
C. fibre	0.90	4.20	2.40	6.00	5.90	4.90	4.70	5.50	3.10	6.60
S.E.I.N.	76.90	76.60	82.00	74.20	76.60	78.60	77.00	72.20	79.10	77.30
Ashes	5.00	4.80	1.30	3.70	6.90	2.00	1.50	2.00	2.40	3.10

Modified from Tirapicos Nunes (1993).

Table 2. Evolution of acorns chemical composition throughout maturation

Month of collection	MS (%)	PB (%)	EE (%)	Soluble sugars (%)	Starch (%)	Total phenols (%)	Tanins (%)
September	46.36	3.16	5.0	9.41	17.98	7.32	9.76
October	53.43	3.26	7.7	10.20	51.64	7.94	7.35
November	58.32	3.69	8.5	13.43	57.29	4.90	2.94

Modified from Almeida and Marinho (1992).

Concerning fatty acids composition, acorns are particularly rich in monounsaturated fatty acids namely oleic C 18:1 (Tables 3 and 4). Fatty acid content of fruits eaten by pigs affects their meat characteristics as well as the ability of muscle and fat tissues to be processed under traditional matrix.

Table 3. Acorns fatty acids composition as % of fat and as % of feed

	C 14:0	C 16:0	C 16:1	C 18:0	C 18:1	C 18:2	C 18:3
Fat%	–†	15	–	3	62	16	1.1
	0.1††	12.23	0.40	3.16	63.46	16.96	0.76
Feed%	–†	0.63	–	0.12	2.62	0.68	0.05

† López Bote, *et al.* (2002).

†† Oliveira (2000).

Table 4. Acorns fatty acids composition as % of fat

Fatty acids	%
Saturated	16.11 ± 1.13
Mono unsaturated	64.63 ± 1.14
Poli unsaturated	17.81 ± 1.39

Modified from Oliveira (2000).

Diets based on acorns are complemented with various other feedstuffs, of animal or plant origin, but grass plays an important role as a source of proteins, fatty acids and vitamins (Table 5).

Table 5. Chemical analyses of grass harvested under oak canopy

	García 1991	Aparicio Macarro 1992	López, 1998	Oliveira 2000	Rey *et al.* 1997
Dry Matter %	22.7	23.0	26.0	14.7	26.3
Ashes %	9.5	9.1	7.0	15.22	7.3
C. Protein %	14.9	15.0	15.5	15.49	13.7
C.Fiber %	21.2	25.0	22.0	20.29	22.2
Total Lipids %	3.8	3.5	6.0	1.97	6.2
α-tocopherol mg/kg DM	–				171
C 16:0 %	–	–	15.6	13.7	15.5
C 16:1 %	–	–	0.3	0.05	0.3
C 18:0 %	–	–	2.0	2.55	2.0
C 18:1 %	–	–	9.4	41.20	9.3
C 18:2 %	–	–	11.8	11.31	11.8
C 18:3 %	–	–	44.9	6.98	44.0

Chestnuts present some differences when compared with acorns (Tables 6 and 7), namely on fat content and on the fatty acids composition, these differences may interfere with the fatty acids concentration in the carcass fat (Table 8).

Table 6. Chestnuts composition

Crude Energy	4200 kcal/kg/MS[†] 17.63 MJ/kg ms[††]
Digestible Energy	3300 kcal/kg/MS[†] 11.44 MJ/kg ms[††]
Crude Protein	6.5 (% MS)[†] 6.8 (% MS)[††]
Total Lipids	1.8[†] (%MS) 2.47[††] (%MS)
Carbohydrates (g/kg DM)	593.5[††]

[†] Secondi (1999).

[††] Nieto, *et al.* (2002).

Table 7. Chestnuts fatty acids composition

	C 16:0	C 16:1	C 18:0	C 18:1	C 18:2	C 18:3
Fat %	15.0[†]	–	1.1	37.1	38.7	4.22
	18.3 – 25.5[††]	0.45 – 0.71	0.47 – 1.1	22.7 – 35.1	34.6 – 43.5	4.09 – 8.08
	16.9[†††]	0.8	1.1	23.8	46.7	9.0

[†] Secondi (1999).

[††] Cardoso (2002).

[†††] Coutron (1996).

Table 8. Fatty acids composition of subcutaneous dorsal fat

Fatty acids	Iberian		Alentejano	Corse	
Saturated	31[†]	32.2[††]	30.9[†††]	38.3♦	35.3♦♦
Mono unsaturated	57.1[†]	57.0[††]	55.8[†††]	51.6♦	55.0♦♦
Poly unsaturated	8.6[†]	10.8[††]	13.8[†††]	10.2♦	9.7♦♦

[†] De Pedro (1989). ♦ Casabianca *et al.* (1990).

[††] Flores *et al.* (1988). ♦♦ Secondi (1999).

[†††] Neves *et al.* (1998).

Feed management

Mediterranean pigs presented poor daily growth rates (between 200 g to 400 g) during a long period when raised under traditional extensive systems (Casabianca, 1996, Diéguez, 1992, Tirapicos Nunes, 1993). This growth curves presented a quite different shape when compared with intensive pig daily gains. From a theoretical point of view this management during pre-finishing period was completely wrong and justified the poor muscle/fat ratio observed. Trying to improve the feeding level, a trial was performed with Alentejano pigs at University of Évora, where a suitable diet, as a standard (N), was tested against quantitatively restraints of the same diet, from 15% (N-15) to 40% (N-40) less feed intake. Average daily gain increased with the standard diet (N) during pre-fattening period (Fig. 1) but depending on the fattening regime (Montanheira *vs* intensive), the previous body weight relevance was quite different. Figures 2 and 3 show an expressive compensatory growth under Montanheira, but the same evidence was not observed on housed pigs fed *ad libitum* with complete meals after identical restraint (Fig. 4).

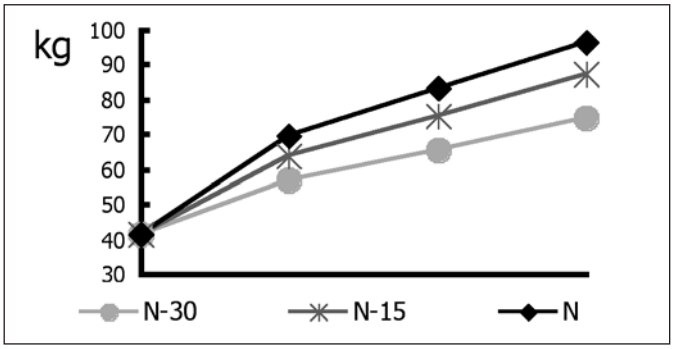

Fig. 1. Body weight evolution.

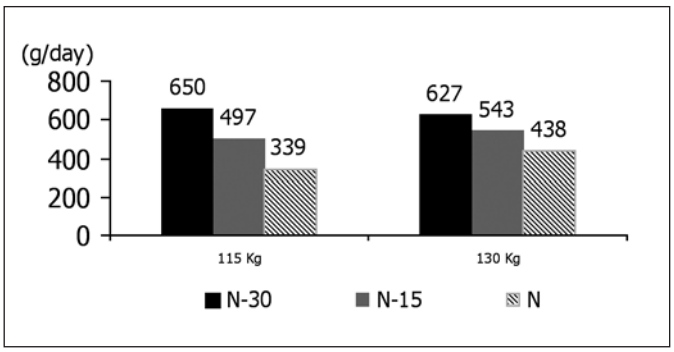

Fig. 2. Average daily gain during "montanheira".

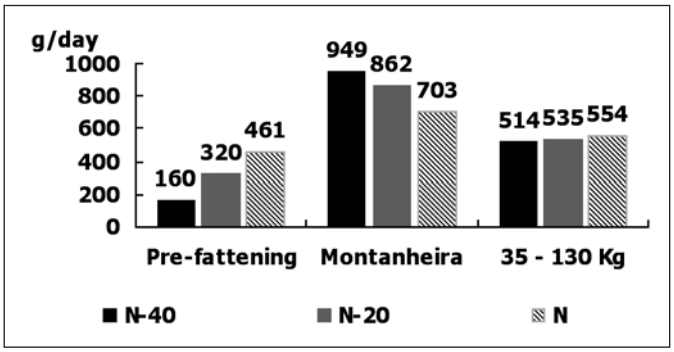

Fig. 3. Average daily gains during pre-fattening and fattening periods

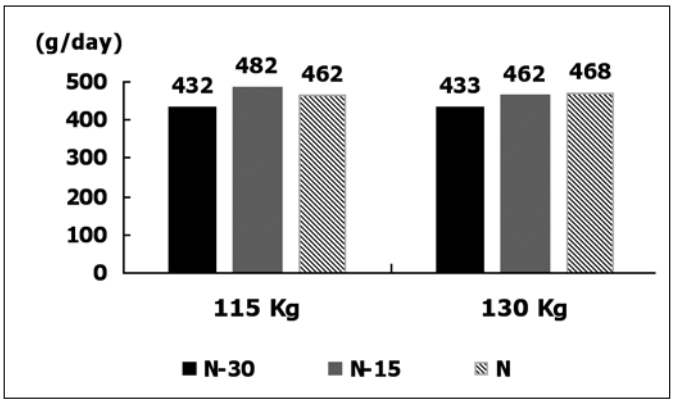

Fig. 4. Average daily gain complete meal.

A pre-finishing restraint benefits fat infiltration into muscles during the fattening period (Freitas, 1998, Casabianca, 1996) and improves meat quality (Neves *et al.*, 1996) however this management increases significantly the percentage of carcass fat (Figs 5, 6 and 7).

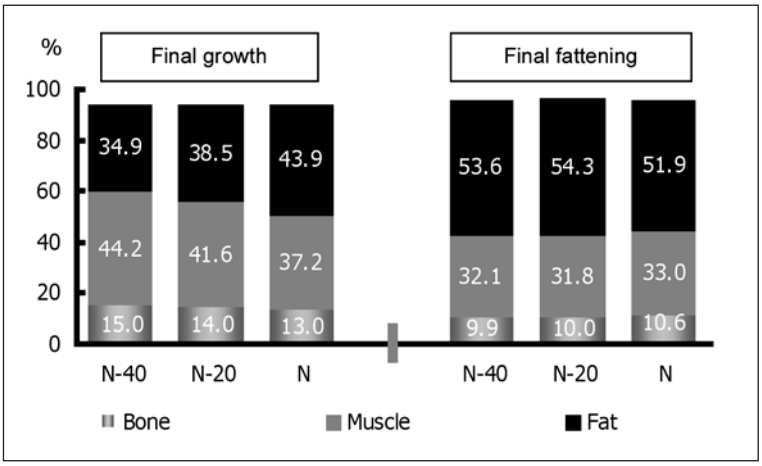

Fig. 5. Carcass composition from alentejano pig at 75 kg and 130 kg live weight.

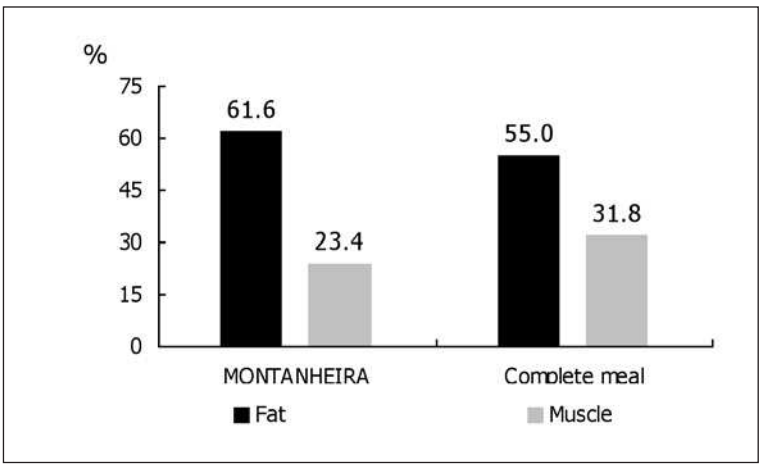

Fig. 6. Percentage of fat and lean gains from 115-130 kg.

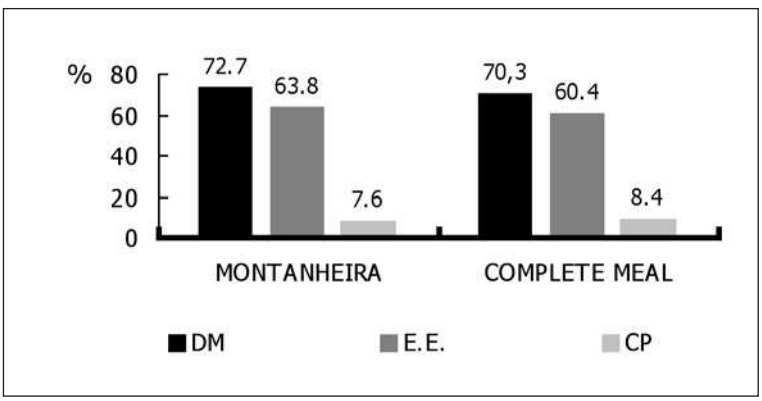

Fig. 7. Chemical carcass composition of alentejano pig slaughtered at 115 kg live weight.

It is well known that exercise during fattening affects meat quality, causing improvements on the texture of meat products and developing pigment accumulation that interferes with colour and also oxidative stability of the meat affecting the flavour of dry meat products (López Bote *et al*., 2002). Exercise also seems to reduce cholesterol at tissue level and increase the plasmatic HDL (Figures 8 and 9).

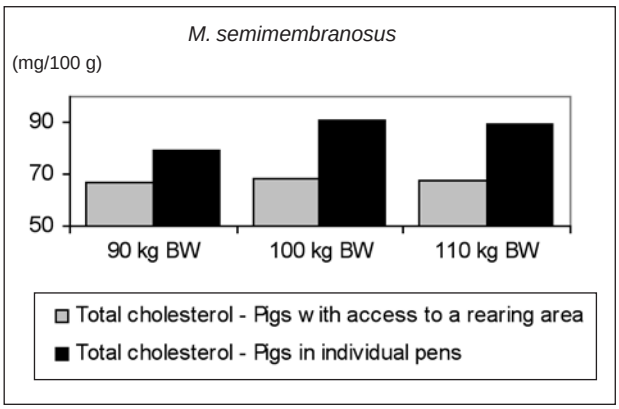

Fig. 8. Muscle cholesterol, evolution according with live weight and production system.

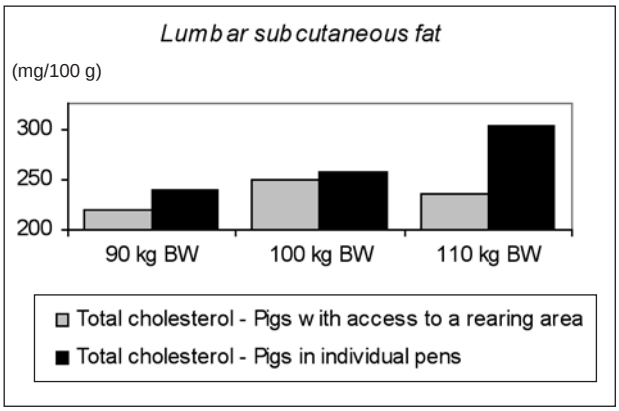

Fig. 9. Fat cholesterol, evolution according with live weight and production system.

Studies on Alentejano pigs where "montanheira" was compared with balanced meals, have proved that feeding regime affects yield and quality of long cured hams, namely fatty acid profile of lean and fat tissue (Figs 10, 11, 12 and 13).

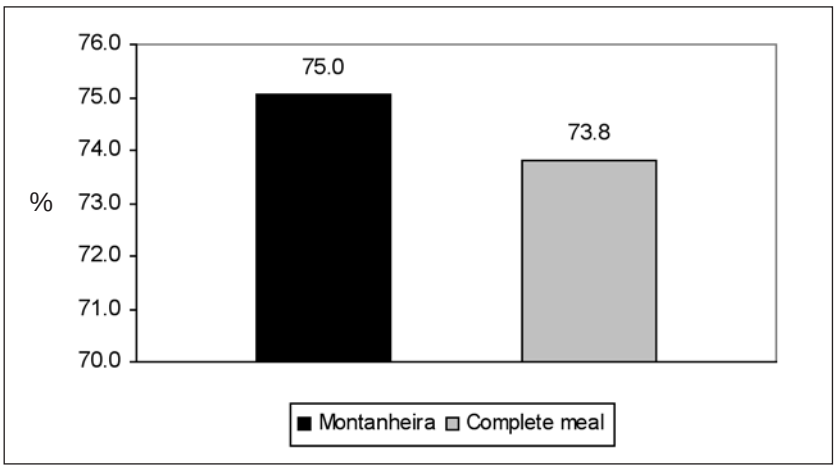

Fig. 10. Technological yield of cured hams.

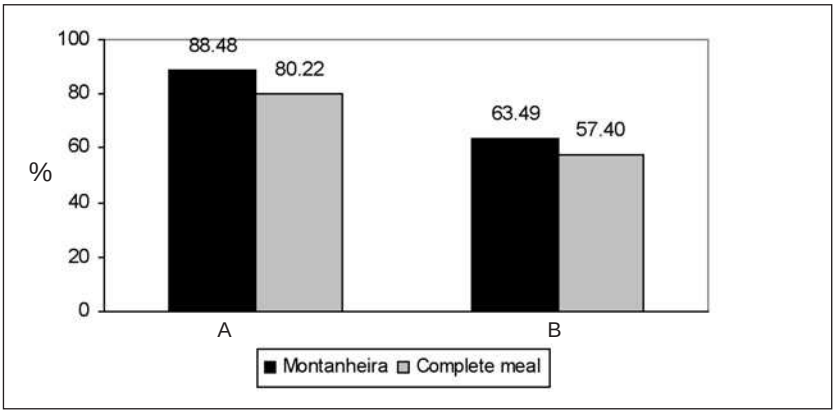

Fig. 11. Tone angle of cured hams according to feed regime (A – external layer; B – internal layer).

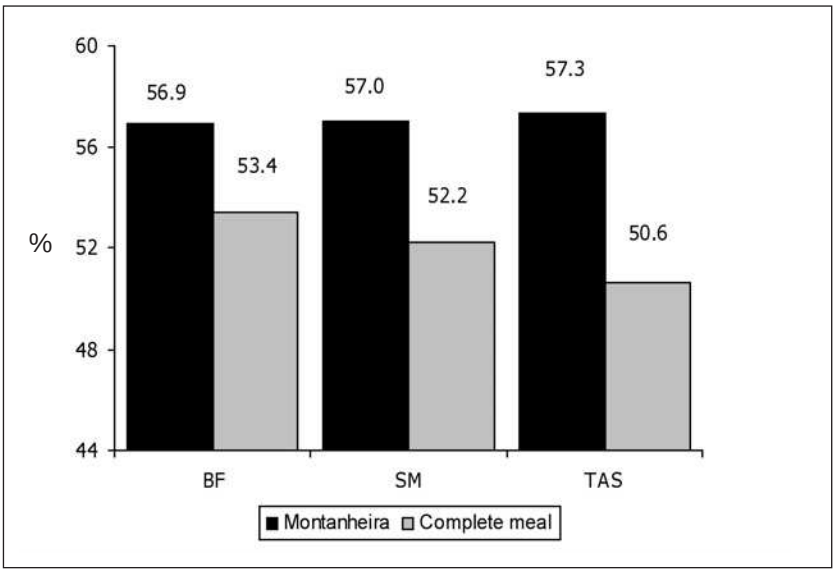

Fig. 12. Mono unsaturated fatty acids (C 18:1) of cured hams
(BF – biceps femoralis; SM – semi membranosus; TAS – backfat).

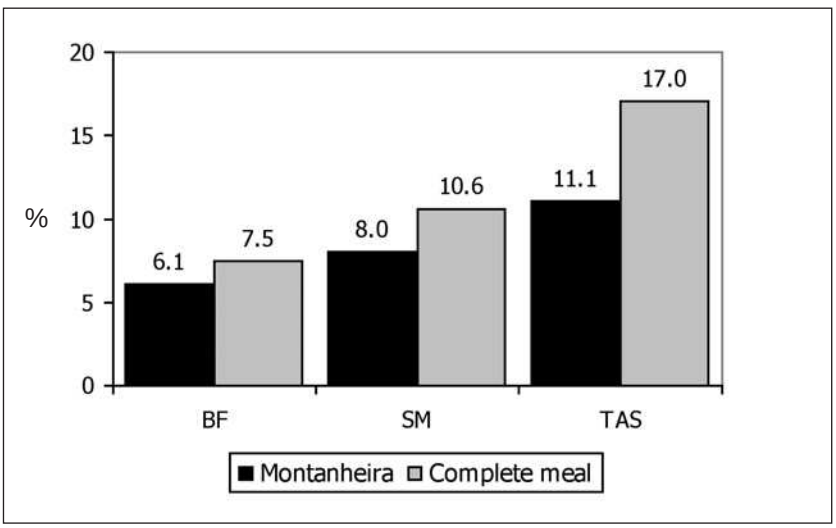

Fig. 13. Poly unsaturated fatty acids (C 18:2) of cured hams
(BF – biceps femoralis; SM – semi membranosus; TAS – backfat).

Conclusions

The oak forest areas are still important as an ecological bio-system but they are also a significant source of income for marginal regions, still under a slow development. Green oak forest represents in Portugal 463,800 ha and cork oak forest 719,400 ha, in Spain Figures are respectively 2,889,300 ha and 365,000 ha. The average acorn production varies between 400 kg to 800 kg per hectare. Natural pastures produce about 2400 kg of DM/ha while improved pastures can produce 4300 kg of DM/ha. Under these conditions the recommended stocking rate varies between one and one and a half pig/ha. This means that considering only the Iberian Peninsula, we can speculate a proactive capacity to produce, fattened pigs under oak canopy, more than four million pigs as compared to the half million or less that are produced nowadays.

Livestock management to optimise the carcass and meat characteristics in farming systems using natural resources should take into account that physiologically it is important to feed pigs in a suitable way during early ages to promote appropriate body development. Besides Iberian pigs don't need the same amount of protein and energy as modern improved pig breeds do. Aguilera and Nieto (2002) found that Iberian pigs couldn't deposit more than 74 g/day of protein with a ratio protein retention/ energy intake of 2.66 g/MJ ME. The author recommended that between 15-50 kg of live weight, there should be a reduction in the protein and metabolisable energy content of the diets of respectively 30-50 g/kg MS and 5-8% of ME. During pre-fattening period animals should have a sustainable daily growth of about 300-400 g to profit "montanheira". Sown crops (i.e. triticale) can supply adequate nutritional needs for long periods if they are directly grazed.

Lastly, it should be considered that: "the optimisation of process should retain the specific values of traditional farming, including its social role, the favourable interactions with landscape and woods management, the associate cultural values and the characteristics of the typical meat products traditionally linked to those breeds". (Carolina Pugliese, *et al*., 2003).

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