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Estimation of the carrying capacity in some Tuscan woods grazed by Cinta Senese pig

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SUMMARY – In Tuscany, pig grazing in the woods shows new perspectives compared to the past, because of differences in rearing systems and wood structure. To exploit wood resources in a sustainable way it is necessary to define the carrying capacity by determining its productivity and acorn nutritive value. An in vivo digestibility trial on acorn, compared to barley, was carried out using 12 pigs (6 Cinta Senese and 6 Large White). Acorn productivity of Turkey-oak *(Quercus cerris)* and Holm-oak *(Quercus ilex)* wood was employed. Wood production in both areas was highly variable and holm-oak was more productive than turkey-oak. DE content of acorn (5.5 MJ/kg of feed) was similar in the two species. Estimated carrying capacity of holm-oak wood varied from 0.4 to 3.5 fattening pigs/ha over a period of 150 days. The carrying capacity of turkey-oak wood varied from 0.1 to 2.1 pigs/ha over a period of 90 days. Reliable estimates of the carrying capacity of woods are recommended to avoid damage to the ecosystem.

Keywords: Cinta Senese pig, digestibility, acorn, grazing in the woods, carrying capacity.

RESUME – *"Estimation de la capacité de charge de quelques forêts de Toscane pâturées par des porcins de race Cinta Senese". En Toscane, le pâturage des porcs en forêt présente des aspects nouveaux par rapport au passé en raison des différentes typologies d'élevage et de forêt. La définition de la charge animale, par la détermination de la valeur nutritive des fruits et de la productivité de la forêt, est indispensable dans le but d'optimiser l'utilisation de cette dernière. Une expérimentation de digestibilité* in vivo *des glands, en comparaison avec l'orge, a été effectuée en utilisant des porcs Cinta Senese et Large White (6 sujets par race). Les données de production des glands de* Quercus cerris *et de* Quercus ilex *obtenues dans différentes expérimentations ont été utilisées.* Quercus ilex *a été plus productif que* Quercus cerris*, mais les deux ont présenté une grande variabilité pendant les quatre années examinées. Le contenu en ED des deux types de glands a été similaire (5,5 MJ/kg de fruit). La capacité de charge a varié de 0,4 à 3,6 porcs à l'engrais/ha pour 150 j l'année pour* Quercus ilex *et de 0,1 à 2,1 sujets/ha pour 90 j l'année pour* Quercus cerris*.*

Mots-clés : *Porc Cinta Senese, digestibilité, gland, pâturage en forêt, capacité de charge.*

Introduction

In Mediterranean area, autochthonous pig is reared mainly in extensive system by the utilization of natural resources. As Cinta Senese pig is concerned, the rearing was traditionally conducted in the Mediterranean wood which furnish mainly acorn and chestnut (Fabbio *et al*., 2005). Wood pasture allows the utilization of natural resources, otherwise unused for domestic animal feeding, and it is important to characterize the pig products (Andrés *et al*., 2001; Coutron-Gambotti *et al*.,1998). It seems very important the nutritive evaluation of wood resources to adjust the intensity of wood pasture and to avoid damage to the ecosystem.

The aim of this work was the definition of the nutritive value of the acorn by means of *in vivo* digestibility trial and to estimate the carrying capacity of some typologies of wood in the rearing area of Cinta Senese pig.

Material and methods

Twelve barrows (6 Cinta Senese (CS) and 6 Large White (LW)) were submitted to 4 digestibility trials using metabolic cages to collect faeces samples. The subjects of the two breeds had the same weight but different age because of the higher growth capacity of LW compared with CS (Table 1). Each trial in cage lasted 7 days and was preceded by a 7-day period on floor.

Table 1. Body weight (kg) of the animals during the whole trial

	Breed		Feed	
	Cinta Senese	Large White	Barley	Acorn
Medium weight	84.4	82.8	84.2	82.0
Minimum weight	69.8	70.2	69.8	70.2
Maximum weight	98.6	99.2	99.2	96.2

To test the nutritive value of acorn, barley was used as control. Both feeds were used alone and were pelletted to allow the ingestion of the entire acorn and to avoid residues in the manger, difficult to evaluate. Pelletted feeds were supplied on a basis of 80 g/kg of metabolic weight, computed whenever the animals were transferred in the cages. The cage period was composed of an adaptation phase (3 days) and a phase of faeces samples collection (4 days), as proposed by Schiavon *et al.* (1996). For each genetic type, two groups of animals were formed and alternatively employed so that the six cages were contemporarily occupied by three subjects for each genetic type fed the same diet. Thrice a day samples of faeces for each subject were collected in order to create the individual daily sample. Feed intake was recorded daily both during the period on floor and during the experimental period in cage. Feeds and faeces were submitted to chemical analysis (Martillotti *et al.,* 1987) and to AIA determination in order to provide the apparent digestibility value (Van Keulen and Young, 1977). Chemical composition of the feeds is reported in Table 2.

Table 2. Chemical composition of pelletted feeds (% on DM)

	Barley	Acorn
Moisture	10.32	11.26
Crude protein	11.07	4.59
Ether extract	2.07	4.53
Crude fiber	4.29	11.40
Ash	3.61	3.30
Tannin	–	10.28

Experimental results obtained in previous digestibility trial on the same animals using 4 diets at different protein content (Pianaccioli *et al.*, 2004) allowed to estimate the amount of faecal endogenous protein (15.7 g/100 g of faecal DM). The value was subtracted to total amount of protein in faeces to calculate the faecal protein of exclusive alimentary origin.

Statistical analysis was carried out by GLM procedure (SAS, 2003) using the following model:

$$Y_{ijkl} = \mu + B_i + S_{ij} + F_k + E_{ijkl}$$

where B is the fixed effect of breed; S is the random effect of subject within breed; F is the fixed effect of feed. Breed x feed interaction never attained significance.

The nutritive value of acorn has been applied in a productive situation to estimate the carrying capacity of wood. As the acorn productivity is concerned, results obtained in other trial (Fabbio *et al*. 2004) on Turkey-oak (*Quercus cerris*) and Holm-oak (*Quercus ilex)* wood throughout four years were considered. To estimate the wood carrying capacity the following formula (Talamucci and Pazzi, 1980) was used:

$$C = (PxS)/(FxD)xK$$

where C is the pigs number; P is the wood production expressed in DE calculated from the acorn production and its nutritive value; S is the pasture surface (1 ha in this case); F is the daily nutritive requirement *per* head; D is the length of pasture period (the acorn fall period, experimentally measured); K is correction coefficient, in this case equal to unit.

Results and discussion

True digestibility of dry matter and of its components is shown in Table 3. Comparison between breeds did not show any significant difference in spite of the higher values for Cinta Senese. In other trial (Acciaioli *et al.*, 2003) Cinta Senese showed lower digestibility than Large White of the same age, but in the present trial Cinta Senese pigs were two months older than the control, fact that probably influenced the result.

Table 3. True digestibility (%) of feed components

	Breed		Feed		RSD
	Cinta Senese	Large White	Barley	Acorn	
Dry matter	74.37	70.40	85.07[a]	59.69[b]	6.56
Organic matter	76.44	72.57	87.09[a]	61.92[b]	6.30
Crude protein	87.62	80.37	98.62[a]	69.37[b]	10.34
Crude fiber	10.25	-2.09	15.60[a]	-7.44[b]	20.27
Ether extract	79.82	75.85	68.77[a]	86.90[b]	5.69
Nitrogen-free extract	81.31	78.93	89.84[a]	70.40[b]	5.03

a, b: within criterion means with different letters differ (P<0.01).

Differences between feeds were always significant. Digestibility of dry matter and of organic matter was higher for barley (about +30%) than for acorn. Absolute values for barley are slightly lower than those obtained with complete diets of similar protein content (Pianaccioli *et al*., 2004) and with diet based on corn and soybean (Morales *et al*., 2002). Real digestibility of protein was nearly to 100% for barley but very lower for acorn (69.37%) probably because of the high tannins content in the latter feed, that have been found to reduce protein digestibility (Morales *et al*., 2002).

As expected, crude fiber digestibility was very low in both feeds and minimal in acorn confirming the negative effect of tannin on the intestinal microbic activity, in agreement with the results obtained in previous trial that compared soybean and field bean (Acciaioli *et al*., 2003). Tannins content of acorn of this trial was particularly high, as the fruit was of Turkey-oak (*Quercus cerris)* and it was employed immediately after the fall. However, it must be considered that during the pasture pigs often eat acorn with lower tannin content because of the effect of wash away by rain.

Nitrogen-free extract digestibility, also, was lower in acorn, probably due to its higher fiber content that reduces the digestibility of all the dry matter components (Mordenti *et al*., 1992). Difference between diets in ether extract digestibility, on the contrary, favoured acorn in respect to barley.

Table 4. Production of acorn (as fresh fruit) of two oak forest types and estimate of digestible energy production

	Holm-oak		Turkey-oak	
	kg/ha	MJ/ha	kg/ha	MJ/ha
2000	426	2503	62	425
2001	365	2144	29	198
2002	1741	10219	916	6310
2003	3253	19097	965	6649

Nutritive value of feed was not different between breeds. As comparison between feeds is concerned, gross energy content had similar value in barley and acorn (18.11 and 18.27 MJ/kg of DM, respectively) but the latter feed had lower content of digestible energy (11.58 *vs* 15.77 MJ/kg of DM) because of the lower digestibility of its components. Overall digestibility coefficient of energy was 87.08% in barley and 63.38% in acorn.

To estimate the carrying capacity of the wood, as above specified, productive data obtained in other research (Fabbio *et al.,* 2004) were employed. In Table 4 the original production and the calculated energetic values (as digestible energy) are reported. Energetic value was calculated applying the aforementioned digestibility coefficients to chemical composition of acorn produced in the controlled oak woods. Acorn fall period lasted 150 days for Holm-oak and 90 days for Turkey-oak (Fabbio *et al.,* 2004). Daily requirements of pig were assumed from the tabulated values and, for instance, two swine categories were considered: pregnant sow (29.3 MJ/d of DE) and fattening pig (35 MJ/d of DE). The latter category has been considered since the acorn feeding during the final fattening period is important to characterize the meat products (Andrés *et al*., 2001; Coutron-Gambotti *et al*.,1998).

Table 5. Average carrying capacity (heads per hectare) of wood per category of pig

Year	Holm-oak		Turkey-oak	
	Pregnant sow	Fattening pig	Pregnant sow	Fattening pig
2000	0.57	0.48	0.16	0.14
2001	0.49	0.41	0.07	0.06
2002	2.33	1.95	2.39	2.00
2003	4.35	3.64	2.52	2.11

Results about the carrying capacity of two typologies of wood are reported in Table 5. On overall, it is remarkable the high variability of carrying capacity throughout the four years, due to the variability of acorn production. Holm-oak wood showed the highest capacity of feeding pigs and allows the pasture during five months, but, according to years, the values ranged from 0.4 to 4.3 heads per hectare. Turkey-oak stand showed lower carrying capacity (max 2.5 sows/ha) and allows the pasture only for three months.

Conclusion

The *in vivo* digestibility trial allowed to estimate the energetic value of acorn and furnished new knowledge on the nutritive evaluation for pig of wood products, considering the lacking of information about this item. No difference emerged between Cinta Senese and Large White on the capacity of nutrients utilisation whereas entire acorn showed more limited digestibility than barley. Using both the energetic value obtained with the digestibility trial and the productivity of wood recorded throughout four years, estimates of theoretical carrying capacity of some typologies of wood were proposed. The high productive variability determines high variability in carrying capacity over the years and makes difficult to program the extensive rearing of pig, if natural resources alone are used. Moreover, the limited protein content of acorn suggests the opportunity of adequate integration of natural resources in the feeding of some pig categories. In conclusion it's necessary to provide a reliable estimate of carrying capacity of wood at the beginning of the productive season to avoid damage to the ecosystem.

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