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# Wool quality in *Gentile di Puglia* sheep breed as measure of genetic integrity

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## ABSTRACT

The *Gentile di Puglia* is a breed created in the 15<sup>th</sup> century by crossing Merino Spanish rams and "gentile" ewes reared in some areas of Southern Italy, mainly Apulia and Basilicata. The crisis of the wool industry, the poor quantity of milk, the inadequacy of *Gentile di Puglia* to be milked by machine and the passage from transhumant to permanent rearing caused a dramatic reduction of this population, which was largely crossed with other breeds and declined from about one million heads in the sixties to 5,000 at the present time. In order to save the ancient typical *Gentile di Puglia* breed, the aim of this work was to estimate the "genetic integrity" of the remaining *Gentile di Puglia* population by means of an analysis of wool quality measured through the diameter of the fibre and the homogeneity of the fleece. Our hypothesis was that the animals originated from outcrosses to other Merino derived breeds specialised for meat would show larger diameters of the fibres and a reduced homogeneity of the fleece. The research was carried out using Herd Book registered animals from 9 farms: 1 from Isernia, 2 from Campobasso and 6 from Foggia province. The statistical analysis on the diameter of the fibre was carried out on a dataset of 38,200 observations (200 records x 191 animals) divided in four classes (ultrafine, fine, croisè, ordinary).

The high frequencies of ultrafine and fine fibre classes show that the quality of the wool is still good in the population. This consideration can be extended to all the farms involved in the study that could therefore be suitable in the conservation programs for this breed. The homogeneity of the fleece was also good in providing further evidence of the genetic integrity of the population. Other analysis carried out on the quality of the wool in relation to the body size confirmed that the observed *Gentile di Puglia* is well representative of the ancient breed.

*Key Words:* *Gentile di Puglia*, Wool quality, Genetic integrity.

## RIASSUNTO

LA QUALITÀ DELLA LANA NELLA RAZZA OVINA GENTILE DI PUGLIA COME MISURA  
DELLA SUA INTEGRITÀ GENETICA

*La Gentile di Puglia è un razza sintetica creata nel XV secolo d.C. dall'incrocio tra arieti Merinos spagnoli e pecore "gentili" allevate in alcune regione dell'Italia meridionale, particolarmente Puglia e Basilicata. La crisi dell'industria laniera, la difficile adattabilità alla mungitura meccanica ed il passaggio dal tipico allevamento*

transumante a quello stanziale ne hanno causato una drastica riduzione da circa un milione di capi negli anni '60 agli attuali 5.000.

Per salvaguardare il tipo genetico originale della Gentile di Puglia, si è voluta stimare "l'integrità genetica" della popolazione residua tramite l'analisi della qualità della lana misurata attraverso il diametro del filamento lanoso e l'omogeneità del vello.

L'ipotesi di partenza è che gli animali originatisi dall'incrocio con altre razze derivate Merinos specializzate per la produzione carne, dovrebbero mostrare maggiori diametri del filamento lanoso ed una minore omogeneità del vello.

La ricerca è stata condotta in nove aziende tutte con soggetti iscritti al Libro genealogico: 1 nella provincia di Isernia, 2 in quella di Campobasso e 6 in provincia di Foggia. Per l'analisi statistica del diametro della fibra è stato utilizzato un dataset costituito da 38.200 osservazioni (200 letture del diametro\*191 animali) suddivise in quattro classi di finezza (lana ultrafine, fine, croisè ed ordinaria).

L'elevata frequenza delle fibre nelle prime due classi dimostra che nella popolazione residua la qualità della lana è ancora buona; la stessa considerazione può essere estesa anche a tutte le aziende studiate che perciò potrebbero fornire un utile strumento per i programmi di conservazione attuati per questa razza. Anche l'omogeneità del vello ha fornito un'ulteriore prova dell' "integrità genetica" della popolazione esaminata.

Altre analisi statistiche condotte per stimare la qualità della lana in relazione alla taglia dell'animale hanno confermato che la popolazione residua di Gentile di Puglia costituisce un campione rappresentativo della razza originaria.

Parole chiave: *Gentile di Puglia, Qualità della lana, Integrità genetica.*

## Introduction

The Gentile di Puglia is a breed created in the 15<sup>th</sup> century from a cross between Merino Spanish rams and "Gentile" ewes reared in some areas of Southern Italy, mainly Apulia and Basilicata (Mascheroni, 1927). After the Second World War the consistency of its population exceeded one million heads.

Its dramatic reduction in population at the beginning of the 60's (AIA, 1961) was determined by many causes. First of all there was the crisis of the wool industry caused by the dramatic drop of the market price due to the introduction of synthetic fibres. Other reasons were the inadequacy of Gentile di Puglia to be milked by machine determined by the udder morphology and the poor quantity of milk, in addition to the transformation of the production system from transhumance to stationary due to changes in the social structure of the human population (Liberale, 2000).

In order to maintain their market shares and, therefore, their livelihood, Gentile di Puglia breeders began the task of crossing their animals with

meat and milk sheep breeds according to their short term production needs. This process resulted in 41 different genetic types (Pollidori *et al.*, 1986). Animals from this pool were used to create a new breed obtained by crosses to various other Merino derived breeds (Ile de France, Berrichon du Cher, Merinos Prècoce, Württemberg, ecc.).

A large number of animals derived from the Gentile di Puglia converged into this new genetic type named Merinizzata italiana contributing to a further decline of the breed. At the present time, with only 5,000 existing animals, the Gentile di Puglia population is considered endangered according to EU parameters (Reg. EC No 445/2002).

It seems appropriate, in such a situation, to reassess the typical products of the breed and to introduce safeguards to avoid its extinction.

Several studies were therefore carried out with the aim to define number, present geographic distribution (Panella *et al.*, 2003) and meat quality (Sarti *et al.*, 2001) of the Gentile di Puglia.

The aim of the present study was to estimate the quality of the breed wool by measuring the

Table 1. The animal population sample.

Farm	Province	Total (n.)	Male (n.)	Female (n.)	Age (years)	
					$\bar{x}$	SD
1	IS	7	2	5	4.00	1.66
2	CB	7	2	5	4.37	2.00
3	CB	5	1	4	3.66	0.94
4	FG	16	3	13	4.87	1.90
5	FG	47	5	42	5.73	2.13
6	FG	35	8	27	5.12	1.66
7	FG	28	3	25	4.59	2.50
8	FG	24	2	22	4.67	1.95
9	FG	22	2	20	4.04	2.57
Total		191	28	163		

IS: Isernia, CB: Campobasso, FG: Foggia (Italy).

diameter of the fibre and its homogeneity in the fleece and to use these traits to evaluate if only ancient animals are in the Gentile di Puglia population. It is in fact assumed that only purebred animals produce wool of a certain quality (fibre diameter  $\leq 24 \mu\text{m}$ ), while out crossed animals produce fibres with larger diameters and therefore lesser quality wool (ASSONAPA, 1997).

## Material and methods

The research was carried out on 9 farms: 1 from Isernia, 2 from Campobasso and 6 from Foggia province. All animals were registered in the National Herd Book.

A random sample of 191 animals (28 males and 163 females) of different ages was extracted from this population; this number was equal to 10% of the total size of each observed farm (Table 1). The wool samples, taken in February 2002, were shared from the flank of each animal, put in plastic bags and analyzed at the Department of Veterinary Science of Camerino. Fibre diameter was measured with an ASTM Standards D 6500 – 00. This is the official method used for fineness and CV (coefficients of variability) fibre analysis

and requires the measurement of 200 diameters using Optical Fiber Diameter Analyser. The medullated and kemp fibres were analysed with the ASTM Standards D 2968 – 95.

Wool grease was removed with ether oil, and then the sample was oven dried (30' at 100°). Finally, the samples were processed for the microscope preparation.

For the statistical analysis the fibre diameter was divided into four classes (ultrafine: 13-16  $\mu\text{m}$ ; fine: 17-24  $\mu\text{m}$ ; croisè: 25-40  $\mu\text{m}$ ; ordinary: >40  $\mu\text{m}$ ) according to Wuliji *et al.* (1999) and other commercial classifications (Helen, 2005).

Frequencies of fibre diameter and main statistical parameters such as mean, standard deviation, maximum and minimum values, coefficient of variability, were estimated on a dataset of 38200 observations (200 records x 191 animals).

The significance of environmental factors on fibre diameter was tested according to the following mixed linear model:

$$y_{ijklm} = \mu + F_i + F(N)_{ij} + A_k + S_l + e_{ijklm}$$

where:

$y_{ijklm}$ : fibre diameter;

$\mu$ : general mean;  
 $F_i$ : effect of farm ( $i = 1, \dots, 9$ );  
 $F(N)_{ij}$ : random effect of animal nested within farm;  
 $A_k$ : effect of age in years ( $k = 1, \dots, 9$ );  
 $S_l$ : effect of sex ( $l = 1, 2$ );  
 $e_{ijklm}$ : experimental error.

The interactions between the factors were not significant and therefore were excluded from the statistical model.

To measure fleece homogeneity, the CV calculated from fibre diameter within each animal were divided into three classes (1: 0.10-0.14; 2: 0.15-0.19; 3:  $\geq 0.20$ ) and the respective frequencies were obtained.

The outcrossing of the Gentile di Puglia to other meat breeds is expected to determine a worsening of fleece quality but also an increase in body size. Therefore the CV classes of fleece were used as a variability factor to estimate the "genetic pollution". In addition, the relationship between the biometric measurements reported on the Gentile di Puglia standard (ASSONAPA, 1997) and average fibre diameter of each animal were also estimated to verify whether the quality of the wool was associated to the body size; the following linear model was used:

$$y_{ijklm} = \mu + CV_i + F_j + A_k + S_l + B(D)_m + e_{ijklm}$$

where:

$y_{ijklm}$ : biometric measurements (biometric measurements reported on the Gentile di Puglia stan-

dard: weight, chest girth, wither height, sacrum height, chest height, rump width, trunk length);

$\mu$ : general mean;  
 $CV_i$ : effect of classes of coefficients of variability of the fleece ( $i = 1, \dots, 3$ );  
 $F_j$ : effect of farm ( $j = 1, \dots, 9$ );  
 $A_k$ : effect of age in years ( $k = 1, \dots, 9$ );  
 $S_l$ : effect of sex ( $l = 1, 2$ );  
 $B(D)_m$ : partial regression coefficient of dependent variable (biometric measurement) on the covariate D (fibre diameter);  
 $e_{ijklm}$ : experimental error.

The interactions between the factors were not significant and therefore were excluded from the statistical model.

Statistical analysis was performed using SAS software (SAS, 2000).

Table 2. Significance ( $Pr > F$ ) of the effects on the fibre diameter.

	Farm	Age	Sex	F(N)
	***	***	***	***
SE			3.76	
R <sup>2</sup>			0.21	

\*\*\*:  $P < 0.001$

## Results and discussion

The frequencies of the four classes of wool fibre diameter were 17.42, 68.34, 14.23, 0.01

Table 3. Frequencies (%) of CV classes by farm.

Class	Farm								
	1	2	3	4	5	6	7	8	9
1	38.79	54.26	26.11	23.53	29.41	8.82	14.29	29.17	0.00
2	46.08	31.49	37.45	58.82	52.94	58.82	50.00	70.83	65.00
3	15.13	14.25	36.44	17.65	17.65	32.35	35.71	0.00	35.00

respectively for classes 1, 2, 3 and 4 and show that the quality of the wool is still high in almost the whole of the Gentile di Puglia population. There are two different considerations to make about this result: the population is barely polluted by the meat breeds used by breeders in the area and therefore is representative of the ancient breed; the good quality of the wool lets us envisage a possible use in the niche of typical products giving a possible chance to the economic competitiveness of this breed.

All the tested fixed factors had a significant effect (Table 2) on the fibre diameter, the estimated means showed that the wool diameter of males (19.9) was lower than that of females (20.4) confirming a better quality of rams fibres.

Mean fibre diameters per farm ranged from 21.6  $\mu\text{m}$  (6 years) to 19.23  $\mu\text{m}$  (2 years) and showed a better quality wool in the younger animals.

The wool diameters resulted very low in all farms ranging from 21.71 (farm 3) to 18.1 (farm 2). This is an encouraging result that shows how the population is well representative of the ancient breed and could therefore be suitable for use in conservation programmes.

The genetic integrity of the Gentile di Puglia population was also estimated using fleece homogeneity, which was measured through the

wool diameter coefficient of variability (CV) of each animal.

The CV had the following total frequencies 17.83, 58.6, and 23.57, respectively, for classes 1, 2 and 3 showing a relatively good homogeneity in the population. The CV frequencies analysed for each farm (Table 3) showed high quality levels in all of them. In fact the percentage of CV values smaller than 0.20 ranged from 100% in farm 8 to 64.29% in farm 7. This result seems to confirm the suitability of the studied flocks for conservation programmes.

In the studied flocks animals with body measures larger than the Gentile di Puglia standards were observed (i.e. sheep weight is 43.0 kg in the standard and 47.0 kg in the sample); this could be due either to the outcrossing with larger breeds and therefore to genetic pollution or to an improvement of the flock management and feeding. In order to answer this question, the relationship between wool diameter and body size was calculated according to the model already referenced in the material and methods section. A positive significant relationship was expected if the first hypothesis were true, on the contrary the statistical analysis showed that the covariate "diameter of wool fibre" has negligible significance levels (Table 4) and therefore it is correct to exclude sig-

Table 4. Significance ( $Pr > F$ ) of the coefficients of variability (CV) of the fleece on the biometric measures.

Biometric measures	Farm	Age	Sex	Fibre diameter	Class of CV	SE	R <sup>2</sup>
Weight	***	***	***	0.86	0.87	6.9	0.73
Chest girth	***	***	***	0.64	0.51	6.3	0.62
Wither height	***	0.02	***	0.62	0.57	2.8	0.56
Sacrum height	0.004	0.33	***	0.94	0.75	3.6	0.43
Chest height	0.004	***	***	0.77	0.56	2.0	0.50
Rump width	***	0.02	***	0.63	0.23	1.8	0.49
Trunk length	***	0.005	***	0.46	0.48	2.8	0.61

\*\*\*:  $P < 0.001$

nificant genetic pollution with exotic breeds in the population.

Moreover, the significance of the environmental factors reported in table 4 proves that also the effect of the CV class on the variability of body measures is negligible supporting the hypothesis that the Gentile di Puglia population is well representative of the ancient breed.

The coefficients of determination, reported in Table 4, were never less than 0.43 (sacrum height) and show that the employed model explains a quite large variability only in some traits (weight and trunk length).

## Conclusions

The excellent wool quality found in the Gentile di Puglia showed by both the small diameter and the good fleece homogeneity allows us to conclude that this population is possibly free from "genetic pollution" and that it would be appropriate to implement suitable strategies to save it from extinction.

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