

EFFECT OF TWO DIFFERENT REARING SYSTEMS ON QUALITY OF DRY CURED “COPPA” OF NERO SICILIANO PIG

Ambra DI ROSA ¹, Alessandro ZUMBO ¹, Maria Elena FURFARO ², Giuseppe CARCIONE ¹, Giuseppe D'ANGELO ², Vincenzo CHIOFALO ^{1,2}

ABSTRACT

The aim of this study was to assess the effect of the *indoors* (IN) vs. *outdoors* (OUT) rearing system on quality traits of dry cured coppa from Nero Siciliano pig. Physico-chemical parameters, fatty acid profile and α - and γ -tocopherol were investigated. The IN group showed a higher level of fat compared to the OUT group (42.45% vs. 37.85%; $P = 0.005$). Significant differences were found for salt content (IN: 4.70% vs. OUT: 5.44%; $P < 0.0001$), Lightness (L^*) and yellow index (b^*) were higher in the IN than OUT group (L^* : 60.24 vs. 56.44, $P = 0.023$; b^* : 6.89 vs. 5.32; $P = 0.002$). No significant differences were observed for fatty acids profile and for α - and γ -tocopherol. As dry cured coppa from both groups showed a similar quality level, to guarantee the availability of this product all through the year, the *indoor* rearing system based on commercial feed could replace the traditional *outdoor* system, when natural resources are limited.

Key words: Nero Siciliano pig/ rearing system/ dry cured coppa/ technological quality/ fatty acid profile

1 INTRODUCTION

Dry cured »coppa« is a traditional Italian product made of deboned muscles of the entire neck, cured and matured in natural casings. As it is known that quality of seasoned products depends, among others, on genetic type and rearing system (Zullo *et al.*, 2007), qualitative traits of dry cured »coppa« from Nero Siciliano pigs fattened *indoors* and *outdoors* were investigated. Nero Siciliano pig is an autochthonous genetic type reared in Sicily in the Nebrodi area characterized by high roughness and strength (Pugliese *et al.*, 2004; Zumbo *et al.*, 2012; Di Rosa *et al.*, 2012). Its survival depends on both the possibility of obtaining quality meat products and its adaptation to the harsh environment (Chiofalo *et al.*, 2007). The traditional link between the breed and its typical products may represent an important tool to increase the value of its farming (Moretti *et al.*, 2004) together with new strategies to increase the number of pigs in order to guarantee the availability of dry cured products all through the year. A possible strategy could be an *indoor*

rearing system based on commercial feed to replace the traditional *outdoor* system when natural resources are limited.

The aim of the present study was to evaluate the effect of the rearing system on physico-chemical characteristics, fatty acid profile and α - and γ -tocopherol of dry cured »coppa« from Nero Siciliano pigs fattened *indoors* on commercial feed and *outdoors* on acorn and grass.

2 MATERIAL AND METHODS

This study was carried out on 40 Nero Siciliano pigs (20 males and 20 females). During the fattening period animals were divided into two dietary groups. The *indoor* group (IN) was reared in confinement and fed commercial feed while the *outdoor* group (OUT) was raised under the traditional free-range system and fed acorn and grass. At the end of the finishing period (60 days), pigs were slaughtered at a live weight of 117.2 kg (± 15.7) and

¹ Dipartimento di Scienze Veterinarie, Polo Universitario dell'Annunziata, 98168 Messina, Italy, e-mail: dirosaa@unime.it

² Consorzio di Ricerca Filiera Carni, Polo Universitario dell'Annunziata, 98168 Messina, Italy

104.5 kg (± 12.6) for the IN and the OUT group respectively.

Neck muscles were trimmed, subcutaneous fat removed and stored 12 h at a temperature of 0–2 °C. »Coppa« were rolled manually in a tank with salt and additives at a temperature of 3–5 °C. The pieces were tumbled at two day intervals for three times and, six days later, the cuts were salted again and tumbling was repeated a fifth and a sixth time at two day intervals. After 12 days, each piece was hung for 24 hours and then stuffed in natural casings (bovine bladder). Salting was followed by a drying period at 19 °C and 60% RH for the first 8 h with a temperature and relative humidity decreasing every 24 h at a rate of 1.5 °C and 2% respectively. Maturing took place at 13–15 °C and RH of 70–75% for 90 days.

Samples for laboratory analyses were taken from cross-sections of each product avoiding heads and tails for about 5 cm. A portion of about 150 g of each sample were ground using a commercial grinder and the chemical composition (moisture, protein, fat and salt content) was determined according to the Association of Official Analytical Chemists (reference 2007.04) by Near Infrared Transmittance Spectroscopy (FoodScan™ Meat Analyser; FOSS, Italy). The determination of pH was carried out by homogenization with distilled water (1/10 weight/volume). Colour parameters were measured on two whole slices taken from the middle part of each sample, using a spectrometer (Spectral scanner, DV Technologie d'Avanguardia, Padova, Italy). The CIE system colour profile for lightness (L^*), red (a^*), and yellow index (b^*) was applied.

Fatty acid composition was determined on the lean portion of each sample and lipid extraction was per-

formed according to Folch *et al.* (1957). Fatty acid methyl esters (FAME) from obtained lipids were prepared by trans-esterification according to Christie (1993). FAME were analyzed by gas chromatography, using an Agilent Technologies 6890N gas chromatograph, equipped with a flame ionization detector (FID) and a fused silica capillary column (30 m \times 0.25 mm I.D, 0.25 μ m film thickness, Omegawax 250; Supelco Bellefonte; PA, USA). Individual compounds were identified by comparing their retention times with those of standards (Supelco, Bellefonte; PA, USA). The quantification of α - and γ -tocopherol was accomplished according to Liu *et al.* (1996) by reverse phase HPLC (Shimadzu LC-10 AT). Tocopherols were quantified using the external standard method.

Data were submitted to analysis of variance by the two-way ANOVA procedure (SAS, 2001) with rearing system and gender as independent variables; no significant differences for sex and interactions were found ($P > 0.05$) and therefore the model was reduced to main effect only (rearing system). The Scheffé's test ($P \leq 0.05$) was used for the evaluation of significant differences between means.

3 RESULTS AND DISCUSSION

Physico-chemical composition of dry cured »coppa« is reported in Table 1. Significant differences were found for fat and salt content. The IN group showed a higher level of fat compared to the OUT group (42.45% vs. 37.85%; $P = 0.005$) and as consequence, a lower level of salt probably because the fat had a retarding effect on diffusing during seasoning period (Vestergaard *et al.*, 2005). Significant differences were found for L^* ($P = 0.023$) and b^* ($P = 0.002$); higher in the IN group according to the higher fat content (Carballo *et al.*, 1996); in fact, a low-fat product is darker and redder than a high-fat product (Jiménez-Colmenero *et al.*, 2012).

Except for the C16:1 percentage that was higher in the »coppa« of outdoor pigs, no significant differences were observed for fatty acids profile (Table 2) between the IN and OUT group even though dry cured »coppa« from *Indoor* system showed a slight lower content of PUFA, C18:2 *n*-6, C18:3 *n*-3 if compared to *Outdoor* system.

The α -tocopherol concentration was higher in the OUT group,

Table 1: Chemical composition and colour parameters of dry cured »coppa«

Chemical Composition	Rearing system				P-value
	IN		OUT		
	mean	sd	mean	sd	
pH	5.87	0.10	5.71	0.09	< 0.0001
Moisture ^a	28.94	2.54	30.38	2.22	ns
Protein ^a	23.64	1.38	25.25	1.00	0.0006
Fat ^a	42.45	4.66	37.85	4.22	0.005
Salt ^a	4.70	0.30	5.44	0.40	< 0.0001
Seasoned Index ^b	1.22	0.04	1.20	0.03	ns
Colour Parameters					
L^*	60.24	3.73	56.44	5.29	0.023
a^*	13.06	1.15	12.42	0.86	ns
b^*	6.89	1.22	5.32	1.47	0.002

^a Values are means expressed as percentage; ^b Seasoned Index = Moisture/Protein

Table 2: Fatty acids and tocopherols content of dry cured »coppa«

Fatty acids [†]	Rearing system				P-value
	IN		OUT		
	mean	sd	mean	sd	
C14:0	1.20	0.11	1.15	0.08	ns
C16:0	22.63	1.34	22.45	0.67	ns
C16:1	2.39	0.31	2.12	0.18	0.047
C18:0	12.81	0.44	13.06	0.62	ns
C18:1	48.98	1.34	48.01	2.05	ns
C18:2 <i>n</i> -6	9.23	1.47	10.13	1.34	ns
C18:3 <i>n</i> -3	0.46	0.17	0.52	0.09	ns
C20:0	0.20	0.01	0.20	0.01	ns
C20:1	1.31	0.16	1.42	0.18	ns
C20:2 <i>n</i> -6	0.53	0.09	0.60	0.07	ns
C20:4 <i>n</i> -6	0.26	0.10	0.35	0.10	ns
SFA ^a	36.85	1.49	36.86	1.13	ns
MUFA ^b	52.68	1.47	51.54	2.29	ns
PUFA ^c	10.48	1.75	11.60	1.53	ns
PUFA/SFA	0.29	0.05	0.31	0.04	ns
<i>n</i> -6/ <i>n</i> -3	23.11	3.92	21.61	2.74	ns
Atherogenic Index	0.44	0.04	0.43	0.02	ns
Thrombogenic Index	1.12	0.08	1.11	0.05	ns
Tocopherols [†]					
α-tocopherol	2.13	0.23	2.38	0.41	ns
γ-tocopherol	0.18	0.04	0.12	0.05	ns

* Values are means expressed as percentage of total fatty acid methylesters; ^a SFA, total amount of saturated fatty acids; ^b MUFA, total amount of monounsaturated fatty acids; ^c PUFA, total amount of polyunsaturated fatty acids; [†] Expressed as mg kg⁻¹

while the γ-tocopherol content was lower in the OUT group despite its higher level in acorn (46.33 mg/kg) compared to commercial feed (0.75 mg/kg). According to recent findings (Pugliese *et al.*, 2009; Daza *et al.*, 2005), γ-tocopherol concentration in dry cured »coppa« seems to be related more to γ-tocopherol metabolism than the diet. In fact γ-tocopherol is metabolized largely to 2,7,8-trimethyl-2-(β-carboxyethyl)-6-hydroxychroman (γ-CEHC), which is mainly excreted in the urine. Catabolism of α-tocopherol appears to be quantitatively much less important than that of γ-tocopherol because urinary excretion of α-CEHC is lower than that of γ-CEHC. Both γ-tocopherol and γ-CEHC, but not α-tocopherol, inhibit cyclooxygenase activity and, thus, possess anti-inflammatory properties (Jiang *et al.*, 2001). Therefore, both a faster γ-tocopherol catabolism and a higher stress due to the *outdoor* system could explain the lower content of γ-tocopherol in dry cured »coppa« from the OUT group.

Nutritional values (Table 1) of dry cured »coppa«

from Nero Siciliano pig are very similar to those reported from different authors (Novelli *et al.*, 1992; Schivazappa *et al.*, 1997; Zanardi *et al.*, 2000; La Pietra *et al.*, 1998; Cengarle *et al.*, 2001).

Slight differences can be related to the anatomical structure of »coppa«, i.e. to the presence of various muscles separated by deposits of intermuscular fat (Novelli *et al.*, 1992; Schivazappa *et al.*, 1997), to the different seasoning period and to the technology production. IN and OUT groups showed a lower moisture and salt content if compared with dry cured »coppa« from northern Italy (Zanardi *et al.*, 2000), Campania (La Pietra *et al.*, 1998), Sardegna and Corsica (Cengarle *et al.*, 2001), with a Seasoned Index of 1.22 and 1.20 respectively. Furthermore, both groups showed a higher level of fat probably due to the breed-dependant ability to synthesize and accumulate large amount of lipids in their tissues (Ventanas *et al.*, 2008). In conclusion, even though dry cured »coppa« from Nero Siciliano reared *outdoors* showed better nutritional traits, both groups are characterized by a physico-chemical profile similar to other Italian dry cured »coppa«.

Based on these preliminary results, it could be argued that, as in Spanish system (*Montanera, Recebo, Cebo*), when natural resources are limited or not available, Nero Siciliano pigs could be reared *indoors* on commercial feed to produce a different label product (according to the feeding background), in order to satisfy the commercial demand of dry cured »coppa« all through the year.

4 ACKNOWLEDGMENT

Results presented in this paper are part of the scientific project «Characterization and traceability of meat and meat products from Nero Siciliano pig subjected to different feeding systems» investigations. The project (2008LYNTAF_003) has been financed by the Ministry of University and Scientific Research, Italy (Prof. Vincenzo Chiofalo).

5 REFERENCES

- Association of Official Analytical Chemists. 2007. Official Methods of Analysis of AOAC INTERNATIONAL (2007) 18th Ed., AOAC INTERNATIONAL, Gaithersburg, MD, USA, Official Method 2007.04
- Carballo J., Fernandez P., Barreto G., Solas M.T. and Jiménez Colmenero F. 1996. Characteristics of High- and Low-Fat Bologna Sausages as Affected-by Final Internal Cooking Temperature and Chilling Storage. *Journal of the Science of Food and Agriculture*, 72: 40–48
- Cengarle L., Tillica G., Carta A., Manca R., Pinna L., Marceddu M.F. 2001. Studio di alcuni parametri nutrizionali di salumi di provenienza sarda e corsa. *La Rivista di Scienza dell'Alimentazione*, 30, 2: 133–143
- Chiofalo V., Zumbo A., Liotta L., Chiofalo B. 2007. In vivo performance and carcass traits of Nero Siciliano pigs reared outdoors and in plain air. *Options Méditerranéennes, Series A*, 76: 39–42
- Christie W.W. 1993. Preparation of Ester Derivatives of fatty acids for chromatographic analysis. In: *Advanced in Lipid Methodology-Two*. Ed. The Oily Press LTD, Dundee, Scotland: 69–111
- Daza A., Rey A.I., Ruiz J., Lopez-Bote C.J. 2005. Effects of feeding in free-range conditions or in confinement with different dietary MUFA/PUFA ratios and α -tocopherol acetate, on antioxidants accumulation and oxidative stability in Iberian pigs. *Meat Science*, 69: 151–163
- Di Rosa A., Chiofalo V., Lo Presti V., Scianò S., Zumbo A. 2012. Influence of finishing diet on fatty acid profile in Psoas maior muscle of Nero Siciliano pig. *Options Méditerranéennes. Série A*, 101: 319–322
- Folch J., Less M., & Sloane G. H. 1957. A simple method for the isolation and purification of total lipids from animal tissues. *Journal of Biology and Chemistry*, 226:497–509.
- Jiang Q., Christen S., Shigenaga M.K and Ames B.N. 2001. γ -Tocopherol, the major form of vitamin E in the US diet, deserves more attention. *The American Journal of Clinical Nutrition*, 74: 714–722
- Jiménez-Colmenero F., Cofrades S., Herrero A.M., Fernández-Martín F., Rodríguez-Salas L., Ruiz-Capillas C. 2012. Konjac gel fat analogue for use in meat products: Comparison with pork fats. *Food Hydrocolloids*, 26: 63–72
- La Pietra L., Pirone G., Longo M., Diaferia C. 1998. Investigation into “capocollo”, a traditional product of Campania. *Industria Conserve*, 73: 117–122
- Liu Q., Scheller and Schaefer D.M. 1996. Technical Note: A Simplified Procedure For Vitamin E Determination in Beef Muscle. *Journal of Animal Science*, 74: 2406–2410
- Moretti V.M., Madonia G., Diaferia, Mentasti T, Paleari M.A., Panseri S., Pirone G., Gandini G. 2004. Chemical and microbiological parameters and sensory attributes of a typical Sicilian salami ripened in different conditions. *Meat Science*, 66: 845–854
- Novelli E., Parisini P., Delbono G., Sardi L., Dazzi G., Campanini G. 1992. Valutazione quanti-qualitativa delle caratteristiche merceologiche della coppa. *Annali della Facoltà di Medicina Veterinaria di Parma*, 12: 183–193
- Pugliese C., Calagna G., Chiofalo V., Moretti V.M., Margiotta S., Franci O., Gandini G. 2004. Comparison of the performances of Nero Siciliano pigs reared indoors and outdoors: 2. Joints composition, meat and fat traits. *Meat Science*, 68: 523–528
- Pugliese C., Sirtori F., D'Adorante S., Parenti S., Rey A., Lopez-Bote C., Franci O. 2009. Effect of pasture in oak and chestnut groves on chemical and sensorial traits of cured lard of Cinta Senese pigs. *Italian Journal of Animal Science*, 8: 131–142
- Schivazappa C., Virgili R., Soresi Bordini C. 1997. Indagine sulle caratteristiche funzionali e analitiche della coppa nazionale. *Industria Conserve*, 72: 13–18
- Ventanas S., Tejada J. F. and Estévez M. 2008. Chemical composition and oxidative status of tissues from Iberian pigs as affected by diets: extensive feeding v. oleic acid- and tocopherol-enriched mixed diets. *Animal*, 2(4): 621–630
- Vestergaard C., Erbou S.G., Thauland T., Adler-Nissen J., Berg P. 2005. Salt distribution in dry-cured ham measured by computed tomography and image analysis. *Meat Science*, 69: 9–15
- Zanardi E., Novelli E., Ghiretti G.P., Chizzolini R. 2000. Oxidative stability of lipids and cholesterol in Salame Milano, Coppa and Parma ham: dietary supplementation with vitamin E and oleic acid. *Meat Science* 55: 169–175
- Zullo A., Barone C.M.A., Colatruglio P., Diaferia C., Genovino G., Matassino D. 2007. Sensory evaluation of dry cured coppa in some swine autochthonous genetic types. *Options Méditerranéennes, Series A*, 76: 295–298
- Zumbo A., Di Rosa A., Furfaro M.E., Chiofalo V. 2012. Different feeding strategies for fattening phase in nero siciliano pigs: fat quality and carcass traits. *Emirates Journal of Food and Agriculture*, 24 Supplementary Issue74: 80