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Some aspects of meat production in pig autochthonous genetic types. II. Rheological and colorimetric characteristics of muscles[†]

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SUMMARY - The research was carried out on 51 pigs, 30 castrated males and 21 whole females, belonging to Calabrese (n=16), Cinta Senese (n=8) and Siciliano (n=27) autochthonous genetic types (AGT). The rheological characteristics were evaluated on muscle samples taken at dissection from the refrigerated carcass; the most important results showed that the genetic type, sex and muscle significantly affect almost all rheological characteristics considered. In particular: (i) in comparison with Siciliano, Calabrese provide more tender meat, which requires a lower chewing energy ($P<0.01$); furthermore, Calabrese meat has a lower springiness and is lighter than other two AGTs ($P<0.01-0.001$); (ii) the meat from castrated males is rheologically better than that obtained from females: it is lighter, more tender, less springy with a lower cohesiveness, hence with a lower chewiness value ($P<0.01-0.001$); and (iii) the muscles display a great histochemical individuality: PM is more tender and requires a lower chewing energy ($P<0.001$), even though it shows a higher adhesiveness value; on the contrary, the CLaTB is the "worst" muscle from a rheological point of view. As regards colorimetric characteristics, Ss is the "lightest" muscle, because of its higher reflectance percentage at any considered wavelength and lightness (L^*); it was followed, in decreasing order, by LD, PM, CLaTB and CLoTB; the last being the "darkest".

Key words: Pig, autochthonous genetic type, meat, rheological and colour characteristics.

RESUME - "Aspects de la production de viande de porcins autochtones. II. Caractéristiques de la structure et de la couleur des muscles". La recherche a été menée sur 51 porcins, dont 30 mâles castrés et 21 femelles entières, appartenant à des types génétiques autochtones (TGA) de Calabrese (n=16), Cinta senese (n=8) et Siciliano (n=27). Les caractéristiques rhéologiques et de couleur ont été relevées sur les échantillons de muscles [Caput longum tricipitis brachii (CLoTB), Caput latérale tricipitis brachii (CLaTB), Supraspinatus (Ss), Longissimus Dorsi (LD) et Psoas major (PM)] prélevés au moment du découpage de la demi-carcasse réfrigérée. Les résultats plus importants ont montré que le type génétique, le sexe et le muscle ont une influence significative sur la valeur de presque toutes les caractéristiques rhéologiques prises en considération. En particulier : (i) le Calabrese produit une viande significativement plus tendre et demande moins d'effort de mastication par rapport au Siciliano ($P<0,01$) ; en outre, la viande présente une résilience élastique inférieure et une plus grande luminosité (viande plus 'claire') par rapport aux deux autres TGA ($P<0,01-0,001$) ; (ii) le mâle castré, par rapport à la femelle entière, fournit une meilleure viande du point de vue rhéologique : plus claire, plus tendre, moins élastique, avec une valeur de cohésion inférieure et donc moins masticable ($P<0,05-0,001$) ; et (iii) le muscle présente une forte individualité histochimique : le PM est le plus tendre et exige moins d'effort de mastication ($P<0,001$), bien qu'il présente une valeur d'adhésion élevée ; vice versa, le CLaTB est le moins bon des muscles du point de vue rhéologique, par contre comme couleur le Ss est le muscle le plus 'clair' grâce à un pourcentage plus élevé de réflectance vis-à-vis des différentes longueurs d'onde considérées et de luminosité (L^*), celui-ci est suivi par le LD, le PM, le CLaTB et, enfin, le CLoTB qui est le plus 'foncé'.

Mots-clés : Porc, types génétiques autochtones, viande, caractéristiques rhéologiques et de couleur.

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Introduction

In the context of rural integral development, according to the concept of sustainable agriculture, autochthonous genetic resources play a critical and irreplaceable role, especially in the light of ongoing progress in human welfare. Autochthonous animal germplasm must be increasingly considered for its irreplaceable role to solve issues related to human nutrition, whose major objective is the achievement of nutritional goals dynamic in space and time (Matassino *et al.*, 1993; Matassino, 1997). Therefore, it is necessary to define the quality of meat obtained from autochthonous genetic types (AGTs) in order to identify a set of peculiarities useful for the characterization of products to be called "typical". In this paper the effect of genetic type, sex and muscle on some rheological and colorimetric characteristics of raw meat will be evaluated.

Material and methods

The research was carried out on 51 pigs, 30 castrated males (CM) and 21 whole females (WF) belonging to Calabrese (n=10 CM and 6 WF), Cinta Senese (n=6 CM and 2 WF) and Siciliano (n=14 CM and 13 WF) autochthonous genetic types (AGT). The animals were slaughtered at 171 ± 6 kg mean live weight. The rheological and colorimetric characteristics were evaluated using texturometer (Matassino *et al.*, 1976) and spectrophotometer Hitachi U3000 at 4 light sources (illuminant A, B, C, and D65), respectively, on muscle samples [*Caput longum tricipitis brachii* (CLoTB), *Caput laterale tricipitis brachii* (CLaTB), *Supraspinatus* (Ss), *Longissimus Dorsi* (LD) and *Psoas major* (PM)], taken at dissecting from the right half-carcass refrigerated for 72 hours at 4°C. The statistical analysis was performed using the following model of variance analysis where genetic type (α_i), sex (β_j), muscle (γ_k) and their interaction were fixed factors and the effect of each was expressed as deviation from the general average μ :

$$y_{ijkl} = \mu + \alpha_i + \beta_j + \gamma_k + (\alpha\beta)_{ij} + (\alpha\gamma)_{ik} + (\beta\gamma)_{jk} + e_{ijkl}$$

The significance of differences among the means estimated by the above cited model was established by Student's *t* test.

Results and discussion

The results showed that genetic type, sex and muscle significantly affect almost all rheological and colorimetric characteristics considered. The analysis model explains about 70% of the total variability for hardness, chewiness and lightness (L^*), 50% for red index and 40% for yellow index as well as for chrome and hue; the muscle is responsible for over 80% of variability. The behaviour of genetic types, sex and muscles as regards colorimetric characteristics show no variations depending on light source.

By examining estimated means and significant comparisons (Table 1 and 2), it emerges that on average:

(i) In comparison with Siciliano, Calabrese provides a significantly more tender meat, which requires a less chewing energy ($P < 0.01$); in addition, it shows lower springiness, higher lightness, a greater colour saturation (chrome) and a higher hue compared to the other two AGTs ($P < 0.01$ - 0.001).

(ii) The meat from castrated male is "lighter" and better from a rheological point of view, compared with that obtained from whole female: it is more tender, less springy, with less value of cohesiveness and chewiness ($P < 0.05$ - 0.001).

(iii) The muscles show strong individuality: the PM is the most tender muscle and requires less chewing energy ($P < 0.001$), although it is characterized by a high adhesiveness; conversely, CLaTB is worse from a rheological point of view; Ss is the "lightest" muscle because of its higher reflectance percentage at any considered wavelength and higher lightness (L^*); it was followed, in decreasing order, by LD, PM, CLaTB and CLoTB which is "darker"; nevertheless, this classing was not confirmed for all genetic types because of a significant interaction between these two factors for lightness and hue values. This behaviour could be due to the higher reflectance percentage and lightness in CLaTB muscle compared to PM in Siciliano and Calabrese; the opposite behaviour was observed in Cinta Senese.

Table 1. Estimated mean value (m) and variation coefficient (cv.,%) of rheological characteristics and significant[†] comparisons between the factor levels

Factor	Rheological characteristics									
	Hardness		Cohesiveness		Springiness		Adhesiveness		Chewiness	
	m	cv. (%)	m	cv. (%)	m	cv. (%)	m	cv. (%)	m	cv. (%)
Genetic type										
Calabrese	1.98 ^a	61	0.53	16	12.60 ^a	9	5.10	123	1355 ^a	67
Cinta senese	2.09 ^{ab}	63	0.53	12	13.21 ^b	10	5.20	112	1515 ^{ab}	70
Siciliano	2.18 ^b	60	0.54	14	12.89 ^c	11	6.29	150	1561 ^b	68
Sex										
Castrated male	1.93 ^a	60	0.54 ^a	13	12.79	10	5.15	116	1388 ^a	67
Whole female	2.23 ^b	61	0.52 ^b	16	13.01	10	5.91	164	1566 ^b	70
Muscle										
ClaTB	3.17 ^a	28	0.57 ^a	11	12.53 ^a	8	1.76 ^a	217	2399 ^a	35
CloTB	2.90 ^b	28	0.54 ^{bd}	18	12.82 ^a	10	1.73 ^a	175	1993 ^b	38
Ss	1.02 ^c	44	0.50 ^c	15	12.50 ^a	9	3.02 ^a	104	640 ^c	47
LD	2.65 ^d	30	0.53 ^d	12	14.03 ^b	10	11.27 ^b	67	2003 ^{bd}	37
PM	0.67 ^e	87	0.52 ^{cd}	11	12.62 ^a	6	9.87 ^{bc}	109	450 ^c	103

[†]Different letters within each factor indicate significant level of $P < 0.05$

Table 2. Estimated mean value (m) and variation coefficient (cv.,%) of colour characteristics and significant[†] comparisons between the factor levels

Factor	Colour characteristics (Illuminant A)									
	Lightness (L*)		Red index (a*)		Yellow index (b*)		Chrome		Hue	
	m	cv. (%)	m	cv. (%)	m	cv. (%)	m	cv. (%)	m	cv. (%)
Genetic type										
Calabrese	37.7 ^a	25	17.4 ^a	14	9.5 ^a	22	19.9 ^a	15	28.6 ^a	15
Cinta senese	34.9 ^b	19	16.3 ^b	13	8.6 ^b	17	18.5 ^b	13	27.7 ^b	11
Siciliano	34.9 ^b	13	17.0 ^a	20	8.9 ^b	22	19.2 ^c	14	27.5 ^b	12
Sex										
Castrated male	36.4 ^a	23	17.0	14	9.0	21	19.3	14	27.9	13
Whole female	35.4 ^b	22	16.8	13	8.9	19	19.1	13	27.9	12
Muscle										
ClaTB	32.2 ^a	9	17.8 ^a	7	9.0 ^{ab}	16	20.0 ^a	9	26.6 ^a	9
CloTB	30.0 ^b	10	17.3 ^a	8	8.5 ^b	15	19.3 ^a	9	26.1 ^a	8
Ss	48.5 ^c	15	14.5 ^b	20	9.3 ^a	27	17.2 ^b	21	32.3 ^b	12
LD	36.4 ^d	12	17.5 ^a	12	9.3 ^a	23	19.8 ^a	14	27.8 ^c	11
PM	32.3 ^d	12	17.5 ^a	9	8.8 ^{ab}	14	19.7 ^a	10	26.7 ^a	7

[†]Different letters within each factor indicate significant level of $P < 0.05$

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