INFLUENCE OF PIG FARM ON FERROCHELATASE ACTIVITY IN FRESH HAM AND ZINC PROTOPORPHYRIN IN MATURED HAMS

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I. INTRODUCTION

Colour has been reported as a key sensory property in influencing consumers' perception of dry-cured ham quality and on purchasing decision. Zinc protoporphyrin (ZnPP) is the natural purple-red pigment occurring in nitrite-free dry-cured ham [1]. Synthesis of ZnPP has been supposed to be enzymatic and the meat-inherent mitochondrial Ferrochelatase (FeCH) (EC:4.99.1.1) is considered to some extent responsible for ZnPP formation in matured ham [2]. The aim of our study was to investigate the variability of FeCH activity in fresh hams from Italian heavy pigs and its role in ZnPP generation and colour development in dry-cured hams.

II. MATERIALS AND METHODS

A total of 195 left hams (weight range 13.0 – 15.0 kg, pH_{48h} range 5.5 - 6.0), coming from 9 months aged pigs belonging to three Italian farms identified as F1, F2, and F3, characterized by specific genetics (Duroc × Large White in F1 and F2, (Duroc × Large White) × (Large White × Landrace) in F3), feeding and management of the animals, were analyzed. FeCH activity was tested in a sample of *Semimembranosus* (SM) muscle of fresh hams (approx. 50 g), taken 48h after slaughter and kept at -80 °C until analysis, by measuring the insertion of Zn(II) into Protoporphyrin IX to form ZnPP [3]. Fresh hams were processed in the same plant, and the ZnPP content of the 15 months aged dry-cured hams (central slice without fat) was analysed by HPLC [3] with an Agilent 1200 apparatus, equipped with a fluorescence detector (ex/em 420/590 nm), a Waters X-Terra™ C18 column (250 × 4.6 mm, 5 µm), and isocratic elution using methanol:ammonium acetate 1 M, pH 5.16 (84:16, v/v) (flow rate 0.6 mL/min). Standard solutions were prepared by dissolving ZnPP (Sigma-Aldrich) in N,N-dimethylformamide, and diluting in methanol/ammonium acetate. Colorimetric indices CIE a* and Hue angle were measured in matured hams (SM and *Biceps femoris* (BF) muscles) with a Minolta CM-700d reflectance spectrophotometer equipped with a Xenon light source (illuminant D65). Statistics. Frequency distribution of FeCH activity and differences in ham traits between farms were performed by means of One-Way ANOVA with the Tukey multiple test (SPSS 28.0 software).

III. RESULTS AND DISCUSSION

The variation in FeCH activity of fresh hams is presented in Fig. 1. The values ranged from 3.0 to 138.2 nmol ZnPP min^{-1} 100 g^{-1} dry weight, with a large variability (CV = 68.3%). The shape of the data frequency distribution curve is slightly skewed on the right (skewness = 0.950). To explore the role of the farm in affecting the variability detected in FeCH activity, the hams belonging to F1, F2, and F3 were compared. As shown in Table 1, the enzyme activity differed significantly, i.e. F3 was the highest ($P < 0.001$), while F2 was higher than F1 ($P < 0.05$). In the present study, at the end of maturing, the highest level of ZnPP was found in dry-cured hams of F3 group ($P < 0.001$), characterized by a redder colour of SM and BF muscles (Table 1). Therefore, the higher the FeCH activity in the fresh hams, the higher the ZnPP and the redness in matured hams.

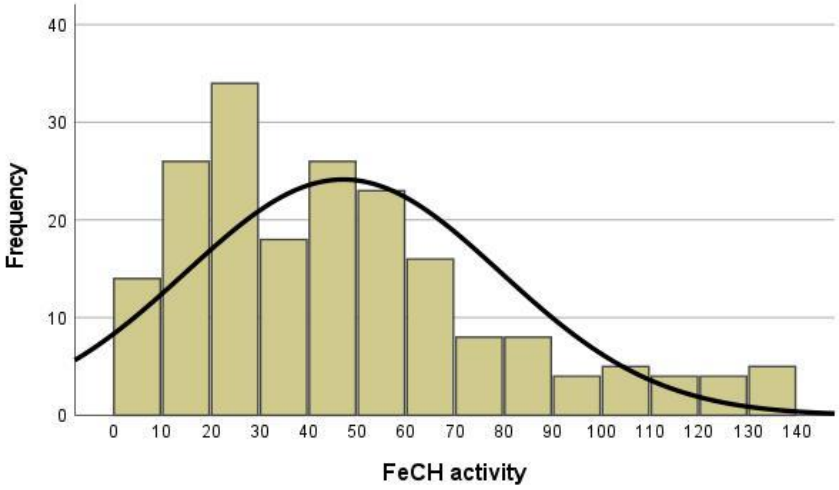

Figure 1. Frequency distribution of the FeCH activity (nmol ZnPP min^{-1} 100 g^{-1} dry weight) of fresh SM muscle.

Table 1. Comparison (One-Way ANOVA) between parameters measured on fresh (FeCH activity) and matured hams (ZnPP and colorimetric indices) coming from pigs belonging to three farms (F1, F2, F3).

Parameters	Farm			P value
	F1 (n. 63)	F2 (n.68)	F3 (n.64)	
Ferrochelatase (nmol ZnPP min^{-1} 100 $g^{-1}_{dry\ weight}$)	30.4^{c}	45.3^{b}	65.0^{a}	< 0.001
Zinc protoporphyrin (mg kg^{-1})	28.4^{b}	26.5^{b}	33.8^{a}	< 0.001
a* SM	10.7^{b}	10.7^{b}	11.3^{a}	< 0.001
Hue angle SM	39.5^{a}	39.4^{a}	36.6^{b}	< 0.001
a* BF	10.8^{b}	10.4^{b}	11.9^{a}	0.002
Hue angle BF	44.9^{a}	46.2^{a}	42.7^{b}	< 0.001

a*: redness (<0 = green and >0 = red); Hue angle: 0 ° = red, 90 ° = yellow, 180 ° = green, and 270 ° =blue, measured on the surface of the *Semimembranosus* (SM) and *Biceps femoris* (BF) muscles.
Values followed by a different letter in the same row show significant differences in the Tukey test (P < 0.05).

CONCLUSION

The results indicate that the supplying farms, when differing in the FeCH activity of fresh hams, influence the development of ZnPP and the instrumental colour of the dry-cured hams. In perspective, the main factors involved in swine production and ham processing should be analyzed for their role in the distribution and amount of pigments that determine the colour of dry-cured hams.

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