REARING PRACTICES AND CARCASS AND MEAT PROPERTIES: A CLUSTERING APPROACH IN PDO MAINE-ANJOU COWS

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Abstract – Through a multivariate statistical approach, 110 PDO "*Protected Designation of Origin*" Maine-Anjou cull cows were grouped into three clusters on the basis of rearing practices data. The clusters showed differences in carcass, muscle and meat properties, without effect on meat tenderness of *Longissimus thoracis* (LT) muscle. The LT of the animals raised on pasture (with high physical activity) showed greater proportions of IIA fibers at the expense of the fast IIX ones. Accordingly, the meat of these animals was darker. In conclusion, pasture-based cattle farming may be more effective in terms of quality and from an economic point of view for the breeders.

Key Words – Production system, PDO Maine-Anjou cows, Meat, Sensory and technological Quality.

I. INTRODUCTION

French suckler herd provides two-third of the beef consumed in France, and is the main European supplier of weanling cattle [1]. In France, the produced beef comes from various types of animals, of different breeds and ages, which have been reared and finished using different rearing practices. Thus, the beef producers are seeking better marketing options through efficient beef production systems. These would help determine which rearing practices and animal traits, as well as live-animal performance and carcass characteristics, need to be improved to reach the desired target market specifications. Hence, this work aimed to use data concerning the life information and finishing practices of PDO Maine-Anjou cows to define groups and to study the differences in their carcass, muscle and meat properties.

II. MATERIALS AND METHODS

A total of 110 French PDO Maine-Anjou cows were used. The rearing practices of each animal were recorded by a survey [2]. The questionnaire included information about the finishing period (part of hay, haylage and/or grass in the finishing diet (% w/w); amount of concentrate; duration (days); physical activity (% days out)) and the animal characteristics (Animals with meat or milk-ability; birth season ; birth weight (kg); age of weaning (month); weaning duration (week); age of first calving; number of calving; suckling value (0-10) and age at slaughter). After slaughter, information for each carcass were measured: hot carcass weight (HCW, kg), conformation (EUROP grid), 6th rib characterization by *Longissimus* muscle weight, muscle weight, rest of muscle weight, carcass fat and bone weights. Samples from LT muscle were excised 24 h after slaughter for the quantification by Dot-Blot of 22 protein biomarkers of tenderness [3, 4] and by electrophoresis of myosin heavy chains [3], color measurement [4], tenderness measurements by trained sensory panel and Warner-Bratzler shear force measurements [3]. The statistical analyses were conducted using principal component analysis (PCA) by the projection of the variables related to the finishing period and to animal characteristics. Afterwards, a *K*-means cluster analysis (k = 3) via the variability explained by all the PCs having eigenvalues > 1.0, allowed the clustering of the animals on classes. Then, these have been projected on a new PCA and a variance analysis (SAS 9.2) was used to compare the classes for carcass, muscle and meat quality traits.

III. RESULTS AND DISCUSSION

The adopted statistical approach grouped the animals into three classes (Figure 1a and Table 1). The ***class 1*** (C1) grouped the young and light cows finished mainly with hay, moderately active, with low calving and milking ability. The ***class 2*** (C2) was very different from C1, grouped old and heavy cows finished under grass diet, with greater activity, calving and milking ability. The ***class 3*** (C3) grouped old and light cows finished with haylage, with low activity and high calving and milking ability. The carcass characteristics of C2 were very different. Its animals have high carcass conformation, as well as carcass, muscle and carcass fat weights

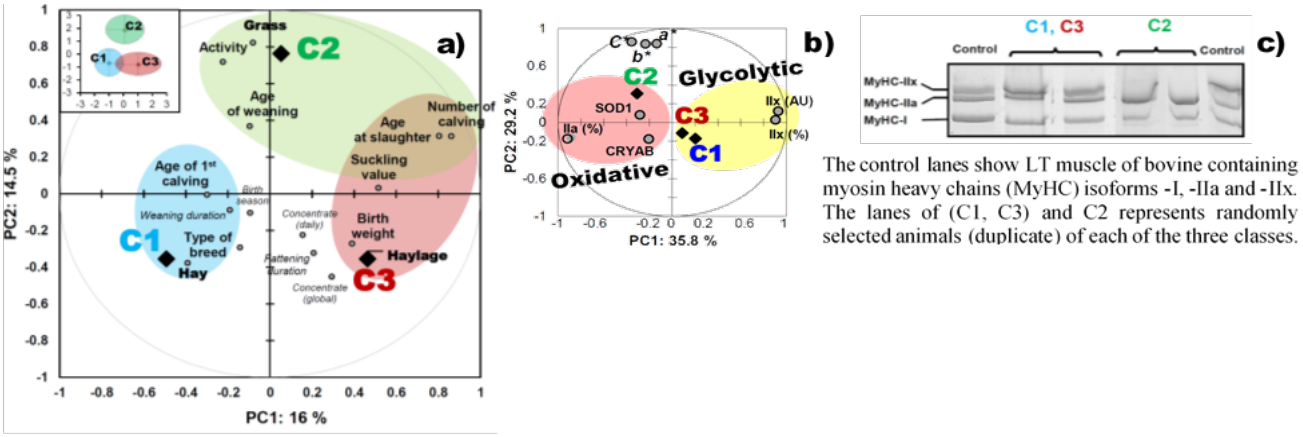

Figure 1. Loading and score plots (a) of the variables used to discriminate between the 110 cows. The classes 1-3 (ellipses of the insert at the upper left corner of PCA) were highlighted in blue, green and red respectively. The variables in bold character are significantly different (P<0.05) between classes and those in italic are not different. (b) Projection of the variables related to muscle and meat quality that were significantly different between classes. (c) Illustration of the electrophoretic separation of MyHC fibers from the animals corresponding to each cluster and showing the differences in the proportions of MyHC-IIA and –IIX between classes.

Also, the animals of C2 have higher proportions of oxidative fibers (IIA) at the expense of II X fibers as previously reported in cattle [5] (Table 1 and Figure 1b,c). Accordingly, the abundances of SOD1 and αB-crystallin were the highest for C2, in line with its metabolic properties. Earlier studies reported higher content of these proteins in oxidative muscles [3, 6]. This may be due to the grass diet and physical activity of the animals, related to the suckling properties of the animals of this cluster, allowing hence intermediate rather than fast contractile properties. Thus, C2 may be ranked as oxidative and C1, C3 as glycolytic (Figure 1b). No difference was found for meat tenderness, but meat color (a*, b* and C*) was significantly different. As expected, the meat of the animals raised on pasture was darker, in agreement to earlier reports [7]. Pasture-based cattle farming may be economic for the farmers.

Table 1. Differences between the three classes.

Variables[1]	**Class 1** (n=44)	**Class 2** (n=30)	**Class 3** (n=36)	SEM	p-value[2]
Variables related to carcass characteristics					
HCW (kg)	427^{b}	459^{a}	435^{b}	3.46	***
Carcass conformation	4.8^{a,b}	5.1^{a}	4.5^{b}	0.08	*
Weight of LT muscle (kg)	3.76^{a,b}	4.07^{a}	3.45^{a,b}	7.57	**
Muscle weight (kg)	18.72^{a,b}	20.26^{a}	17.73^{b}	38.6	*
Carcass fat weight (kg)	5.59^{b}	6.50^{a}	5.53^{b}	18.2	*
Variables related to muscle characteristics					
SOD1 (arbitrary units)[3]	94^{b}	119^{a}	96^{b}	3.63	*
αB-crystallin (AU)	211^{b}	253^{a}	217^{b}	8.04	*
MyHC-IIx (AU)	97^{a}	78^{b}	92^{a}	2.63	*
MyHC-IIx (%)	14.5^{a}	6.9^{b}	13.8^{a}	1.34	*
MyHC-IIa (%)	55.0^{b}	61.2^{a}	54.8^{b}	1.22	*
Variables related to meat quality traits					
Redness (a*)	8.62^{b}	9.27^{a}	8.67^{b}	0.12	*
Yellowness (b*)	7.03^{b}	8.31^{a}	7.24^{b}	0.14	***
Chroma (C*)	11.2^{b}	12.5^{a}	11.3^{b}	0.18	**

[1] Only the variables that were significantly different are shown; [2] *: P < 0.05; **: P < 0.01; ***: P < 0.001; [3] Superoxide dismutase 1 in AU.

IV. CONCLUSION

This work allowed to separate among PDO Maine-Anjou cows, animals according to their characteristics and rearing practices. Old cows raised mainly on pasture have better carcass and color characteristics, while having an equivalent tenderness to those finished with hay or haylage.

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