Rearing practices and carcass and meat properties: a clustering approach in PDO Maine-Anjou cows

Mohammed Gagaoua, Brigitte Picard, S. Couvreur, G. Le Bec, G. Aminot, Valérie Monteils

Rearing practices and carcass and meat properties: a clustering approach in PDO Maine-Anjou cows

Conference Paper · August 2017

CITATIONS
4

READS
119

6 authors, including:

Mohammed Gagaoua
French National Institute for Agriculture, Food, and Environment (INRAE)
252 PUBLICATIONS **6,039** CITATIONS
SEE PROFILE

Brigitte Picard
French National Institute for Agriculture, Food, and Environment (INRAE)
523 PUBLICATIONS **11,711** CITATIONS
SEE PROFILE

Sébastien Couvreur
Groupe ESA Higher education and research in life sciences
75 PUBLICATIONS **1,269** CITATIONS
SEE PROFILE

Valérie Monteils
VetAgro Sup
102 PUBLICATIONS **1,899** CITATIONS
SEE PROFILE

2017
CORK IRELAND
ICoMST
63rd INTERNATIONAL CONGRESS OF MEAT SCIENCE & TECHNOLOGY

Nurturing Locally, Growing Globally



63rd INTERNATIONAL CONGRESS OF MEAT SCIENCE AND TECHNOLOGY



edited by:
Declan Troy
Ciara McDonnell
Laura Hinds
Joseph Kerry

63rd International Congress of **Meat Science** and **Technology**

NURTURING LOCALLY, GROWING GLOBALLY

edited by:

Declan Troy
Ciara McDonnell
Laura Hinds
Joseph Kerry

Wageningen Academic
P u b l i s h e r s

EAN: 9789086863136
e-EAN: 9789086868605
ISBN: 978-90-8686-313-6
e-ISBN: 978-90-8686-860-5
DOI: 10.3921/978-90-8686-860-5

First published, 2017

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

M. Gagaoua[1*], B. Picard[1], S. Couvreur[2], G. Le Bec[2], G. Aminot[3] and V. Monteils[1]

[1]*UMR1213 Herbivores, INRA, VetAgro Sup, Clermont université, Université de Lyon, 63122 Saint-Genès-Champanelle, France;* [2]*URSE, Université Bretagne Loire, Ecole Supérieure d'Agricultures (ESA), 55 rue Rabelais, BP 30748, 49007 Angers Cedex, France;* [3]*S.I.C.A. Rouge des Prés, Domaines des rues, 49220 Chenillé-Champteussé, France;* mohammed.gagaoua@inra.fr

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

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.

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.

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

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.

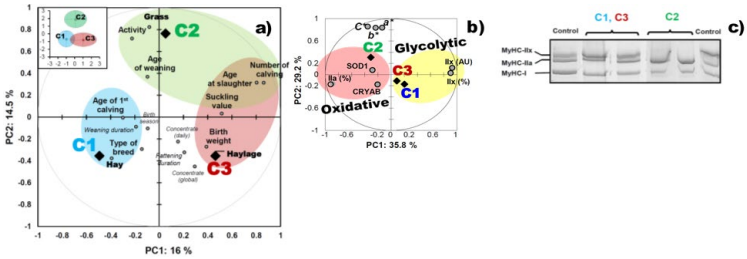


Figure 1. Loading and score plots (a) of the variables used to discriminate between the 110 cows. The classes 1-3 (ellipses of the insert at the upper left corner of PCA) were highlighted in blue, green and red respectively. The variables in bold character are significantly different ($P<0.05$) between 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.

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.

CONCLUSIONS

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.

REFERENCES

1. Veysset, P., Lherm, M., Roulenc, M., Troquier, C., & Bébin, D. (2015). Productivity and technical efficiency of suckler beef production systems: trends for the period 1990 to 2012. *Animal*, 9: 2050-59.
2. Couvreur, S., Le Bec, G., Micol, D., Aminot, G., Picard, B. (2013). PDO Maine-Anjou Culled cow characteristics and finishing practices influence meat quality. *In*: 20èmes *Rencontres Recherches Ruminants* (p. 165-168), Paris.
3. Picard, B., Gagaoua, M., Micol, D., Cassar-Malek, I., Hocquette, J. F., & Terlouw, E. C. (2014). Inverse relationships between biomarkers and beef tenderness according to contractile and metabolic properties of the muscle. *Journal of Agricultural and Food Chemistry*, 62: 9808-9818.
4. Gagaoua, M., *et al.*. (2015). Understanding early post mortem biochemical processes underlying meat color and pH decline in the *Longissimus thoracis* muscle of young blond d'Aquitaine bulls using protein biomarkers. *J Agric Food Chemistry,* 63: 6799-6809.
5. Jurie, C., Ortigues-Marty, I., Picard, B., Micol, D., & Hocquette, J. F. (2006). The separate effects of the nature of diet and grazing mobility on metabolic potential of muscles from Charolais steers. *Livestock Science*, 104: 182-192.
6. Hollander, J., Fiebig, R., Gore, M., Bejma, J., Ookawara, T., Ohno, H., & Ji, L. L. (1999). Superoxide dismutase gene expression in skeletal muscle: fiber-specific adaptation to endurance training. *American Journal of Physiology-Regulatory*, 277: R856-R862.
7. Dunne, P. G., Monahan, F. J., & Moloney, A. P. (2011). Current perspectives on the darker beef often reported from extensively-managed cattle: Does physical activity play a significant role? *Livestock Science*, 142: 1-22.

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

M. GAGAOUA[1]*, B. PICARD[1], S. COUVREUR[2], G. LE BEC[2], G. AMINOT[3], and V. MONTEILS[1]

Background

Meat comes from various types of animals which have been managed and finished using different rearing practices.

Beef producers are seeking better marketing options through efficient beef production systems.

There is a need to use high-throughput technologies for joint management of carcasses and meat quality.

Aim

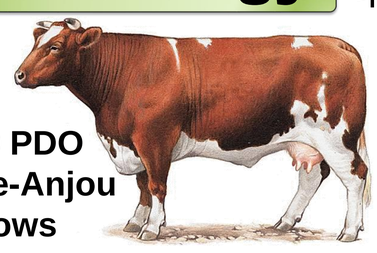
Use of an innovative statistical approach to classify PDO Maine-Anjou cows according to their rearing practices:

⬇

to seek for differences and consistencies on carcass, muscle/biomarkers and meat quality traits.

Methodology

-Rearing practices data were recorded by a survey :



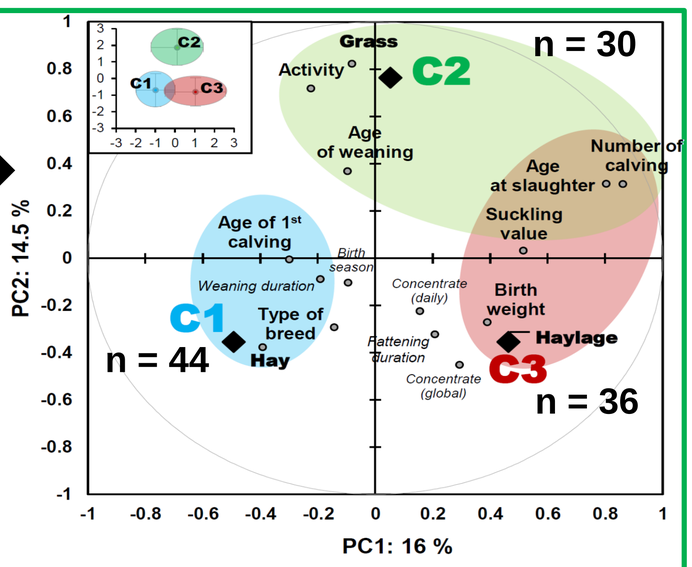
110 PDO Maine-Anjou cows

Finishing period ✚ **Animal characteristics**

Part of hay, haylage and/or grass in the finishing diet;
Amount of concentrate;
Finishing duration;
Physical activity (% days out)

Meat or dairy;
Birth season;
Birth weight;
Age of weaning;
Weaning duration;
Age of first calving;
Number of calving;
Suckling value
Age at slaughter

"PCA – *K*-means" statistical approach for cows clustering



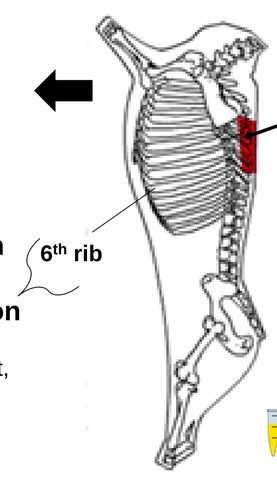
Graph 1

"**Hay**", "**Grass**" and "**Haylage**" rearing practice classes after PCA – *K*-means clustering. The variables in bold character are significantly different ($P<0.05$) between classes and those in italic are not different.

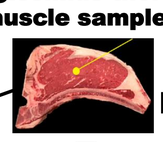
Carcass quality

Hot carcass weight
EUROP conformation

6th rib characterization
Whole ribeye weight
Longissimus muscle weight,
Muscle weight,
Rest of muscle weight,
Carcass fat weight
Bone weight

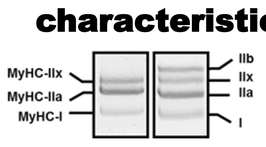


***Longissimus thoracis* muscle samples**



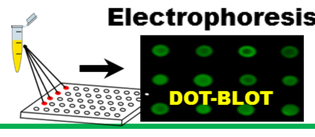
Meat quality

Muscle characteristics



Fibers

Electrophoresis



Biomarkers

Warner-Bratzler shear force
Sensory traits :
Tenderness
Juiciness
Beef flavor
Overall liking

Meat color
L, a*, b*, C*, h**

Ultimate pH
Intramuscular fat

GLM (SAS 9.1) & Tukey test for LSMeans comparisons

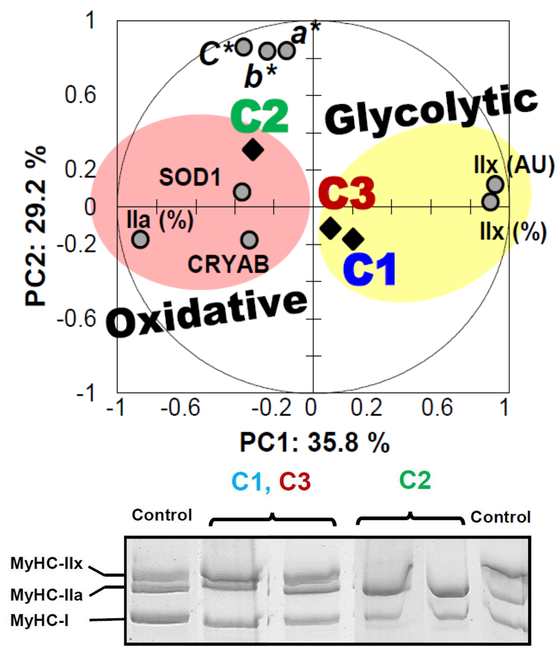
Results

The 110 PDO "Protected Designation of Origin" Maine-Anjou cull cows were grouped into three clusters on the basis of rearing practices data using an innovative statistical approach (**Graph 1**).

➔ Animals of "**Grass**" class have high carcass conformation, as well as hot carcass, ribeye, muscle and fat carcass weights (**Table 1**).

➔ Due to high physical activity, the animals of "**Grass**" class have higher proportions of oxidative (IIA) at the expense of IIX fibers (**Graph 1**).

Graph 2



Biomarkers discriminate between rearing practices (Graph 2)

"**Grass**" class
➔ Higher MyHC-IIA, Superoxide dismutase (SOD1) and CRYAB
➔ Lower MyHC-IIX (quantified by SDS-PAGE and DOT-BLOT)

Grass rearing practice gives better meat color characteristics
➔ As expected the meat of the animals raised on pasture was darker

Table 1. Significant differences between the three rearing practices class.

Variables	Class 1 "Hay"	Class 2 "Grass"	Class 3 "Haylage"	SEM	*p*-value[1]
Variables related to carcass characteristics					
Hot carcass weight (kg)	427[b]	459[a]	435[b]	3.46	***
EUROP Carcass conformation	4.8[a,b]	5.1[a]	4.5[b]	0.08	*
Weight of the whole ribeye (g)	2956[b]	3333[a]	2903[b]	61,10	**
Weight of *Longissimus* muscle (kg)	3.76[a,b]	4.07[a]	3.45[a,b]	7.57	**
Muscle carcass weight (kg)	18.72[a,b]	20.26[a]	17.73[b]	38.6	*
Fat carcass weight (kg)	5.59[b]	6.50[a]	5.53[b]	18.2	*
Variables related to muscle characteristics					
SOD1 (arbitrary units (AU))	94[b]	119[a]	96[b]	3.63	*
αB-crystallin (*CRYAB*) (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	**
Hue angle (h*)	38.9[b]	12.5[a]	11.3[b]	0.18	**

[1] *: $P < 0.05$; **: $P < 0.01$; ***: $P < 0.001$

For the three classes no differences were found for :

➔ Tenderness, juiciness, beef flavor and overall liking

➔ Intramuscular fat content and ultimate pH

Conclusion

PCA – *K*-means approach separated, 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, juiciness and flavor to those finished with hay or haylage.

Pasture-based cattle farming may be economic for the farmers.

* Correspondence: mohammed.gagaoua@inra.fr ; gmber2001@yahoo.fr
[1] UMR1213 Herbivores, INRA, VetAgro Sup, Clermont université, Université de Lyon, 63122 Saint-Genès-Champanelle, France
[2] URSE, Université Bretagne Loire, Ecole Supérieure d'Agricultures (ESA), 55 rue Rabelais, BP 30748, 49007 Angers Cedex, France
[3] S.I.C.A. Rouge des Prés, Domaines des rues, 49220 Chenillé-Champteussé, France