Effects of Dexamethasone on meat quality of Friesian bulls

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Abstract — **This study investigate the effects of illegal administration of Dexamethasone on meat quality of Friesian bulls. Twenty finishing Frisian bulls (initial LW=440±53.4 and age=387±36.9 days), were randomly divided into three groups: HD (n=6), LD (n=6) and C (n=8). The HD and LD groups were respectively administered 1.4 and 0.7 mg head/d of oral dexamethasone-21-sodium-phosphate for 60 days and slaughtered after a suspension period of 26 days. The third group (C) served as control. Samples of m. *longissimus thoracis* and *lumborum* were taken in order to evaluate: meat color, thawing loss, WB peak and break on cooked meat, drip and cooking losses, meat cooking shrinkage (MCS), MCS cooking and cooling losses, WHC total and halo area and WHCtrend. The treated groups showed a significant lower thawing loss (HD:7.0^{ab}, LD:5.6^{a}, C:7.2^{b} %), WB peak (HD:78.8^{aA}, LD:94.1^{a}, C:114.8^{bB} N) and break (HD:66.4^{aA}, LD:83.9^{b}, C:97.5^{bB} N); the meat was lightish (HD:38.5^{a}, LD:37.1^{ab}, C:35.6^{b}), reddish (HD:24.8^{AB}, LD:25.4^{A}, C:24.0^{B}), yellowish (HD:8.7^{a}, LD:8.7^{a}, C:7.7^{b}), higher chrome (HD:26.7^{a}, LD:26.8^{a}, C:25.2^{b}) and hue (HD:0.33^{a}, LD:0.33^{a}, C:0.31^{b}); MCS was lower in control group (HD:20.9^{ab}, LD:22.8^{a}, C:19.5^{b} %). The Canonical Discriminant Analysis shows a significant separation between control and treated groups due to thawing loss, red-green index (a*), WB break, cooking loss mcs. The illegal use of Dexamethasone positively influenced some meat quality traits, making the meat more attractive to consumers.**

Keywords— **Beef, Dexamethasone, Quality.**

I. INTRODUCTION

Whilst the use of illegal hormones in farm animals is known to increase the efficiency of meat production [1], the use of such compounds within the European Union has been prohibited (Directive 88/146/EEC) since the late 1980s [2].

Glucocorticosteroids are widely used in buiatrics to limit inflammatory processes that otherwise would significantly contribute to pathology, prolong recovery time, and compromise animal welfare [3, 4]. Dexamethasone is a potent synthetic analogue of hydrocortisone, illegally used in association with anabolic steroids as growth promoters in veal calves and beef production, in order to improve quality and quantity of meat [5, 6, 7, 8).

In the European Union, some corticosteroids are permitted for therapeutic use in livestock. However, the use of corticosteroids is regulated by the Commission Regulation (EEC) N° 37/2010 [8], which sets maximum residue limits (MRLs) for betamethasone, dexamethasone, methylprednisolone and prednisolone. The member states are required to monitor the use of pharmacologically active substances in animals used for the production of food for human consumption. They must follow the indications of Council Directive 96/22/EC [9], which was amended by Directive 2003/74/EC [10] and 96/23/EC [11].

Due to the economic benefits that can be gained from the use of illegal growth promoters in beef cattle, producers continue in their illegal administration [12]. Recent surveys revealed that dexamethasone is often present, at detectable concentrations, in the liver of slaughtered animals [13, 14, 15].

Studies, that have been performed to assess the effects of non-therapeutic dexamethasone use on beef quality and slaughter performance have provided conflicting evidence concerning the effects of dexamethasone on the growth rate in cattle and meat quality.

In the last 10 years, farmers have progressively reduced the dosages of illegal administration of these drugs to avoid the penalties of the public veterinary services.

Such changes in hormone abuse have highlighted the need for developing new techniques to improve the detection of growth promoter use during meat production. Illegal treatments are used in different

categories of animals, and in particularly to improve performance of male Friesian bulls.

Meat tenderness, colour, marbling, flavour and juiciness are qualitative parameters that influence consumer's decisions to purchase meat. Italian Friesian male cattle are animals whose aptitude is not to produce meat; for this reason using illegal treatment could be a desirable motivation for the breeders.

This study was conducted to determine the effects of an administration of low doses of Dexamethasone on few meat quality traits of Italian Friesian male cattle.

II. MATERIALS AND METHODS

Twenty finishing Frisian bulls (initial LW=440±53.4 and age=387±36.9 days), were randomly divided into three groups: Higher Dexamethasone (HD n=6), Lower Dexamethasone (LD n=6) and Control (C n=8). The HD and LD groups were respectively administered 1.4 and 0.7 mg head/d of oral dexamethasone-21-sodium-phosphate for 60 days and slaughtered after a suspension period of 26 days. The third group (C) served as control. Samples of m. *longissimus thoracis* and *lumborum* were taken in order to evaluate: meat color (CIE L*, a*, b*, Chrome, Hue), Thawing Loss, WB peak and break on cooked meat, Drip and Cooking Loss, Meat Cooking Shrinkage (MCS), MCS Cooking and Cooling Loss, WHC total and halo area and WHC trend. Analyses were done according to the protocol developed at the Dipartimento di Scienze Zootecniche [16, 17].

Data analysis was performed by SAS/ STAT in SAS 9.2 [18] using one-way analysis of variance (GLM procedure) and treatment as independent variable. Results are expressed as LSmeans and MSE. A Stepwise Discriminant Analysis (STEPDISC procedure) was applied to the full set of variables (16 parameters) to select the best discriminating ones among treatments. Only variables with a significance level to enter or to stay at 0.20 were retained at the end of the stepwise procedure. The selected variables were then submitted to a Canonical Discriminant Analysis (CANDISC procedure), a dimensional reduction technique that performs both univariate and multivariate one-way analysis to derive canonical functions, i.e. linear combinations of the quantitative variables that summarize the variation among groups.

III. RESULTS AND DISCUSSIONS

The High and Low treatments showed, in a different way, a significant influence on meat quality (Table 1). Thawing Loss, WB peak and break were significant lower. The meat was more: lightish, reddish, yellowish; the Chroma and Hue were higher and also the Meat Cooking Shrinkage was greater in HD and LD groups. The meat from treated bulls tends to be more tender and pink, positive aspects for the consumer [19, 20]. A negative aspect is given by a greater cooking shrinkage regarded by consumers as an indicator of unhealthy meat.

Table 1. LSMeans and MSE of the qualitative meat parameters (N=20)

LSMeans by parameter in the same row with different letters are significantly different (a, b, c: P<=.05; A, B, C: P<=.01)

		GROUPS			
Parameters		HD	LD	C	MSE
Thawing Loss	%	7.0^{ab}	5.6^{a}	7.2^{b}	1.65
Drip Loss	%	3.0	4.4	4.1	4.29
Cooking Loss	%	13.8	15.6	15.3	31.09
L*		38.5^{a}	37.1^{ab}	35.6^{b}	6.76
a*		24.8^{AB}	25.4^{A}	24.0^{B}	0.75
b*		8.7^{a}	8.7^{a}	7.7^{b}	0.75
Chroma		26.7^{a}	26.8^{a}	25.2^{b}	1.13
Hue		0.33^{a}	0.33^{a}	0.31^{b}	0.001
WB Peak	N	78.8^{aA}	94.1^{a}	114.8^{bB}	383.57
WB Break	N	66.4^{aA}	83.9^{b}	97.5^{bB}	221.93
Cooking Loss mcs	%	23.1	25.2	25.9	12.84
MCS	%	20.9^{ab}	22.8^{a}	19.5^{b}	8.95
Cooling Loss mcs	%	3.4	3.2	4.1	1.63
WHC Total Area	mm^2	1330	1345	1321	4411.1
WHC Halo Area	%	40.8	41.8	40.1	16.02
WHCTrend k2		-.0016	-.0017	-.0014	$1.06E^{-7}$

From the 16 qualitative parameters measured in meat, the following four significant parameters were retained at the end of the Stepwise Discriminant Analysis: Thawing Loss, red-green index (a*), Warner Bratzles break, Cooking Loss mcs. The Cooking Loss

mcs did not differ among groups in the GLM. This is a possible result, as the Stepwise Discriminant Analysis is a multivariate technique that evaluates all involved variables to determine which one contributes most to the discrimination among groups. The contribution of the single variable is evaluated in relation to the others to delineate the optimal variable profile to separate groups. As a consequence, a variable that is not significant for group separation in the univariate approach could be important in the multivariate sense. The process of extracting canonical variables is repeated until the number of canonical variables equals the number of original variables or the number of classes minus one, whichever is smaller. With four variables and three groups the Candisc returns two canonical variables and the first one accounts for 76% of the total variability. The univariate R^2 are variable and range between 0.11 for Cooking Loss mcs and 0.47 for WB Break. The multivariate test for differences between the classes is significant at the 0.0005 level.

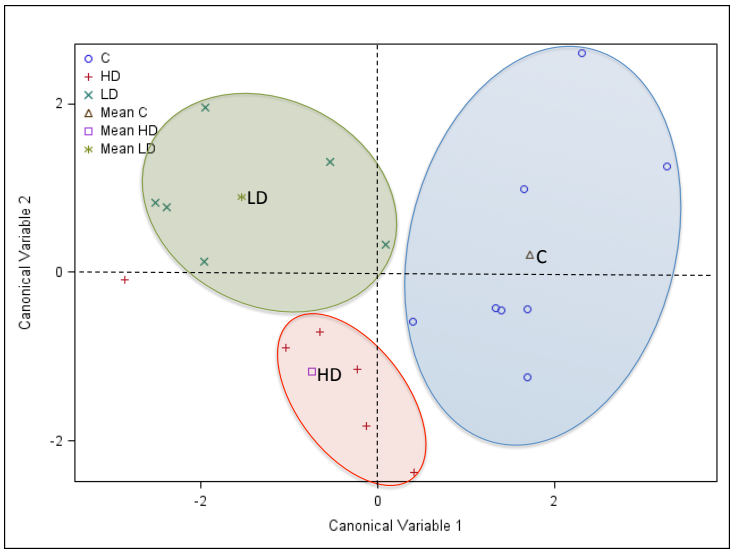

Figure 1. Canonical Discriminant Analysis of selected qualitative meat parameters (Thawing Loss, a*, WB break, Cooking Loss mcs)

The Canonical Discriminant Analysis (Figure 1) shows a significant separation between control and treated groups. The first canonical variable explains the 76% of between-class separation and is due to the color parameters a* and the Thawing Loss. The raw canonical coefficients, for the first canonical variable, show that the classes differ most widely on the linear combination of the centered variables: 0.8195 x Thawing Loss -1.0337 x a* +0.0324 x WB Break +0.1717 x Cooking Loss mcs. The second canonical variable divides the two treated groups and is due again to the Thawing Loss. The raw canonical coefficients, for the second canonical variable, show that the classes differ most widely on the linear combination of the centered variables: -0.2516 x Thawing Loss +0.8723 x a* +0.0661 x WB Break +0.0334 x Cooking Loss mcs.

Finally was applied a Discriminant Analysis to evaluate the model. In classification the accuracy was interesting; the total misclassification error was 0.15. In cross-validation the accuracy was not so good for HD (0.33) but the total misclassification error was 0.20. An important implication of the multivariate approach is that the discriminant coefficients could be ideally used to classify meat samples as treated or not treated. The information thus obtained can be used to officially control for the residues of illegal growth promoters in the carcasses tested positive.

IV. CONCLUSIONS

The illegal use of Dexamethasone positively influenced some meat quality traits, making the meat more attractive to consumers. The two treatments gave variable results. The high dose increased the meat tenderness, lightness and colour, while the lower dose gave a more red meat, less thawing loss, higher cooking meat shrinkage and lower WB Peak. This confirms the interest of farmers for both livestock and qualitative results but there are side effects for consumers and animals. There are health risks for consumers. In animals, Dexamethasone pharmacologically mimics some of the effects of the elevated activity of the hypothalamic-pituitary-adrenocortical axis that accompanies stress and their use has also been associated with generalized immunosuppression and a consequent exacerbation of infectious diseases [21].

REFERENCES

1. Gottardo F, Brscic M, et al. (2008) Administration of dexamethasone per os in finishing bulls. I. Effects on productive traits, meat quality and cattle behavior as indicator of welfare. Animal 2:1073-1079
2. Stephany RW (2010) Hormonal growth promoting agents in food producing animals. Handbook of Experimental Pharmacology 195:355-367, DOI 10.1007/978354079088416
3. Sustronck B, Deprez P, et al. (1997) Efficacy of the Combination Sodium Ceftiofur-Flumethasone in the treatment of experimental Pasteurella haemolytica Bronchopneumonia in calves. J of Vet Med Series A: Physiol Pathology Clinical Medicine 44(3):179-187
4. Moiré N, Roy O, Gardey L (2002) Effects of dexamethasone on distribution and function of peripheral mononuclear blood cells in pneumonic calves. Vet Immunology and Immunopathology 87(3-4):459-466
5. Istasse L, Evrard P, et al. (1988) Trenbolone acetate in combination with 17 beta-estradiol: influence of implant supports and dose levels on animal performance and plasma metabolites. J Anim Physiol A: Anim Nutr 62:150-158
6. Courtheyn D, Le Bizecb B, et al. (2002) Recent developments in the use and abuse of growth promoters. Analytica Chimica Acta 473(1-2):71-82
7. Biolatti B, Bollo E, et al. (2005) Effects of low-dose dexamethasone on thymus morphology and immunological parameters in veal calves. J Vet Med Series A: Physiol Pathology Clinical Medicine 52(4):202-208
8. EEC Commission Regulation N° 37/2010 Official J of the European Community L 15 p1
9. EEC Council Directive N° 22/1996 Official J European Community L 12 p3
10. EEC Council Directive N°74/2003 Official J European Community L 262 p17
11. EEC Council Directive N° 23/1996 Official J European Community L 125 p10
12. Nebbia C, Urbani A, et al. (2011) Novel strategies for tracing the exposure of meat cattle to illegal growth-promoters. The Vet J 189:34-42
13. Biolatti B, Rosmini R, et al. (1999) Genital and accessory reproductive organs, mammary gland and thymus changes following illegal anabolic treatment in veal calves. Proc. vol. 175 17th Meeting of the European Society of Veterinary Pathology, Nantes, France, 1999, pp 14-17
14. Biolatti B, Valpreda M, et al. (2002) Anabolic target organs pathology in cattle slaughtered in Piemonte region (Italy). Proc. 20th Meeting ESVP, Grugliasco (TO) Italy, 2002, p58
15. Carraro L, Ferraresso S, et al. (2009) Expression profiling of skeletal muscle in young bulls treated with steroidal growth promoters. Physiol. Genomics 38:138-148
16. Isoppo S, Sala G, Barbera S (2009) A Protocol for the assessment of physical and sensorial characteristics of meat. ICoMST 55th International Congress of Meat Science and Technology. Copenhagen, Denmark, 2009, ICOMST_PS4_Part2_ver2_Final.pdf. PE4.75 pp 736-739
17. Barbera S, Tassone S (2006) Meat cooking shrinkage: Measurement of a new meat quality parameter. Meat Science 73(3):467-474
18. SAS (2010) The SAS System for Windows, Release 9.02. SAS Institute Inc., Cary, NC, USA. At http://support.sas.com/documentation
19. Zamora F, Aubry L, et al. (2005) Serine peptidase inhibitors, the best predictor of beef ageing amongst a large set of quantitative variables. Meat Science 71(4):730-742
20. Verbeke W, Federico JA, et al. (2010) European citizen and consumer attitudes and preferences regarding beef and pork. Review Article. Meat Science 84(2):284-292
21. Anderson BH, Watson DL, Colditz IG (1999) The effect of dexamethasone on some immunological parameters in cattle. Vet Res Communications 23:399-413