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FEEDING SYSTEM AND GLUTATHIONE PEROXIDASE ACTIVITY, SELENIUM CONTENT AND ANTIOXIDANT STATUS OF ANGUS MEAT

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Abstract - The objective of this study was to determine the glutathione peroxidase (GPx) activity, the selenium (Se) content, and the total antioxidant status in bovine meat produced in three different feeding systems. For this, 10 Aberdeen Angus steers were fed natural and improved pastures, 10 were fed pasture plus grain supplementation and 10 were produced in a feedlot. After slaughter, the *Longissimus dorsi* (LD) muscle was obtained and divided in two pieces, one was frozen at -20ºC and the other was vacuum packaged and aged at 1-2ºC during 14 days. A feeding system effect ($p<0.01$) (pasture<pasture+supplementation<feedlot) and an ageing effect ($p<0.05$) were found (aged<fresh) for the GPx activity. A feeding system effect ($p<0.05$) was also found for Se content (feedlot<pasture), but no ageing effect was observed. No feeding nor ageing effects were found for the antioxidant potential results, but an incubation time effect was observed ($p<0.0001$), where oxidation values increased with incubation time. So we can conclude that the feeding system affects the GPx activity and the selenium content in Angus meat and that GPx activity decreases with meat ageing.

I. INTRODUCTION

In Uruguay, beef cattle production systems are based on pasture feeding, but more recently livestock producers have been investing on improved pastures and supplementation with concentrate, leading to cattle with different carcass and meat quality attributes [1]. Feed-lot strategies are also gaining place among producers. Meat produced on pasture or grain differs in their antioxidants, pro-oxidants and fatty acid composition. Pasture-fed cattle rendered meat with higher n-3 polyunsaturated fatty acids (PUFA) and conjugated linoleic acid (CLA) content than their counterparts fed concentrate diets [2]. Grass, in pasture feeding, is particularly rich in natural antioxidants such as vitamins from group A, C and especially E, or phytochemicals such as carotenoids and flavonoids, and so, offers a great protection against lipid oxidation. Grains are less rich in vitamin antioxidants, but also contain antioxidant compounds such as polyphenols and phytic acid [3]. Oxidation induces modifications of muscle lipids and proteins and, therefore, affects the organoleptic and nutritional properties of meat and meat products [4]. In meat, to decrease oxidation, endogenous protective systems, including small peptides such as glutathione, carnosine and anserine or proteins, essentially antioxidant enzymes, are also implicated. The enzymes superoxide dismutase (SOD), catalase and glutathione peroxidase (GPx) constitute the primary mechanism for protecting cells from oxidative damage in vivo [3]. GPx is a key enzyme in the antioxidant defence system of cells since it reduces a number of peroxides [5]. The GPx family contains at least four selenoproteins, cellular, extracellular, phospholipid hydroperoxide and gastrointestinal GPx [6]. The importance of Se is principally associated with its role as an essential part of GPx [7]. The Se content in animal derived foods reflects that of the feeds consumed by the animals [8]. Contribution of each antioxidant, when measured separately, does not really reflect antioxidant status of meat. An estimation of global antioxidant

status can be useful to describe the capacity of muscle to resist oxidation processes [3]. The aim of this work was to determine the effect of feeding system (pasture, pasture plus grain supplementation and feedlot) on Angus meat antioxidant status, considering its selenium content, GPx activity and total antioxidant potential. Also, search for a relationship between Se content and GPx activity.

II. MATERIALS AND METHODS

Briefly, 30 Aberdeen Angus steers were divided into three different feeding systems: 1) free access to pasture where animals reached a mean weight of 479.8 kg, 2) pasture plus grain supplementation during the last month where animals reached a mean weight of 502.4 kg, and 3) feedlot during the last 110 days reaching a mean weight of 497.4 kg. After slaughter, the *Longissimus dorsi* (LD) muscle was removed from each carcass and divided in two pieces. One of them was vacuum packaged, aged during 14 days at 1-2 ^{o}C and then frozen at -20 °C. The other piece was directly frozen at -20 °C, until further analysis. For the glutathione peroxidase (GPx) activity determination, the De Vore & Greene (1982) method was followed, adapted by Terevinto [9]. Results were expressed as nanomoles of NADPH oxidized/min/mg protein. The protein content of the muscle extracts was determined at 280 nm [9] using bovine serum albumin as a standard. Selenium was analyzed by graphite furnace atomic absorption [10] with Cu and Mg (nitrate salts, Fluka) as chemical modifiers for the determination of selenium in aqueous media. All the determinations were performed in triplicate. To measure the total antioxidant potential, the iron-induced lipid oxidation method described by Mercier et al. [11] was followed. The data of GPx activity, Se content and iron-induced lipid oxidation were reported as mean ± standard error of the media for fresh and aged meat. To evaluate feeding and ageing effects for each variable determined, an analysis of variance using the GLM procedure (NCSS, 2007) was followed. Also, a one way ANOVA was used to compare within feeding systems, fresh and aged muscle.

III. RESULTS AND DISCUSSION

Results of GPx activity and Se content are shown in Table 1. A feeding system effect was found for the GPx activity ($P<0.01$), were meat produced on pasture had lower activity than that from pasture plus supplementation, and this one lower than that from feedlot. This agrees with other works [4] where also found a higher GPx activity in meat from steers fed grains compared to meat from steers fed pasture. Also, an ageing effect was found ($P<0.05$), were aged meat had lower activity than the fresh one. With regards to selenium content results, we found a feeding system effect ($P<0.05$), were meat from the feedlot system had lower Se content than the meat from pasture, and the meat from the pasture plus supplementation was not different from neither of the other two systems. This result is opposite to what we expected because a higher GPx activity was found in meat from the feedlot system, which could be explained by a higher Se content in the LD muscle of animals in feedlot. No ageing effect was found for Se content in LD. As the principal form of GPx is a seleno-dependent protein, it has been proposed that selenium in the diet is the major source of variation of GPx activity [2]. It has been reported that, cereal grains, were richer in selenium than forages [11]. Hintze et al. (12) showed that in muscle of bovines fed grass, the selenium content of muscle was significantly correlated with selenium level in the grass and that the greatest source of variation in selenium content of muscle was the geographic region from which the beef originated. In the study of Gatellier et al. [3] important differences in muscle selenium content were found between the two diet groups. Mixed diet finished animals had higher content of selenium than pasture finished animals. This difference in selenium content in meat from animals finished on pasture or with the mixed diet, could partly explain difference in GPx activities. A significant correlation between GPx activity and Se content in beef muscles were found by Gatellier et al. [3]; and DeVore & Greene (1982) but not by O´Grady et al. [13] as in the present work.

Table 1. Glutathione peroxidase activity (nmoles/min/mg protein) and total selenium concentration (µg/kg), in fresh and aged *Longissimus dorsi* muscle of steers fed pasture, pasture plus grain supplementation (P+S) and feedlot.

		Pasture	P + S	Feedlot
GPx	Fresh	9.6 ± 0.7 a	11.0 ± 1.1	10.7 ± 0.2
	Aged	7.6 ± 0.5 b	9.2 ± 0.3	10.7 ± 0.4
Main effects: Diet: p<0.01 Ageing: p<0.05				
Se	Fresh	555 ± 20	441 ± 45	357 ± 36
	Aged	423 ± 36	398 ± 89	303 ± 52
Main effects: Diet: p<0.05 Ageing: NS				

Data are means ± SEM (n=10). Different lower case within each feeding system means significant difference to *P<0.05*

No feeding nor ageing effects were found for the total antioxidant potential results, but an incubation time effect was observed (*P<0.0001*), where oxidation values increased with incubation time with iron and hydrogen peroxide. When observing Figure 1, we can see that meat from the feedlot system has lower initial levels of lipid oxidation and significantly increases (*P<0.05*) with time of incubation, while in the meat from animals fed pasture lipid oxidation values keep almost constant.

IV. CONCLUSION

From this work we can conclude that the feeding system affects the GPx activity and the selenium content in Angus meat and that GPx activity decreases with meat ageing. When evaluating the global antioxidant status of meat, no differences between production systems can be seen.

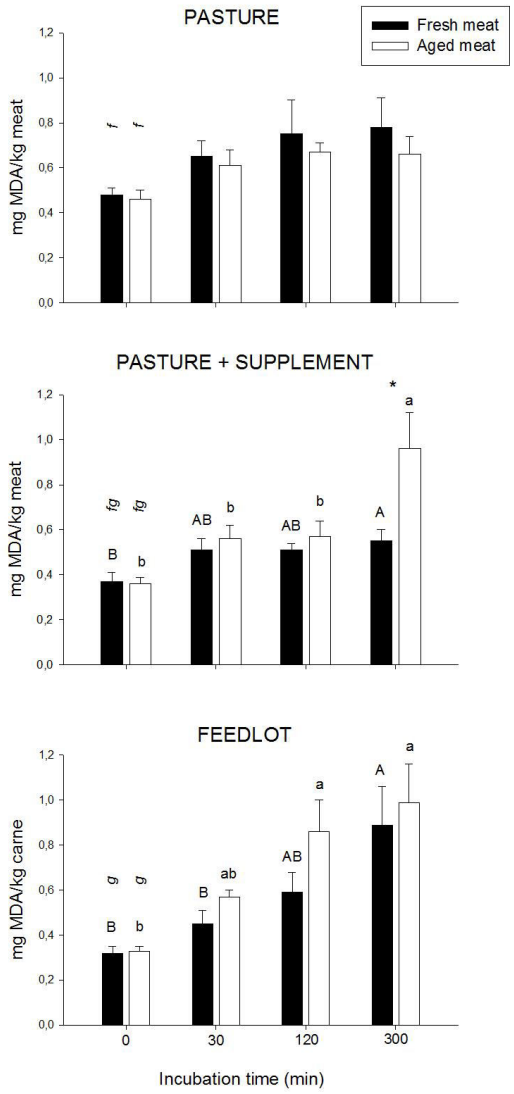

Fig. 1. Iron-induced lipid oxidation (TBARS) in fresh and aged *Longissimus dorsi* muscle of Aberdeen Angus steers fed pasture, pasture plus grain supplementation and feedlot. Bars are means ± SEM (n=10). Different capital letters show significant differences between incubation times for fresh meat (*P<0.05*). Different small letters show significant differences between incubation times for aged meat (*P<0.05*). Different small letters in italics show significant differences between feeding systems for fresh or aged meat in each incubation time (*P<0.05*). * indicates significant differences between fresh and aged meat of the same feeding system in each incubation time (*P<0.05*).

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