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OXIDATION AND LIPOLYSIS DURING FROZEN STORAGE OF BEEF AND PORK MEAT

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I. INTRODUCTION

The release of free fatty acids (FFAs) through lipolysis is linked to flavor development in meat [1]. Additionally, lipid oxidation during frozen storage contributes to discoloration and off-flavor formation [2]. Despite this, frozen meat is widely used in processed meat production due to its extended shelf life it is essential to understand the biochemical changes occurring during frozen storage [3]. Lipid oxidation is related to the lipolytic process which progress under freezing temperatures due to the stability of lipolytic enzymes. Therefore, the objective of this study is to compare the lipolytic processes in pork and beef meat during frozen storage, aiming to determine the optimal storage time to minimize oxidation reactions and their impact on meat quality.

II. MATERIALS AND METHODS

Samples. Meat samples (n= 6) from beef (VC) (cuts from flanks including muscles *Transversus abdominis*, *Obliquus externus* abdominis, *Obliquus internus abdominis*) and pork (PPC) (n= 6) (cuts from leg including *Semitendinosus* and *Semimembranosus* muscles*)* were selected (Embutidos Martínez, Valencia, Spain) at time 0, 3 and 6 months of frozen storage (-20°C).

Lipolysis analysis. The lipolysis was studied by the analysis of the free fatty acid (FFA) content. Total lipids were extracted from 5 g of meat [4] and FFA were separated from the lipid fraction using an ion exchange resin. FFAs were converted into fatty acid methyl esters (FAME). The samples were analyzed using a gas chromatograph (GC) from Agilent 7890A equipped with FID detector [5]. The capillary column was a HP88 (Agilent Technologies; 100 m x 0.25 mm i.d. x 0.2 µm film thickness). The individual FAME were identified by comparing their retention times with those of standard FAME and quantified calculating the response factors and expressed as mg per 100 g of meat.

Lipid oxidation analysis. Thiobarbituric acid reactive substances (TBARS) were determined [5], using trichloroacetic acid as solvent and data expressed as mg of malonaldehyde per kg of meat.

Statistical methods. Statistical analysis was done using the Generalized Linear Model (GLM) procedure (XLSTAT 2018, Addinsoft, Spain) and including the effect of specie (beef and pork) and frozen storage as fixed effect while samples were considered as random effect. Means were compared using the Tukey test.

III. RESULTS AND DISCUSSION

The results presented in Table 1 show the increase in oxidation values (TBARS) during frozen storage of both meat types, pork and beef. Both factors, specie and frozen time affected the oxidation process being beef more susceptible to oxidation than pork reaching higher TBARS values after 6 m of storage. In addition, after 3 months of frozen storage a significant increase in TBARS values were detected.

Table 1. Oxidation values measured as TBARS (mg/kg) in meat from beef and pork frozen for 0, 3, and 6 months

	Beef VC						Pork PPC									
months	0		3		6		0		3		6		RMSE	*Psp*	*P fr*	*Psp*fr*
TBARS (mg/Kg)	0.59	bc	0.9	ab	1.1	a	0.2	e	0.54	cb	0.50	cb	0.18	***	***	ns

**Different letters in the column indicate significant differences at P < 0.05.*

The lipolysis process in both meats was similar as observed by the increase in FFA during frozen storage. All type of FFAs, SFA, MUFA and PUFA, increased during storage (Figure 1) although a higher increase was detected in beef than in pork meat. The relathionship between free PUFA content and TBARS values (Figure 2) showed a higher relation in frozen beef than in pork meat indicating the highest susceptibility of beef to oxidation.

It should be considered that FFA participate in Maillard reactions during cooking as they are more susceptible to oxidation and giving rise to rancidity notes. However, there are many factors that affect the type and content of FFA in pigs and therefore, the final sensory properties. One of them is the pig antemortem handling as it was observed

that a fasting period of more than 19 h before slaughtering produces a greater proteolytic and lipolytic effect on muscle, leading to lower drip losses and higher oxidation values (TBARS) and free fatty acids [6]. Also, other factors affecting FFA content are the muscular metabolic type, diet etc. In beef, attempts have also been made to establish relationships between sensory and the type of fatty acid profile [7], showing that the total lipid and FA content in beef is positively associated with sensory characteristics.

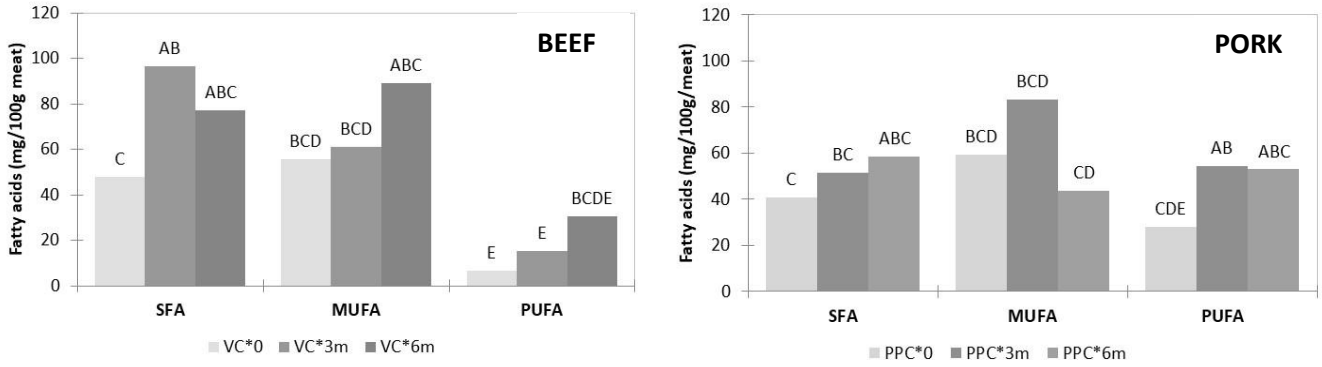


Figure 1. Free fatty acids content (SFA, saturated, MUFA monounsaturated, PUFA, polyunsaturated) in meat from beef (left) and pork (right) frozen for 0, 3 and 6 months.

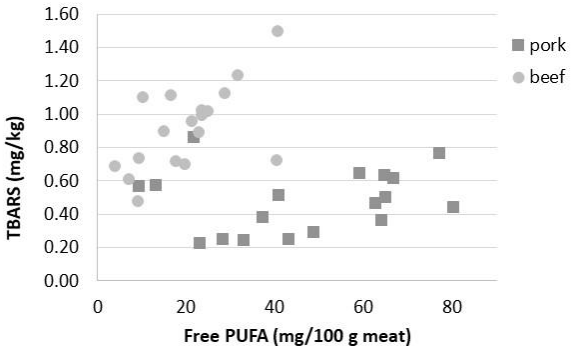


Figure 2. Relationship between free PUFA and TBARS values in meat from beef and pork frozen for 0, 3 and 6 months.

IV. CONCLUSION

In summary, there is a certain lipid oxidation and lipolysis during the frozen storage of pork and beef, which is more noticeable in beef. Therefore, the control of freezing conditions is essential in order to prevent lipolysis phenomenon and oxidation reactions and the development of off-flavors in the manufacture of meat products.

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