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Quality of the sirloin "presa" of the Iberian pork in two types of package

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Abstract. Availability of meat from Iberian pork, which is allowed to graze free range Dehesas (acorn forests) giving pigs fat its unique sweet *flavour*, is limited as its production is seasonable. Freezing may be an option to prolong commercialization periods and further consume of this meat, which represents high economic value. Aim of this study is to compare the quality of frozen meat, "presa" packed under vacuum in PA/PE material and frozen meat packed under vacuum in PA/PE material and stored in carton boxes, taking refrigerated meat as a reference. For this study, 24 samples were freeze using different storage conditions, namely 12 samples were packed individually under vacuum, and 12 samples were packed individually under vacuum and laid up in cardboards. Reference samples were prepared from same batch and stored at refrigerating conditions.After a conservation period of 5 month at -18°C, samples were thawed and its physicochemical properties (pH, color, moisture, water retention capacity), texture (Texture Profile Analysis, penetration) and sensorial analysis (performed by a trained panel), were assessed with the aim of evaluating possible damages caused by freezing. The results show evidences on differences between refrigerated packaging systems. Frozen meat delivered a lower pH and was darker then refrigerated meat which was confirmed by a decrease on L*. Cut resistance was as well lower for frozen meat. After thermal treatment, moisture content decreases followed by a decrease on meat hardness and adhesiveness. Sensory analysis points out a decrease on *flavour* persistence, overall acceptance, and aftertaste, with significant differences being verified on meat packed only in PA/PE material.This results evidence that packing Iberian pork meat under vacuum and cardboards is the packaging alternative which delivers meat with closest characteristics to the ones observed on refrigerate meat.

Keywords. Iberian pig – "Presa" – Meat – Freezing – Packaging.

La qualité de la longe ("presa") du porc Ibérique surgelée sous deux formes d'emballage

Résumé. *La disponibilité de la viande de porc Ibérique élevé en chênaie, est fonction du rythme saisonnier de sa nourriture (glands). La congélation permet de prolonger sa commercialisation et par conséquent la consommation de cette viande, d'une valeur économique supérieure. Cette étude vise à comparer la qualité de la longe ("presa") du porc Ibérique surgelée en pochette, ainsi que celle de la même viande surgelée en pochette et placée en boîte, par rapport à la viande réfrigérée, et à évaluer le processus de congélation. Nous avons utilisé 24 échantillons surgelés, 12 échantillons emballés individuellement sous vide et 12 échantillons emballés sous vide mais placés en boîtes et 12 échantillons réfrigérés, du même lot, qui ont servi comme référence. Après 5 mois de conservation à une température de -18ºC, les échantillons ont été décongelés et leurs propriétés physiques et chimiques (pH, couleur, humidité, capacité de rétention de l'eau), leur texturation (analyse du profil de la texture, test de pénétration simple) et leurs propriétés sensorielles (panel de dégustateurs chevronnés), ont été évaluées, afin d'apprécier les altérations provoquées éventuellement par la congélation. Les résultats démontrent qu'il existe des différences entre les formes d'emballage, notamment la diminution du pH, la diminution de la valeur L* et la diminution de la résistance à la coupe. Après un traitement thermique, on a constaté une diminution de l'humidité, de la dureté et de l'adhésivité. L'évaluation sensorielle démontre que l'acceptation globale, la persistance de la saveur propre à la viande et le goût résiduel ont diminué, et présentent une différence significative, ceci uniquement dans les échantillons surgelés en pochette. On arrive ainsi à la conclusion que la congélation en pochette avec empaquetage en boîte est la modalité qui permet le mieux à la longe (« presa ») surgelée, de se rapprocher de la longe réfrigérée.*

Mots-clés. *Porc Ibérique – Longe ("Presa") – Congélation – Surgelé – Emballage.*

I – Introduction

The production of the Iberian pork may be considered seasonal as there are some offering peaks. During the periods of higher distinct production, freezing will be a way of storing the product and so there is a guarantee of adjusting to the market. In industry the portions of a greater economic value were commercialized fresh. When there were no freezing processes, the meat portions were almost used in the manufacture of smoked sausages. The aim of this work is testing the freezing method of the ("presa" / sirloin or portion) ventral, serriform, toraxic and cervical muscles of the Iberian pork used in the enterprise "Damicarnes". As we are dealing with meat of high economic value, it is supposed to evaluate the differences between the refrigerated and the frozen product in two distinct forms of package which create differences in the freezing speed of the product. Among all the characteristics of the quality of the meat, texture is extremely important for the consumer (Lawrie,1998).

The texture of the meat corresponds to sensations of succulence and tenderness which are evaluated by instrumental techniques or by a panel of tasters. The greatest difficulty in evaluating the meat texture is, no doubt, establishing a relationship between the results obtained by the two methods, and above all, because the meat has to suffer a thermal treatment before being consumed, which increases the impact in the meat characteristics (Genot, 2003). Freezing is a preservation system and the technology used tries to limit the damages aiming at causing the slightest number of alterations (Varnan and Sutherland, 1998). Package may confer distinct degrees of protection to the product. The development of flexible pellicles and vacuum package led to the evolution of the meat distribution sector. Meat frozen after vacuum package, keeps its natural quality during a more prolonged period (Price and Schweigert, 1994). The main causes for the deterioration of fat are hydrolysis and oxidation. It is of the utmost importance to freeze as fast as possible after production, under the correct conditions and reduce to the minimum the temperature fluctuations during storage and transportation (Varnan and Sutherland, 1998).

Freezing is the best way to preserve meat at a long term but it must be well done. The maintenance of the characteristics of the product during preservation depends on the temperature of the storage and the type of meat (Prandal *et al*., 1994) The loss of CRA and the lack of capacity the fibres have to reabsorb the water when thawing and then high ionic force causes denature of the muscle proteins (Lawrie, 1998). The quantity of exsudation varies according to the initial characteristics of the product, the speed of freezing and thawing, the temperature and the period of storage, however, this quantity is lower when the meat is vacuum stored with an impermeable material to oxygen and the flavour of rancidity also decreases. According to Genot (2003), the freezing usually causes a slight increase in the tenderness of the meat, and the force of the muscle cutting which suffered freezing is much lower than in the fresh meat. Pork is slightly more tender and juicy, when it is frozen and it is also more easily chewed. An excessive loss of exsudation is a determining factor in the quality of the meat and unpleasant to the consumer, restricting the acceptability of the product (Varnan and Sutherland, 1998).

II – Material and methods

The sample used in this study is the sirloin of the Iberian pork. The sirloin is made up of the serriforme, ventral toraxic and cervical near the thigh (Mayoral *et al.*, 2003). It is considered a sample, a portion of meat which corresponds to the sirloin and weighs approximately 700 g with the dimensions 20 x 10 x 5 cm, which suffered a process of freezing in a current of forced air and picked at hazard from the right and left side of males and females. Thirty six examples of the sirloin of the Iberian pork were collected which came from the same lot of meat from animals which underwent identical conditions of handling and slaughter and were vacuum stored at +2ºC. The plan of sampling followed in this study is the following: 6 samples were used in laboratory analyses and the remaining 6 in a sensorial analysis. The sirloin was packed unit by

unit, in vacuum with a poliamid polyethylene pellicle of 125 µm thickness in a thermoformative machine and frozen according to Table 1. After freezing it was moved to the preservation chamber of frozen products.

Table 1. Plan of samples

No. of samples	Refrigerated samples	Samples frozen in a vacuum pouch under a shelf (0ºC to -7ºC) 4h30; 5 months at -18ºC	Samples frozen in a vacuum pouch and packaged in carboard boxes under a shelf; (0ºC to -7ºC) 12h; 5 months at -18ºC
6+6	CR		
6+6		CBL	
6+6			CCX

pH was determined according to the rule NP 33441 / 1990. The colour was determined by a colorimeter previously calibrated by a plate with a white reference no. 19733057, channel 0 (L*= 97.10; a*= + 0.07; b*= +1.83). Result expressed in: L*,a*,b*; Relationship a/b; Chromaticity C= $(a^2 + b^2)0.5$;Tone Hº = arctangent b/a* 360º / (2*3.14)(Minolta, 1991). The percentage of humidity (moisture) was determined according to the procedure of the rule NP 1614/2002. The capacity of water retention was carried out according to the pistometric method (Grau and Hamm, 1953). The rheologyc characterization was carried out in a texturometer. The samples were submitted to tests of a simple cutting. Slices of the muscle were cut, 2 cm length in the vertical and each one in parallelepipeds of 1.5 cm. They were grilled in a convector oven at 150ºC, during 20 minutes, the grilled meat was kept in a stove at about 55ºC until the experiment. The test was carried out with a chopping knife and the speed of the test was 1 mm s^{-1} the distance of 10 mm. The test was carried out with a thermal treatment and without a thermal treatment (in the direction of the muscular beam and against it). The characteristics determined were the resistance to the cutting and the work of the strength of the cutting.

The sensorial evaluation of the Iberian pork was tested by a panel of tasters selected and trained by the Agrarian High School in Beja , according to the NP ISO 8586-1 (2001). Tasting occurred according to NP 4258 (1993). To carry out the experiments, slices of meat were cut with 2 cm width and each slice in parallelepipeds of 1.5 cm and they were grilled in a convector oven.

III – Results and discussion

The average values of pH in the refrigerated meat are superior and with significant differences compared to the values found in the frozen meat inside a pouch and inside a pouch and a box which also show significant differences (Table 2) The average values of CRA don't show significant differences in the different ways of package of the meat frozen in a pouch and a box compared to the refrigerated meat. However, the values showed clearly a fall. Bustabad (1999) refers that vacuum package and the package in cardboards is effective and contributes to reducing the loss of water.

The values of moisture in the meat before being submitted to a thermal treatment don't show any significant differences, however, they don't include the loss of water suffered by the exsudation of the thawed meat (which was about 3%). Farouk *et al*. (2003) showed that the losses of water when thawing were identical to the freezing speeds either high or low, when evaluated after 6 months preservation and increase all along the preservation period. The values obtained in the moisture of the meat after thermal treatment, show significant differences between the refrigerated meat, frozen in a pouch and frozen in a pouch and a box. Under the same conditions under the thermal treatment, the refrigerated meat, managed to keep the water

in a more outstanding way than the meat which was frozen. Lawrie (1998) refers that a pH of 5.9 causes cooking losses superior to the losses when the pH is 6.0, that's to say that the reduction of pH caused an increase of water losses during cooking in a continued way.

Table 2. Averages, pattern deviations and results of the analysis of the variation of the physic chemistry parameters of the sirloin of the Iberian pork refrigerated (CR) frozen in a pouch (CBL) and frozen in a pouch and a box (CCX)

	CR	CBL	CCX
pH	6.17[a] (0.15)	5.93[b] (0.06)	5.85[c] (0.11)
CRA %	32.83[a] (2.12)	29.67[a] (7.14)	30.00[a] (3.84)
Meat moisture without thermal treatment	70.85[a] (1.43)	70.77[a] (0.86)	69.45[a] (2.87)
Meat moisture after thermal treatment	57.67[a] (0.36)	54.68[b] (0.46)	50.56[c] (0.18)

The Table 3 shows the values obtained in the colour of the muscle in the lateral face and in the medial face. It is verified that the meat lost its brightness, got dark after freezing and thawing packed in a pouch or in a pouch and box when compared to the values obtained in the refrigerated meat.

Table 3. Averages, patterns deviations and results of the analysis of the variation of the colour of the muscle in the outside lateral face and medial face, L*,a*,b*, (CIE) of the sirloin of the Iberian pork refrigerated (CR) frozen in a pouch (CBL) and frozen in a pouch and box (CCX)

	CR	CBL	CCX
L*	38.96[a] (2.60)	30.98[b] (3.46)	32.27[b] (2.32)
a*	17.72[a] (0.97)	15.67[b] (2.12)	18.76[a] (1.12)
b*	4.36[a] (1.04)	4.21[a] (1.84)	4.44[a] (1.19)
a/b	4.28[a] (1.07)	4.31[a] (1.52)	4.48[a] (1.08)
$C=(a^2 + b^2)^{0.5}$	18.27[a] (1.11)	16.28[b] (2.24)	19.30[a] (1.28)
H^o = arctang b/a	0.24[a] (0.05)	0.25[a] (0.09)	0.23[a] (0.05)
L*	42.47[a] (4.16)	32.81[b] (3.33)	33.72[b] (3.59)
a*	17.98[a] (2.48)	18.01[a] (1.75)	18.06[a] (1.78)
b*	5.15[a] (1.76)	4.55[a] (1.17)	4.85[a] (1.36)
a/b	4.20[a] (2.75)	4.34[a] (1.74)	4.02[a] (1.22)
$C=(a^2 + b^2)^{0.5}$	18.75[a] (2.689)	18.62[a] (1.60)	18.74[a] (1.90)
H^o = arctang b/a	0.28[a] (0.08)	0.25[a] (0.07)	0.26[a] (0.07)

In the study carried out by Estevéz *et al*. (2003) , the values of L* fell down just like it happened in this study, which can be explained by the water losses after thawing and hemoglobin concentration which reduces the value of L *. According to Price and Schweigert (1994) if the temperature of freezing is superior to -57ºC it is usually produced a dark colour because metamioglobin is formed. Because of the fall of the pH and CRA , the colour gets dark owing to the passage of mioglobin and metamioglobin (Farraia da Graça,1987) and the effect is greater with values of pH superior to 5.8 (Varnam and Sutherland 1998).

In all the tests of a simple cut in meat without thermal treatment it was observed that the cut resistance and the work of the cut strength showed lower values with significant differences, in the frozen meat inside a pouch or inside a pouch and box, when compared to refrigerated meat (Table 4)

The cellular destruction owing to the formation of intercellular ice crystals, led to the reduction of the cut force in the thawed meat (Lagerstedt *et al*., 2008). The denatured proteins are particularly sensitive to the attack of proteolitic enzymes, causing the reduction of hardness (Lawrie ,1998).

Table 4. Averages, pattern deviations and results of the analysis of variance for the parameters of the test of a simple cut in the sirloin of the Iberian pork refrigerated (CR), frozen inside a pouch (CBL), and frozen inside a pouch and a box (CCX), without thermal treatment (direct or against the muscular beam), and with thermal treatment

	Without thermal treatment for the muscular beam			Without thermal treatment against the muscular beam			With thermal treatment		
	CR	**CBL**	**CCX**	**CR**	**CBL**	**CCX**	**CR**	**CBL**	**CCX**
Cut resistance (N)	51.45^{a}	29.27^{b}	28.09^{b}	50.73^{a}	36.48^{b}	38.04^{b}	45.61^{a}	38.83^{ab}	31.92^{b}
	(35.79)	(7.58)	(8.72)	(17.63)	(10.45)	(11.23)	(27.06)	(5.56)	(9.79)
Work cut strength (NS)	107.94^{a}	72.00^{b}	66.13^{b}	140.02^{a}	97.29^{b}	104.82^{b}	121.64^{a}	133.20^{a}	100.95^{a}
	(46.11)	(23.03)	(24.22)	(46.14)	(32.25)	(40.70)	(75.44)	(20.96)	(39.09)

The average values in the same line differ when affected with different letters to ≤,0,05.

The values obtained in the cut for the muscular beam show a greater difference between the frozen meat and the refrigerated meat than in the values against the muscular beam, and the joints are more easily destroyed in freezing. According to Farag *et al*. (2009) another factor that influences the texture of the meat is the direction of the muscle fibres. After the thermal treatment it was checked that the cut resistance decreased especially in the meat which suffered freezing compared to refrigerated meat. The panel tasters detected significant differences in the residual taste of the frozen samples in the pouch when compared to the refrigerated ones and with those frozen in a pouch and box (Table 5). For an intermediate freezing speed, the ice is formed outside and inside the cell together with a variable temperature during preservation and leads to damages in the tissues. The CRA of the frozen meat in a pouch is inferior to the one frozen in a pouch and box, which becomes evident in a greater quantity of lost liquids during the thermal treatment , being drawn some precursors of the residual taste that represents the detection of remaining substances (Chamorro and Losada, 2002). In the global appreciation the panel of tasters considered that the samples frozen in a pouch show significant differences from the refrigerated ones but were not significant among the frozen samples.

Table 5. Average, pattern deviations and results of the analysis of variance for the sensorial parameters in the sirloin of the Iberian pork refrigerated (CR), frozen in a pouch (CBL), and frozen in a pouch and box (CCX)

	CR	**CBL**	**CCX**
Tenderness	5.66^{a}(0.62)	4.79^{a}(0.21)	5.61^{a}(0.15)
Succulence	5.38^{a}(0.24)	3.93^{a}(0.61)	4.29^{a}(1.11)
Flavour of rancidity	0.44^{a}(0.16)	0.79^{a}(0.11)	0.82^{a}(0.16)
Characteristic *flavour*	6.15^{a}(0.28)	5.68^{a}(0.16)	5.79^{a}(0.60)
Persistence	5.72^{a}(0.12)	4.93^{b}(0.10)	5.04^{b}(0.15)
Residual taste	5.13^{a}(0.12)	4.36^{b}(0.10)	4.93^{a}(0.20)
Global appreciation	6.64^{a}(0.43)	4.50^{b}(0.20)	5.57^{ab}(0.51)

The average values in the same line differ when affected with different letters to ≤,0,05.

IV – Conclusions

Freezing in a pouch and box obtained a better result than freezing in a pouch. In the existing conditions it isn't the speed of freezing that interferes in the quality of the frozen meat; this means that the method used at present in the enterprises is the most advisable, however it is important to stabilize the preservation temperatures to minimize the undergone changes. The frozen meat after being thawed and compared to refrigerated meat, shows an inferior aspect, a decrease in pH caused by the development of lactic acid bacteria, a darkness caused by the formation of metamioglobin, a decrease of CRA as well as moisture, hardness , adherence and cut resistance, caused by proteic denature.The tasters classified negatively the residual taste of the frozen sample in a pouch in comparison to the refrigerated one and to the frozen one in a pouch and box. In the global appreciation, tasters preferred refrigerated meat which they consider not showing significant differences with the frozen meat in a pouch and box, only manifesting significant differences in the frozen meat in a pouch. Weight loss during freezing and the storage of frozen meat oxidative and colour changes in meat from three lines of free-range reared Iberian pigs slaughtered at 90 kg live weight and from industrial pig during refrigerated storage.

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