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POSTER

Shelf-life of vacuum packed, heat-treated traditional Sardinian suckling pig meat

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SUMMARY

Roasted suckling pig is a traditional dish widely consumed all over the island of Sardinia and very appreciated by the tourists. Unfortunately, because of the resurgence of African Swine Fever (ASF) in Sardinia, the export of fresh pork meat and/or derived products has been banned. In the implementing act of the extraordinary eradication program of the ASF 2015-2017, issued by the Regional Government, some precautions needed to obtain the permission to export pork meat products are stated. One of these consists in applying a precooking heat treatment to the meat until reaching the temperature of 80°C in the whole mass. Exporting pork meat represents an important economic opportunity for the Sardinian operators of the sector that have shown great interest in testing the effectiveness and applicability of the heat treatment to guarantee the safety and quality of their products. The aim of this study was to assess, throughout the whole expected shelf-life at 4°C, samples of vacuum packed meat, monthly, from 0 to 150 days from the heat treatment. Therefore, five sides of piglet per sampling point were analysed, from a microbiological (counts of pathogens and spoilage bacteria), and chemical (lipid peroxidation) point of view, before cooking completion. After 40' in the oven at 210°C, sensory analysis (acceptance test) was performed to examine consumer liking. The results allow concluding that despite a microbial post-process contamination, quality and sensory acceptance of the product was not affected until 150 days of shelf-life. A post-lethality treatment should be assumed to reduce microbial contamination.

Parole chiave aggiuntive

Prodotti carnei.
Peste Suina Africana.
Sicurezza Alimentare.

Shelf-life della carne di suinetto sardo tradizionale e trattata termicamente confezionata sottovuoto

SOMMARIO

Il suinetto da latte arrosto è un piatto tradizionale della Sardegna ampiamente consumato in tutta l'isola e molto apprezzato dai turisti. Purtroppo, a causa della recrudescenza della peste suina africana (PSA) nell'isola, è stata vietata l'esportazione di carni suine fresche e/o prodotti derivati. Alcune precauzioni necessarie per ottenere il permesso di esportare i prodotti a base di carne di maiale sono contenute nel provvedimento attuativo del Programma straordinario di eradicazione della PSA 2015-2017 emanato dal Governo Regionale. Una di queste consiste nel trattamento termico di precottura della carne fino al raggiungimento di una temperatura di 80 °C in tutta la massa. L'esportazione della carne di maiale rappresenta un'importante opportunità economica per gli operatori sardi del settore, fortemente interessati alla dimostrazione dell'efficacia e applicabilità del trattamento termico per garantire la sicurezza e la qualità dei loro prodotti. Lo scopo di questo studio era quello di valutare, mensilmente, da 0 a 150 giorni, la shelf-life dei campioni di carne trattati termicamente e conservati sottovuoto a 4 °C. Pertanto, cinque mezzene di suinetto, per punto di campionamento, sono state analizzate da un punto di vista microbiologico (conta di batteri patogeni e alteranti) e chimico (perossidazione lipidica), prima del completamento della cottura. Dopo 40 min in forno a 210 °C, è stato eseguito il test di accettabilità sensoriale, per valutare il gradimento dei consumatori. I risultati ottenuti consentono di concludere che la contaminazione microbica post-processo non ha determinato un decadimento della qualità e dell'accettabilità sensoriale del prodotto, fino a 150 giorni di shelf-life. I risultati evidenziano la necessità di prendere in considerazione l'applicazione di un trattamento post-letale per ridurre la contaminazione microbica.

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INTRODUCTION

Several bibliographic notes document an ancient history of pig farming in the island of Sardinia, and a tradition of processing and preserving pork products (ham, sausages, lard), widespread in the island since the time of Roman Empire, that has been continued up until now (Cetti 1774; Cherchi Paba 1974; Meloni 1990; Vera 2004). Among traditional pig meat products, roasted suckling pig meat has been described as the Sardinian traditional dish in early 19th century (La Marmora 1826). Nowadays, together with a small number of intensive farming, many extensive and semi-extensive farms coexist (Porcu et al. 2007) that make difficult to control African Swine Fever (ASF) diffusion. Wild boar populations can also act as reservoir and contribute

to the virus persistence. Unfortunately, because of the recurrence of ASF in Sardinia, the export of fresh pork meat and/or any its derivative has been banned. In the implementing act of the extraordinary eradication program of the ASF 2015-2017, issued by the Regional Government (Regione Autonoma della Sardegna 2016), some precautions needed to obtain the permission to export pork meat products are stated. One of these consist in applying a pre-cooking heat treatment to the meat, until reaching the temperature of 80°C in the whole mass as provided by Council Directive 2002/99/EC (European Commission 2003). The aim of this study was to assess microbiological and chemical aspects throughout the expected shelf-life of vacuum packed pre-cooked suckling pig, during refrigerated storage at 4°C, and its sensory quality after cooking completion needed before consumption.

MATERIAL AND METHODS

The study was carried out from July 2015 to January 2016 on half piglet carcasses, packaged under vacuum after a pre-cooking heat treatment in oven, applied until reaching the temperature of 80°C in the whole meat mass, and an overnight chilling phase in a cold room at 2-4°C (Porcu et al. 2016).

Before cooking completion, on five half carcasses per sampling point (0, 30, 60, 90, 120, 150 days of storage at 4 °C) were performed physico-chemical and microbiological analyses.

Two determinations per sample were conducted and the mean was considered. One-way ANOVA was applied to the datasets ($P<0.05$).

At *M. longissimus dorsi* level, the potentiometric measurement of pH was carried out by inserting a pH-meter GLP 21 (Crison, Carpi, MO, Italy); water activity (a_w) was determined by a dew-point hygrometer (Aqualab CX3, Decagon Devices Inc., Pullman, WA, USA), and calibrated with standard solutions (a_w=0.984 and a_w=0.760) at +25°C; lipid oxidative state of meat was assessed by TBA test (Raharjo, Sofos & Schimdt 1992; Nudda *et al*. 2013) and expressed as mg of MDA (malonaldeyde)/kg of meat.

For microbiological analysis, each half carcass was sampled by means of Hydrated-Sponge with 10 ml Buffered Peptone Water Broth (3M, Milan, Italy), immediately after opening the package under sterile conditions, at neck, belly and ham sites, by using a 5x5 cm sterile template (Copan, Brescia, Italy), for a total surface of 75 cm^2 for each half carcass.

All the samples were analysed for: Lactic Acid Bacteria (LAB) on MRS agar (Microbiol, Cagliari, Italy), incubated under anaerobic conditions at 30 °C for 72 h; Total Mesophilic Count (TMC) on PCA (Microbiol), incubated at 30 °C for 72 h; Psychrotrophic bacteria on PCA (Microbiol), incubated at 6.5 °C for 10 days; *Enterobacteriaceae* on VRBGA (Microbiol), incubated at 37 °C for 18-24 h; *Pseudomonas spp*. on Pseudomonas agar base with Cetrimide, Fucidine and Cephaloridine (CFC, Oxoid, Milan, Italy), incubated at 25 °C for 48 h; mesophilic aerobic sporulating bacteria on tryptone glucose extract agar (TGEA, Oxoid), incubated at 30,°C for 48 h; sulfite-reducing clostridia on Perfringens agar base (Biolife, Milan, Italy), incubated at 30°C under anaerobic conditions for 48 h; *Clostridium perfringens* on Perfringens agar base with Tryptose Sulphite Cycloserine (TSC, Biolife), incubated at 30°C under anaerobic conditions for 48 h; *Salmonella spp*. (ISO 6579/2002), *Listeria monocytogenes* (ISO 11290-1:1996 and 11290-2:1998).

After oven cooking completion (40 min at 210 °C), acceptance test (Lawless & Heymann 1998) was performed on the same half carcasses previously sampled for microbiological and chemical analyses. Consumers (n=40) indicated their level of liking on a 9-point hedonic scale (1=dislike extremely and 9=like extremely). One-way ANOVA was applied to the dataset ($P<0.05$) using Statgraphics Plus 5® Software (Manugistics, Inc. Rockville, MD USA).

RESULTS AND DISCUSSION

During storage, pH and a_w evolution showed irregular trends with a slight increase during storage (pH mean value 5.68±0.09 at 0 days, 5.77±0.06 after 150 days; a_w initial and final mean level of 0.968±0.007 and 0.983 ±0.005, respectively). The observed pH and a_w mean levels were as expected **(Table I)**.

The lipid oxidative state of the meat did not change significantly, reaching a maximum MDA mean value of 0.7±0.2 mg/kg of meat, at 150 days, resulting below the critical value of 1-2 mg of MDA per Kg of meat, considered as indicator of rancidity (Spaziani, Del Torre & Stecchini 2011)**(Table II)**.

Microbial counts are shown in **Figure 1** and **Table III.** TMC initial counts were 5.13±0.83 log_{10}/cm^2, showing a sharp and statistically significant ($P<0.05$) increment during the first 30 days after heat treatment and packaging. LAB initial counts (3.67±1.01 log_{10}/cm^2) were lower than TMC, but a similar trend was detected, showing a significant ($P<0.05$) increase (>7 log_{10}/cm^2), during the first 30 days after heat treatment and packaging. Then, no significant differences ($P<0.05$) among counts, both for TMC and LAB, were observed until 150 d.

Table I. pH and aw (mean±sd) evolution during storage of piglets stored under vacuum, at 4°C (Evoluzione di pH e aw (media±ds) durante la conservazione dei suinetti sottovuoto, a 4°C).

	Days of storage					
	0	30	60	90	120	150
pH	5.68±0.09	5.77±0.05	5.76±0.06	5.74±0.07	5.76±0.05	5.77±0.06
aw	0.968±0.007	0.975±0.006	0.967±0.002	0.967±0.003	0.977±0.010	0.983±0.005

Table II. MDA values of meat during storage (Valori di MDA nella carne durante la conservazione).

Days of storage	MDA (mg/kg of meat)		
	Mean		SD
0	0.6[a]	±	0.3
30	0.6[a]	±	0.2
60	0.4[a]	±	0.1
90	0.5[a]	±	0.1
120	0.5[a]	±	0.2
150	0.7[a]	±	0.2

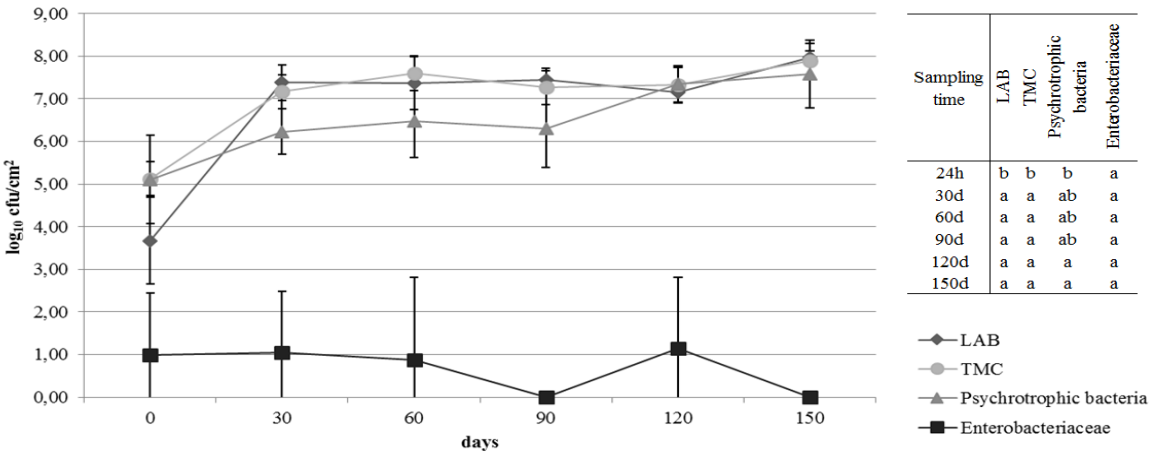
Means followed by the same letter do not differ significantly (P<0.05)

Psychrotrophic bacteria grew slowly reaching their highest counts after 120 d, while *Enterobacteriaceae* remained constantly at low level, during the whole shelf-life. *Pseudomonas spp*. showed an irregular trend, being detected only in samples at 30 and 60 days of storage with mean levels of 2.76±1.59 (prevalence 80%) and 2.62±2.47 (prevalence 60%), respectively. Mesophilic aerobic sporulating bacteria were detected at the same intervals with a prevalence of 20%, at mean levels of 0.83±1.14 and 0.30±0.66 after 30 and 60 days of storage, respectively. Sulfite-reducing clostridia, *Clostridium perfringens*, *Salmonella* and *Listeria monocytogenes* were not detected in any of the samples **(Table III)**.

As regards the acceptance test, the liking level (ranging between 6.54 ± 1.27 and 7.07 ± 1.23) remained high until 150 days of shelf-life and no significant hedonic difference was found among samples, at different storage times **(Table IV)**.

CONCLUSIONS

The results allow concluding that, despite a microbial post-process contamination, mainly represented by LAB, quality and sensory acceptance of the cooked product was not affected until 150 days of shelf-life. Though precooked under vacuum roasted suckling pig is a meat product to be consumed after cooking completion, a post-lethality treatment should be as-



Sampling time	LAB	TMC	Psychrotrophic bacteria	Enterobacteriaceae
24h	b	b	b	a
30d	a	a	ab	a
60d	a	a	ab	a
90d	a	a	ab	a
120d	a	a	a	a
150d	a	a	a	a

Figure 1. Evolution of spoilage bacteria counts in vacuum packed roasted pig meat, during shelf-life at 4°C. Different letters within the same microbial group denote a statistically significant difference among means (Evoluzione dei batteri contaminanti durante la shelf-life dei suinetti arrrosto, conservati sottovuoto a 4°C. Lettere differenti, in corrispondenza dello stesso gruppo microbico, indicano differenze significative tra le medie).

Table III. Mean counts (mean±sd $\log_{10}$ cfu/cm²) of spoilage and pathogens bacteria in piglets packaged stored under vacuum, at 4°C. In brackets prevalence (%), is reported (Media±ds $\log_{10}$ ufc/cm²) dei batteri alteranti e patogeni nei suinetti conservati sottovuoto, a 4°C. Tra parentesi è riportata la prevalenza (%)

Microbial group	Days of storage					
	0	30	60	90	120	150
Pseudomonas spp.	-[1]	2.76±1.59 (80)	2.62±2.47 (60)	-	-	-
Mesophilic aerobic sporulating bacteria	-	0.83±1.14 (20)	0.30±0.66 (20)	-	-	-
Sulfite-reducing clostridia	-	-	-	-	-	-
Clostridium perfringens	-	-	-	-	-	-
Salmonella	-	-	-	-	-	-
L. monocytogenes	-	-	-	-	-	-

[1]Not detected.

Table IV. Acceptance test: means and standard deviations of liking level (Test di accettabilità: medie e deviazioni standard del livello di gradimento).

Days of storage	Acceptability
0	6.97[a] ± 0.98
30	7.07[a] ± 1.03
60	6.63[a] ± 1.16
90	6.93[a] ± 0.83
120	6.54[a] ± 1.27
150	6.85[a] ± 1.19

Means followed by the same letter do not differ significantly (P<0.05).

sumed to reduce microbial contamination that could alter the product. The treatment applied seems to preserve the good sensorial quality of the product, for at least 150 days from packaging, and to be effective to accomplish the Council Directive 2002/99/EC on the pork meat export.

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