PLSR APPLICATION IN PORK HAM ANALYSIS WITH DIFERENT COOLING METHODS

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Abstract

During Otoman Empire Romania was under his influence and because of this the breading of pork take advantage in order to avoid paying the tribute in nature as cows, sheps,etc. The Romanian cousine and meatstuff was developed around this specie and whole processing was under this ind of meat requirements. One of the most important meatstuff made from pork meat is Pork Ham.
The production was developed centuries ago and become one of the best quality and best seller meat product comparable with Prosciuto crudo or Jamon from mediteranian countries.
Tere are concerns of the producing in the old fashion way of this kind of meat product but the issues are related with economical efficiency and meeting the legal requirements.
The aim of the study is to asses the production technologies issues and during maturation and storage to asses the quality of the product from physico - chemical point of view.
The physico - chemical parameters were the following: water content, NaCl content, nitrits content and protein content.
The storage of the product wasdone at three levels of temperature refrigeration at 0 - 4℃, room temperature at 20℃ and freezing at 18℃. The duration of the experiment was six months.
Based on the data recorded we propose an monitoring tool clled PLSR - Points Levels Recorded of Stability.

Key words: pork, ham, physico - chemical parameters, production technology

INTRODUCTION

The increase of the demands of the consumers regarding the global quality of the meat stuff determined the orientation of the producers towards the manufacture of increasingly valuable products.

Thus we distinguish the manufacture of meat preparations that have a distinct anatomical basis, products that have a high nutritional quality but also high sensorial quality. Unfortunately this raise serious issues regarding technological process (related with spicing dynamic, storage) and even consumption. In this way there are serious trends to replace traditional pork ham based on rear pork leg with deboned and pressed pork ham.

There are concerns during last decades to use raw materials and materials of natural origin, without substituent's and without synthetic additives.

Ham is one of the most popular pork specialties. Tasty, with fine aromas, often spiced with aromatic herbs, smoked with different kind of wood, the ham is always welcome on consumers tables, meant to soak up our senses.

Made from carefully chosen meat from different parts of the pig, the ham is salted with brine in which are added spices and flavored herbs (pepper, thyme, dill, bay leaf, basil). Nowadays there are also used food additives to increase the quality of the product, shelf life and improve the the economical efficiency.

The production of the meat stuff from the category of ham, high value product is confined to draconian quality conditions due to the high unit price and the fierce competition on the market. In this sense, the present paper addresses the manufacturing technology to produce a high value product, corresponding to the highest standards assessed by methods use according to Romanian standards.

The production of the Pork Ham is starting with right chosing of pork diet. In this way the diet is rich in proteins because the fat on the pork parts used for ham production must be at the lowest level possible.

The sloughtering of the pigs must be done properly and according with conditions of wellfare of animals.

The storage of the carcases is recomanded to be done at the refrigeration level in order to preserve the meat properties and sensorial assets.

In this way a very important place is assigned to the quality of the raw materials and auxiliary materials in terms of their quality parameters, this will ensure proper production flow.

The technological process of manufacturing of "Pressed Pork ham" is the following according to the Romanian standards:

1. Preparation of raw material

The raw material for the preparation of the pressed ham is pork without bone, according to STAS 2709-77. The pulp is detached from the semi-carcass, and then it is shaped, removing the excess fat from the inside, coccygeal region and hamstring, leaving the bone of the pelvis and femur with adjacent tissues. The pulp with bacon, without rats, is shaped by removing the outer fat, which must remain in a layer of maximum 1 cm on the surface of the pulp.

2. Meat injection

Boneless pork pulp, properly formed and cooled to 0 - + 4 °C, are injects with 20% brine into the multi-needle injection machine. The meat is weighed before and after the injection in order to check the percentage of brine retained in the meat. Weighing is done on the scale, with daily weights checked, ensuring additional meat to cover weight loss during previous operations. If the amount of brine injected is not more than 19% the difference of 1% brine is added over the injected meat before mixing. If the weight of the injected brine is found to be smaller, the meat is reinserted into the machine to be injected. If the brine retained in the meat is more than 20%, the injected meat is drained before massaging.

3. Massaging the meat

The injected pulp is transported with the help of trolleys to the meat massaging plant. Place the meat in the mixer and first knead the injected meat for 60 minutes. It is preferable to perform vacuum massage if is available in tumblers. It is very important that the first kneading of the meat is carried out at less than 0.5 hours after the completion of the injection. otherwise the meat loses brine which, after mixing, is no longer fully enclosed.

4. Maturation of meat

After massaging the meat is placed in the basin, stored in cold rooms at 0 - + 4 °C for maturation and preservation for 4 - 6 hours, until all muscle mass, in section becomes red and maturation has occurred in meat, revealed by proper aspect.

5. Mixing II

It is also made in a mixer and results is a finished product with a porous appearance. It is very important that this last mixing should be done at 30 minutes before filling. In order to achieve a good mixing, there must be pay attention that the filling of the vats with meat does not exceed the working capacity provided in the machine design.

The mixing will last for 3 - 6 hours, until the brine is completely embedded in the meat.

6. Filling the forms

For filling, traditional forms of pressed ham with a capacity of about 4 kg of meat will be used. Each press will be lined with polyethylene foil. The meat is introduced in stainless steel, with foot and removable bottom. When placing in forms, the following steps must be taken:

- the meat pieces should be placed with the muscle fibers in the direction of the longitudinal axis of the shape;
- the adjacent pieces are of a hue as close as possible;
-the pieces of meat are placed and pressed so that there are no gaps between the pieces;
- the heads of the pieces should overlap on a portion of about 2 cm.

The filling process is done manually.

7. Folding polyethylene film

Folding the polyethylene film is done after filling the meat in presses, the entire surface of the meat should be covered with polyethylene foil.

8. Laying the covers on shapes

The seated lid is meat is pressed as much as the meat resistance allows.

9. Pasteurization

The ham forms are stacked in perforated baskets and inserted with the basket in boiling kettles. The boiling is done at a water temperature of 80 °C.

10. Pressing

After boiling, before cooling the lid is pressed again, thus pressing the hot ham.

11. Cooling

After boiling and pressing the product is cooled in a stream of cold water, after which the presses are placed in refrigerated rooms for 12-16 hours. The product is considered to be cooled when the temperature inside the ham is 0 - +4 °C.

12. Removing molds

After cooling the product is removed from the molds, then allowed to scratch slightly and then molded on the edges.

13. Product packaging and labeling

The pressed ham is individually wrapped in parchment paper and placed in plastic crates. After packing, the finished product is labeled by stamping the package or pasting a label on the package.

The label applied to the package must contain the following data:
-the name of the product;
- the name of the producing unit;
- date of manufacture;
-expiration date;
- the composition of the product;
- the caloric content of the product mass unit;
- the name and number of the regulations in force regulating the organoleptic, physico-chemical and microbiological parameters of admissibility.

There are technical problems arising during the development of the technological process:

Tumbling - Mixing:

Foam formation in the tumbler due to too high temperature and/or too low vacuum;

Poor slice integrity, poor water binding ability, shorter durability, poorer color stability at too hot a tumble;

Too high temperature also leads to poor protein breakdown, especially at the beginning of the tumbling process;

Poor slice integrity, gel formation under certain conditions among individual pieces of meat;

Formatting or wrong wrapping respectively:

Holes are formed inside the call and thus gel deposits and poor slice integrity appear, a fibrous appearance if made incorrectly;

Too short tumbler/wrong choice of intervals/tumbler neglect (loading below 2/3 of the total load capacity);

Insufficient protein decomposition, resulting in poor slicing integrity and poor water binding ability, the piece has a strong bite;

Too long tumble:

Inclusions in the form of filling between the pieces of meat. If the tumbling is not done under vacuum, then strong foaming, atypical structure, gummy consistency may occur;

Pasteurization:

Too short boil/too low core temperature:

Poor durability, poor color stability, but under certain conditions an internal and external inversion may occur;

Too long boil / too high core temperature:

They lose the cooking, the lack of straw, dry.

Boiling too fast/Boiling at a temp. of the environment too high:

Despite the correct core temperatures, there is a consistency of straw on the edge, and relatively large cooking losses.

Cooling

Cooling too slowly or too short:

The ham hardens too much and reaches a temp. Too high core. This results in too high operating losses. At too low a core temperature, undisturbed microorganisms can multiply too quickly. This leads to very limited durability.

Lack of rest after boiling:

The hammer can break down because it has not stabilized yet.

Packaging/Cutting:

Using the same cutting machine for all types of ham:

Low durability in the chair and in vacuum, because microorganisms (*Lactobacillus ssp*.) are introduced to each other in different meat products;

Too low vacuuming:

It promotes unwanted germs and decreases durability,

Laying in shape / pulling in the sheath

Pressing force too strong:

Losses - too large - when cooking and drying.

Press too low:

Inappropriate form.

The results of respecting the production flow is a low rate withdrawal valuable product that is respecting the shelf life even after is purchased in households.

MATERIALS AND METHODS

The study was designed in the following way:

Storage of product at following temperature:

- room temperature at 20℃
- refrigeration at 0 - 4℃,
- freezing at 18℃

The relative air humidity during storage was kept at 75%.

The duration of the study was six months for each level of temperature.

There were conducted following analysis:

- Sensory analysis,
- Physical - Chemical analysis

Sensory analysis was done by panel method with 0 to 10 score for the following parameters:

- Taste,
- Smell,
- Color,
- Aspect,
- Consistency.

There were ten students that conduct sensory analysis at each month of storage. The refrigerated ham was heated at 20℃, frozen pork ham was defrozen and also heated at 20℃ before sensory assessment. The sensory analysis was done at room temperature at 20℃

Physical - Chemical analysis were done by following parameters:

- Water content,
- NaCl content,
- Nitrits content,
- Protein content,
- Fat content,
- Fat oxidation.

The Physical - Chemical analysis were done at every month.

The Physical - Chemical analysis were done according following methods:

- Water content, by drying in owen at 105 ℃ in 5 hours,
- NaCl content, by Mohr method,
- Nitrits content, by Griess method,
- Protein content, by Kejdahl method.
- Fat content, by Soxleth method,

- Fat oxidation, by Kreiss method,

The samples were done triplicate and we use the average values as presented data.

The statistical interpretation of data was done by average and differences.

Based on the data we propose an integrated tool for assessing not just parameters but also the stability of the product. This approach was related to product appearance and Physical - Chemical properties. The proposed method called PLRS - Points Levels of Recorded Stability was establish links between the changes from product and the admissibility of the product according Romanian law because most of the time product meet the requirements from Physical - Chemical properties but not from sensory properties.

This toll help the people from the field to rise concerns when appearance is exceeding the Physical - Chemical properties of admissibility.

RESULTS AND DISCUSSION

After production of the Pressed Pork Ham during storage there were recorded following values for studied Physical - Chemical parameters:

Table 1. Water content of the Pressed Pork Ham during storage

Month	Water content, %				Diferences		
	Production moment	Storage					
		20℃	0 - 4℃	-18℃	20℃	0 - 4℃	-18℃
01	68	64	66	68	5,88	2,94	0,00
02	68	62	59	68	8,82	13,24	0,00
03	68	59	53	68	13,24	22,06	0,00
04	68	57	51	68	16,18	25,00	0,00
05	68	54	51	67	20,59	25,00	1,47
06	68	51	47	67	25,00	30,88	1,47

Table 2. NaCl content of the Pressed Pork Ham during storage

Month	NaCl content, %				Diferences		
	Production moment	Storage					
		20℃	0 - 4℃	-18℃	20℃	0 - 4℃	-18℃
01	2,38	2,38	2,38	2,38	0,00	0,00	0,00
02	2,38	2,52	2,38	2,38	-5,88	0,00	0,00
03	2,38	2,57	2,44	2,38	-7,98	-2,52	0,00
04	2,38	2,68	2,48	2,38	-12,61	-4,20	0,00
05	2,38	2,82	2,68	2,38	-18,49	-12,61	0,00
06	2,38	3,12	2,84	2,44	-31,09	-19,33	-2,52

Table 3. Nitrites content of the Pressed Pork Ham during storage

Month	Nitrites content, mg/100 g				Diferences		
	Production moment	Storage					
		20℃	0 - 4℃	-18℃	20℃	0 - 4℃	-18℃
01	6,22	6,22	6,22	6,22			
02	6,22	6,30	6,22	6,22			
03	6,22	6,32	6,22	6,22			
04	6,22	6,41	6,31	6,23			
05	6,22	6,47	6,38	6,25			
06	6,22	6,87	6,38	6,28			

Table 4. Protein content of the Pressed Pork Ham during storage

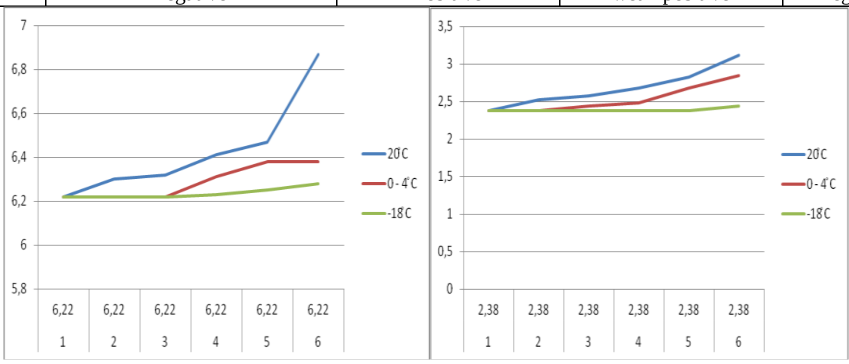
Month	Protein content, %				Diferences		
	Production moment	Storage					
		20℃	0 - 4℃	-18℃	20℃	0 - 4℃	-18℃
01	13	12,60	13	13	3,08	0,00	0,00
02	13	12,54	12,77	13	3,54	1,77	0,00
03	13	12,50	12,71	13	3,85	2,23	0,00
04	13	12,32	12,68	13	5,23	2,46	0,00
05	13	12,24	12,54	13	5,85	3,54	0,00
06	13	12,18	12,48	12,75	6,31	4,00	1,92

Table 5. Fat content of the Pressed Pork Ham during storage

Month	Fat content, %				Diferences		
	Production moment	Storage					
		20℃	0 - 4℃	-18℃	20℃	0 - 4℃	-18℃
01	27	25	27	27	7,41	0,00	0,00
02	27	24	26	27	11,11	3,70	0,00
03	27	21	26	27	22,22	3,70	0,00
04	27	21	26	27	22,22	3,70	0,00
05	27	20	25	27	25,93	7,41	0,00
06	27	19	23	26	29,63	14,81	3,70

Table 6. Fat oxidation of the Pressed Pork Ham during storage

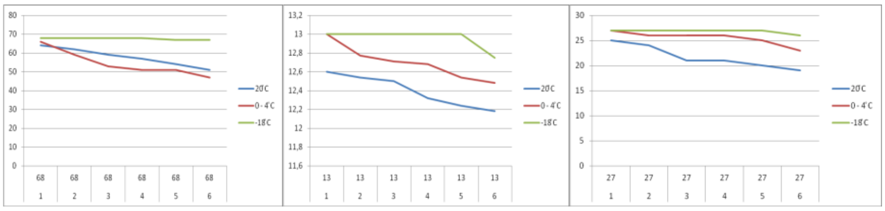
Month	Fat oxidation			
	Production moment	Storage		
		20℃	0 - 4℃	-18℃
01	negative	negative	negative	negative
02	negative	negative	negative	negative
03	negative	weak positive	negative	negative
04	negative	weak positive	negative	negative
05	negative	weak positive	weak positive	negative
06	negative	Positive	weak positive	negative



(a) (b)

Figure 1. Comparison of the Nitrites content (a) and NaCl content (b) during storage as PLRS

There were shown that the Nitrites content and NaCl content during storage are acting as PLRS. After three months stored ham at room temperature become very close to the maximum allowed limit for nitrites (7 mg/100g) and after six months exceded even the maximum aloved limit for NaCl content (3%).



(a) (b) (c)

Figure 2. Comparison betwen samples during storage from the water content (a), protein content (b) and fat content (c) point of view as PLRS

The second batch of results water content, protein content and fat content are PLRS and shown us slopes that indicate a severe decreasing of nutritional values (protein and fat content) but also losees in water that lead to sensory issues as we will present bellow.

The Kreiss reaction, fat oxidation confirm that the issues of storage revealed by measured parameters presented as PLRS in picture as dynamic are cathc by PLRS.

Sensory analysis shown the following as Points Levels Recorded of Stability:

Table 7. Sensory analysis of the Pressed Pork Ham during storage

Month	Sensory analysis																			
	Production moment					Storage														
						20℃					0 - 4℃					-18℃				
	Taste	Smell	Color	Aspect	Consistency	Taste	Smell	Color	Aspect	Consistency	Taste	Smell	Color	Aspect	Consistency	Taste	Smell	Color	Aspect	Consistency
01	8	9	8	8	7	8	9	8	8	7	8	9	8	8	7	8	9	8	8	7
02	7	8	7	7	7	7	8	7	7	7	7	8	7	7	7	7	8	7	7	7
03	7	7	6	7	7	7	7	6	7	7	7	7	6	7	7	7	7	6	7	7
04	7	7	6	7	6	7	7	6	7	6	7	7	6	7	6	7	7	6	7	6
05	6	6	6	7	6	6	6	6	7	6	6	6	6	7	6	6	6	6	7	6
06	4	6	5	5	6	4	6	5	5	6	4	6	5	5	6	4	6	5	5	6

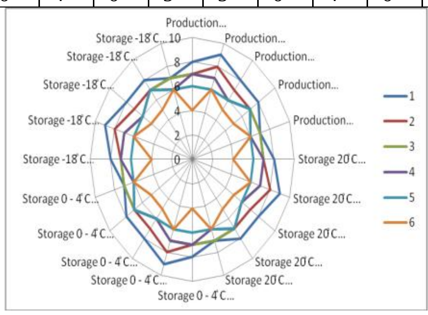


Figure 3. Sensory analysis as PLRS

After comparison of the parameters we can assume that from 3rd month for room temperature and from 5th month for refrigerated one the ham in not apropriate for consumption despite that the Physical - Chemical properties of admissibility are meeting the requirements.

CONCLUSIONS

In conclusion assessing Physical - Chemical properties of admissibility and correlation of them with Sensorial parameters must be done. As we shown on the graphs there were similar behavior of ham batches regarding all parameters at the studied storage temperature.

The final evaluation based on Physical - Chemical properties and Sensorial parameters allow to design an integrated toll for assessing the global pork ham quality and admissibility in consume PLRS - Points Levels of Recorded Stability.

There are side conclusions regarding values of PLRS that shown us the recommended storage of pork ham - refrigeration at 0 - 4°C for long time storage.

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