



Processing dry-cured ham as formed meat product using different bond systems

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Contents

1. Introduction and research aims
2. The State of Knowledge
3. Materials and methods
4. Results and discussion
5. Summary

1. Introduction and research aims

Definition and legal basis

Depending on the country of origin, dry-cured raw ham is traditionally manufactured using either whole pork legs

Parma ham from Italy



www.rovagnati.it

Serano ham from Spain



www.jamonescastillo.com

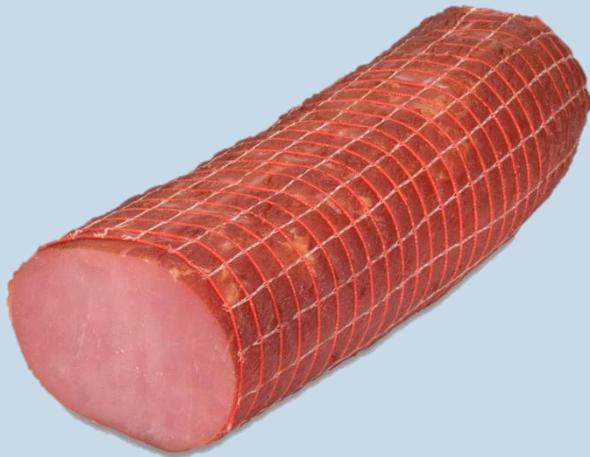
1. Introduction and research aims

Definition and legal basis

or defined whole muscles or a combination of different parts

M. longissimus dorsi

Tenderloin ham from Austria



<http://www.landler-schinken.de>

M. rectus femoris,
M. vastus lateralis,
M. vastus medialis,
M. vastus intermedius

Nusschinken from Germany

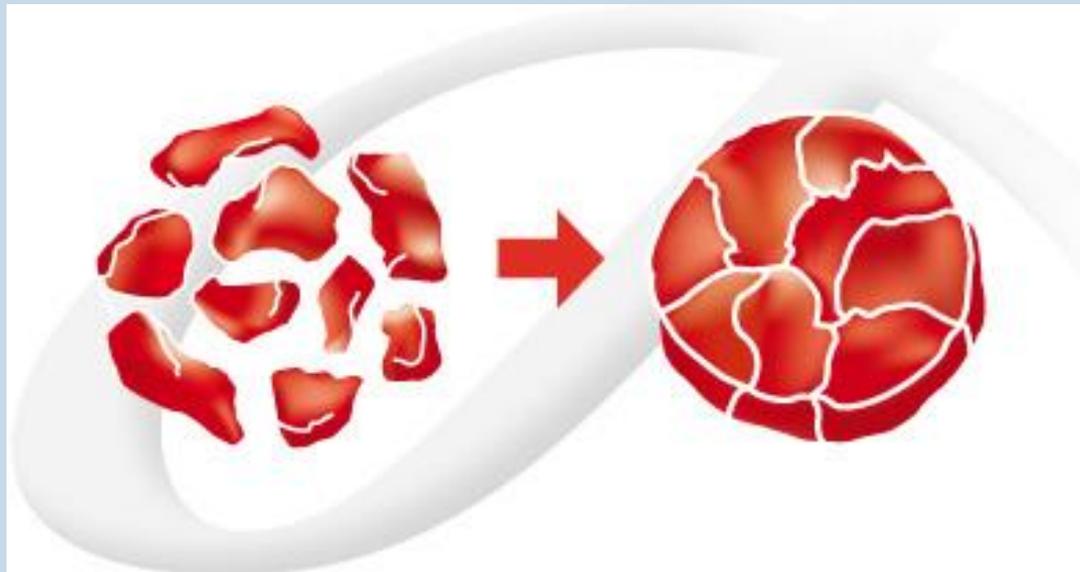


www.fleischerei-kaeding.de

1. Introduction and research aims

Definition and legal basis

Meanwhile, another category of aggregated (or agglomerated) raw ham products came up where relatively small pieces of meat with an edge length of 2 to 10 cm can be used as raw material (Islam, 2011; Beneke et al., 2011; Lautenschläger, 2013, 2011).



www.ajinomoto.de

1. Introduction and research aims

Definition and legal basis

Nevertheless, such product can be produced based on the Regulation (EU) No 1169/2011 of the European Parliament and of the Council of 25 October 2011 on the provision of food information to consumers.

According to Annex VI, Part A, Pt. 7 of this regulation

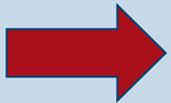
“Meat products, meat preparations and fishery products which may give the impression that they are made of a whole piece of meat or fish, but actually consist of different pieces combined together by other ingredients, including food additives and food enzymes or by other means, shall bear the following indication:

‘formed meat’”

1. Introduction and research aims

Dry-cured formed ham is a completely new product category

- Lack of appropriate information regarding
 - Safety: Microbiology and Analytics
 - manufacturing technology
 - detectability



There is a considerable need for research

1. Introduction and research aims

Objectives and content of the research project:

- Market analysis to clarify the
 - Availability
 - sensory, microbiological and physico-chemical properties

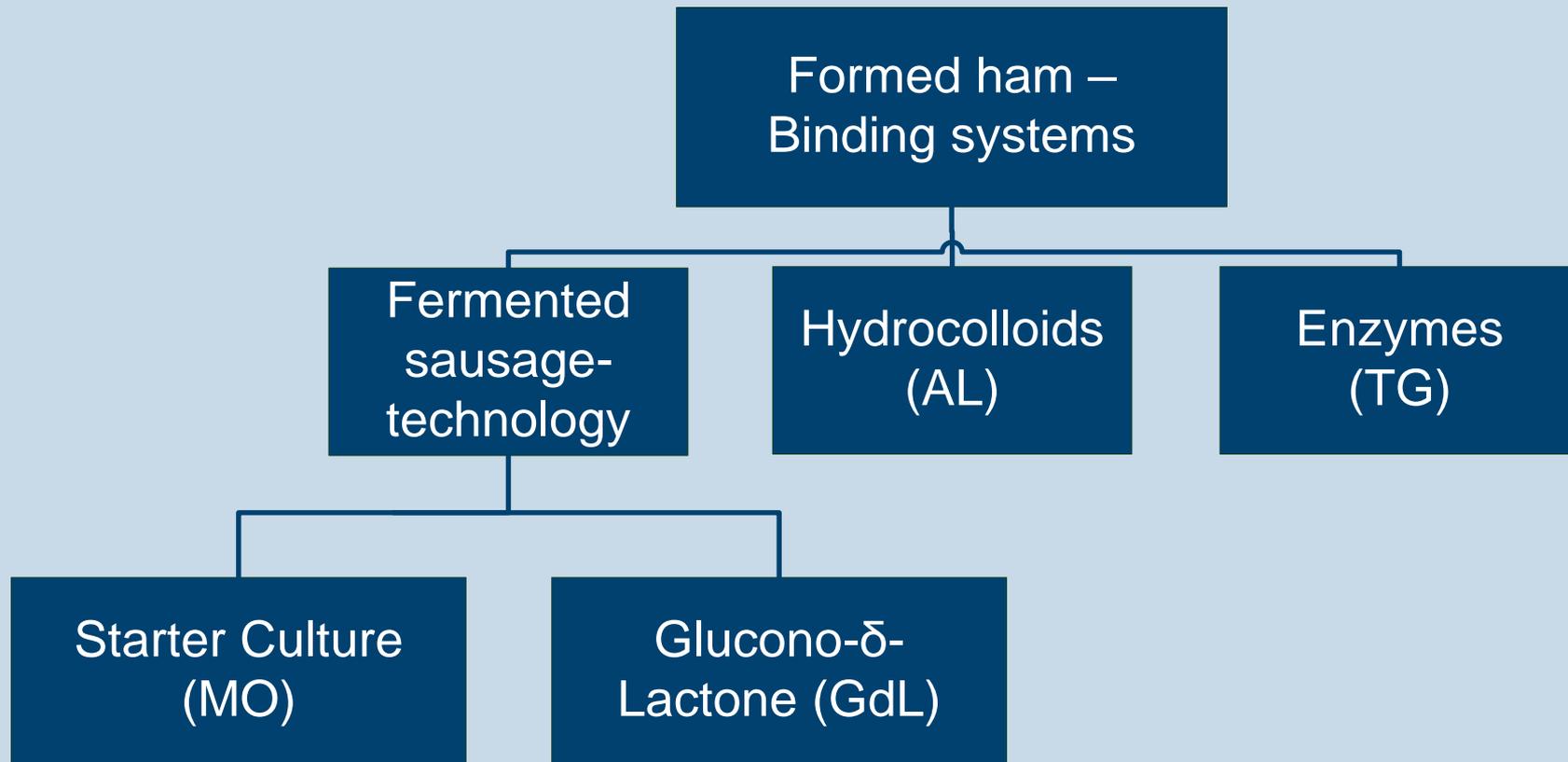
- Literature research to determine the current available knowledge,

- Own investigations
 - manufacturing technology
 - Product and Consumer Safety

2. The State of Knowledge

Technology of formed dry cured ham

For the production of such new products, the following possibilities are available:



2. The State of Knowledge

Fermented sausage-technology

The native salt soluble myofibrillar proteins of meat, which can be partially denatured by influence of acid, can act as a bond system between the smaller meat pieces.

Glucono-delta-Lactone

- GdL is an inner anhydrite of gluconic acid and is mainly used as an acidulant in fast-ripened raw sausages, which accelerates the color formation and the increase in firmness (Stiebing, 2007).

Starter Culture

- Selected microorganisms with defined metabolic properties
 - *Lactobacillus sakei*
 - *Lactobacillus plantarum*
 - *Micrococcus kocuria*
 - *Staphylococcus xylosus*
 -

2. The State of Knowledge

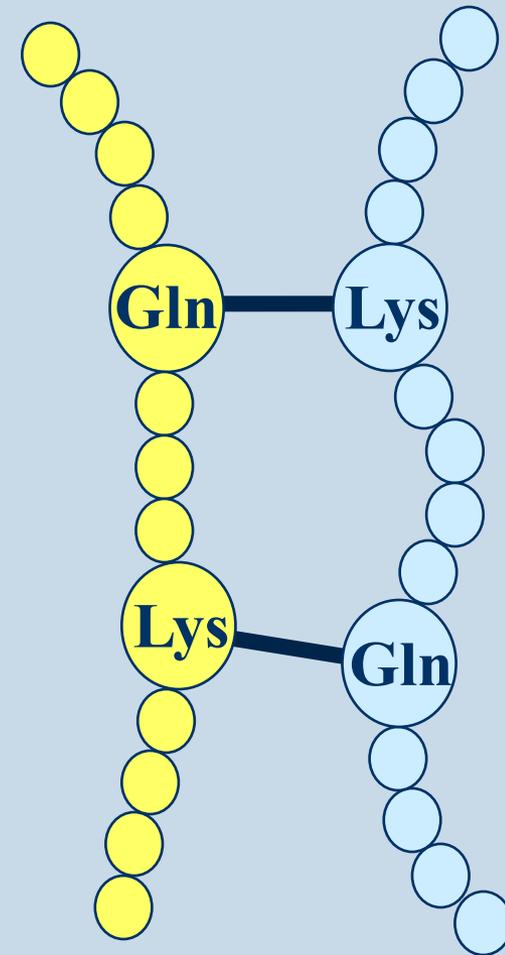
Use of structure-forming enzymes

The complete name of TGase is protein-glutamine γ -glutamyltransferase (EC 2.3.2.13) and it belongs to the group of acyltransferases.

TGases catalyze the acyl-transfer reactions between a γ -carboxyamine group of a peptide-bound glutamyl residue and a primary amino group of a variety of substrates including the ϵ -amino group of lysine or lysyl residues in proteins (Buchert et al., 2010; Kanaji et al., 1993)

It crosslinks the protein molecules by the formation of covalent intra- and intermolecular isodipeptide bonds.

This creates larger protein associations from smaller peptides and proteins.



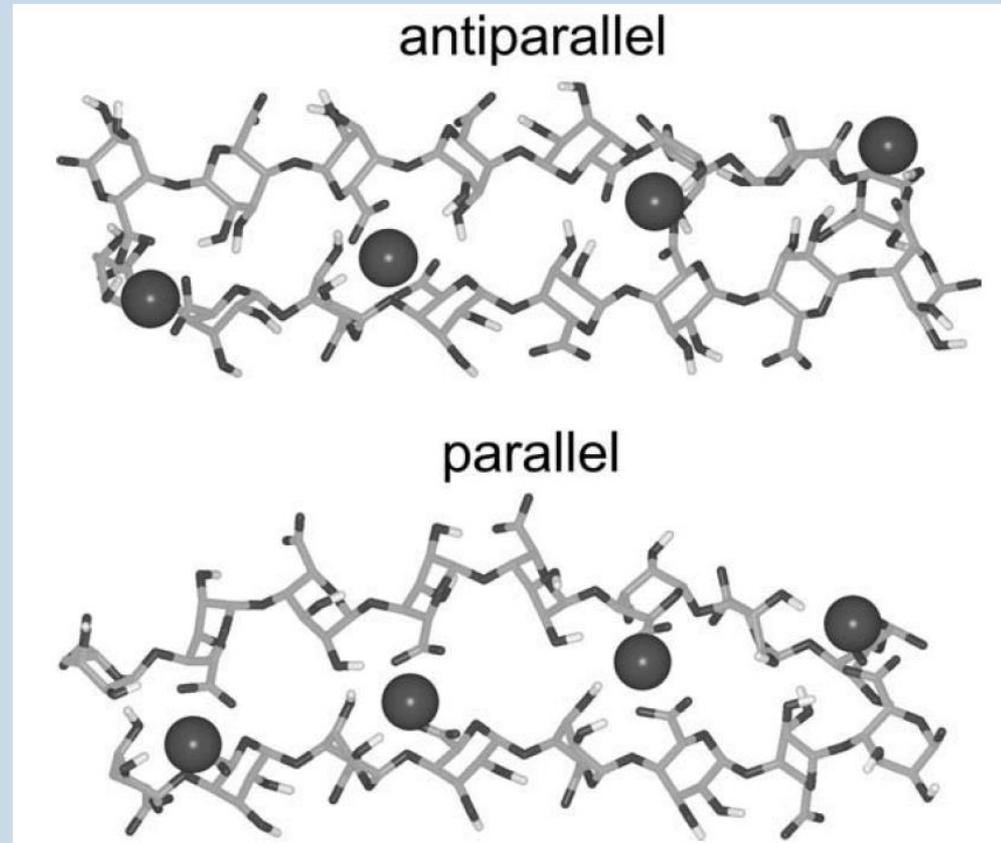
Heukeshofen (2013)

2. The State of Knowledge

Use of hydrocolloids

The monomers of alginate are
 α -L-guluronic acid
 β -D-mannuronic acid

The gel formation is based on
association (GG blocks) of
polyguluronate chains by chelation
of Ca^{2+} ions



Structures of the Ca^{2+} -oligo (guluronate) complexes
(Plazinski, 2011)

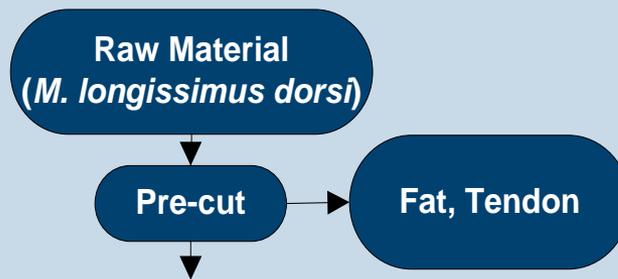
3. Materials and Methods

Raw Material
(*M. longissimus dorsi*)



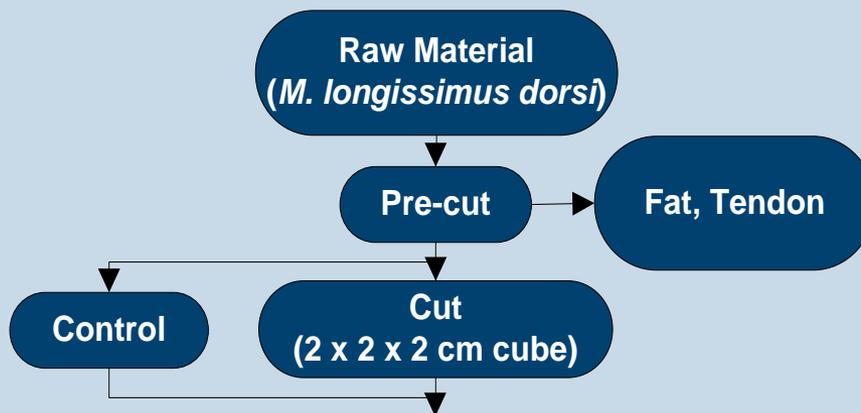
Flow chart showing the manufacturing steps

3. Materials and Methods



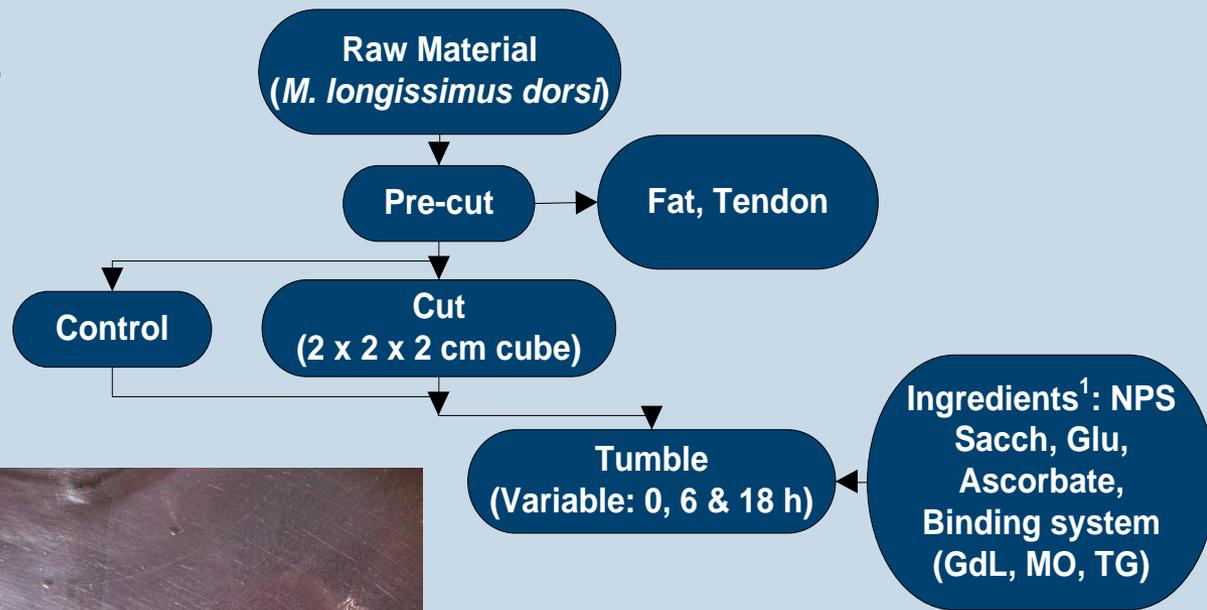
Flow chart showing the manufacturing steps

3. Materials and Methods



Flow chart showing the manufacturing steps

3. Materials and Methods



Tumbling distance:

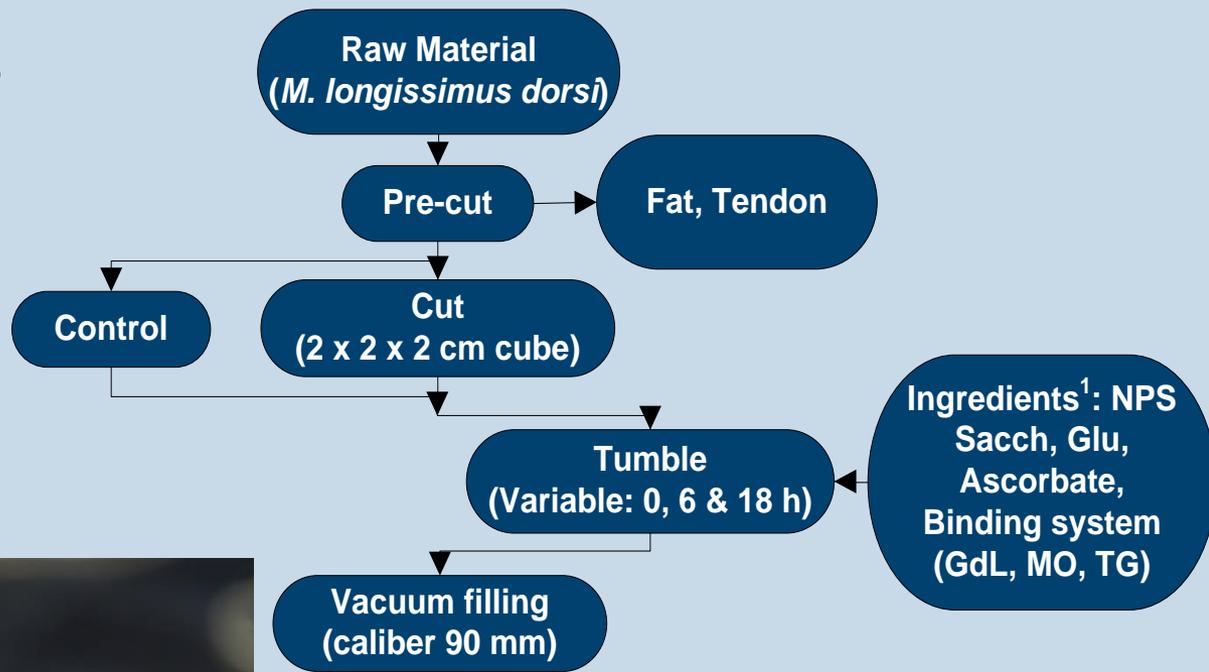
0 h \triangleq 0 m

6 h \triangleq 5736 m

18 h \triangleq 17208 m

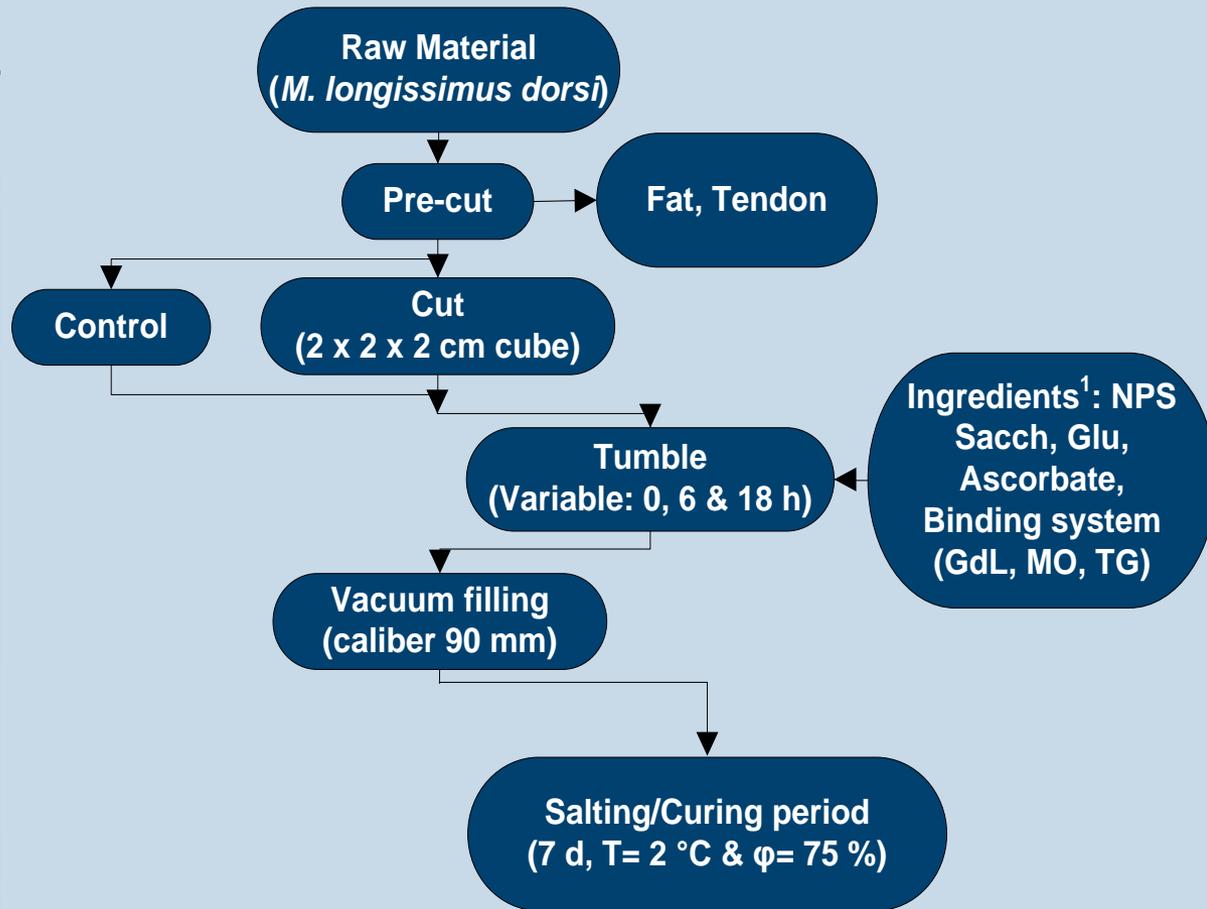
Flow chart showing the manufacturing steps

3. Materials and Methods



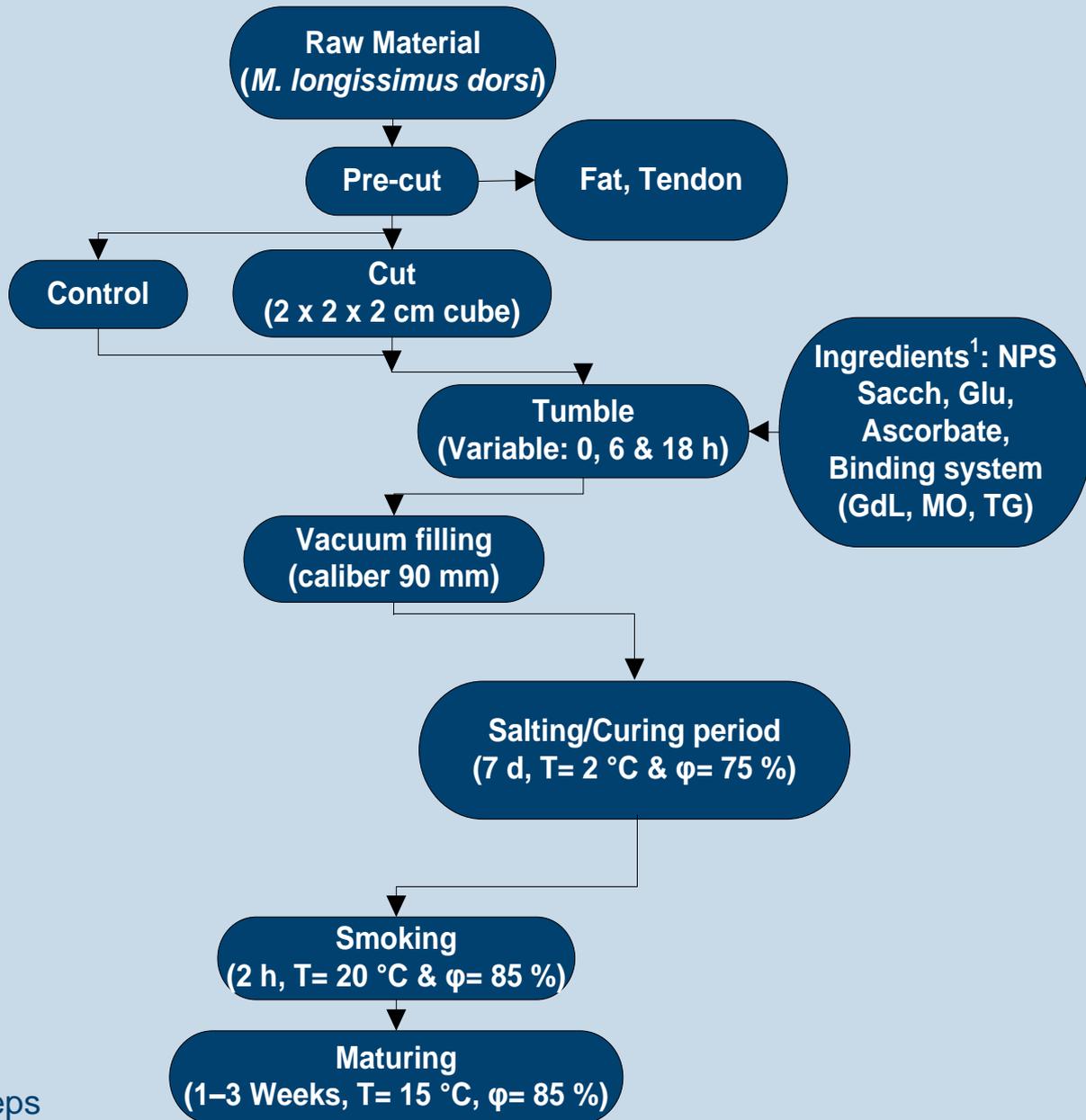
Flow chart showing the manufacturing steps

3. Materials and Methods



Flow chart showing the manufacturing steps

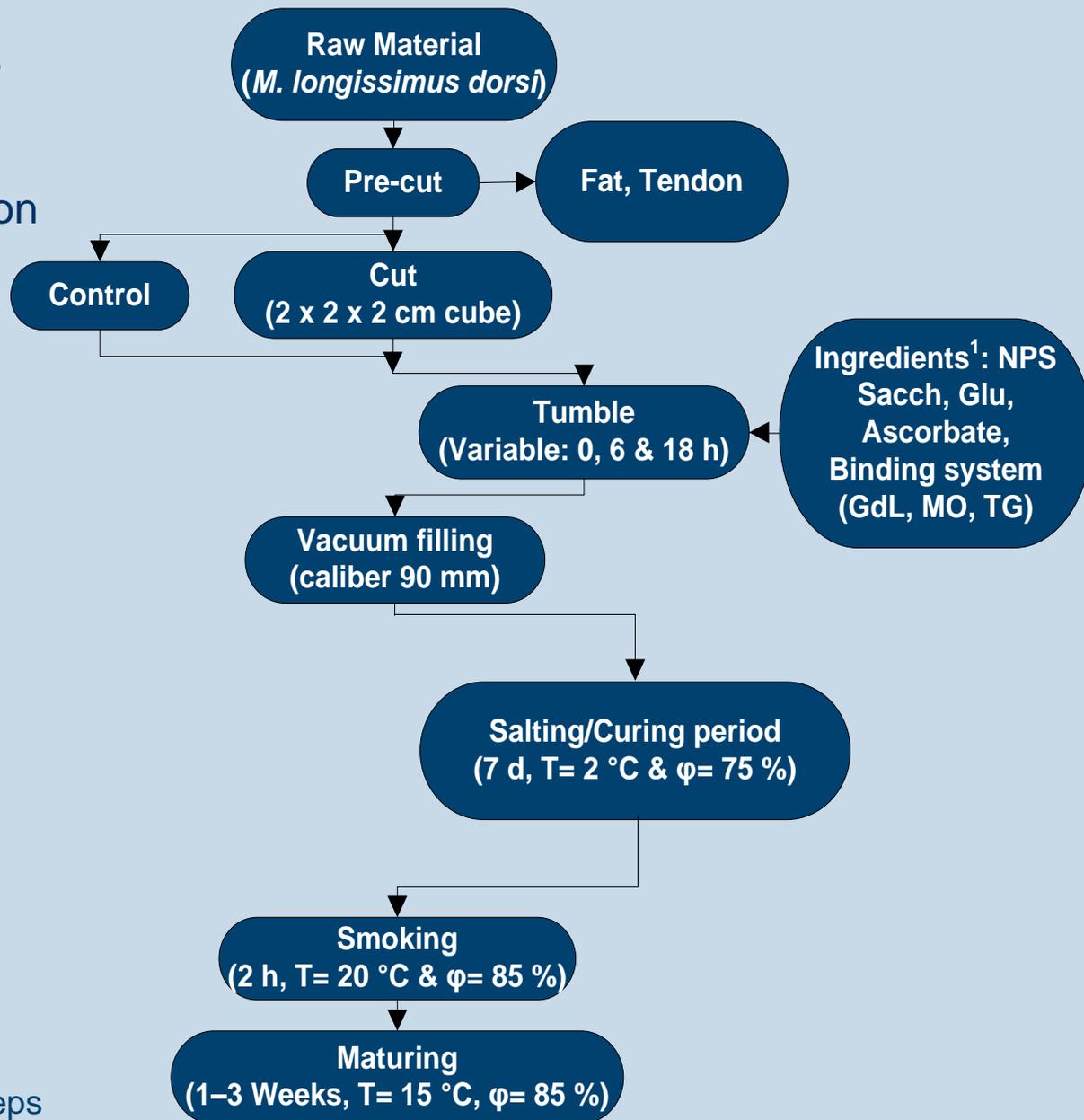
3. Materials and Methods



Flow chart showing the manufacturing steps

3. Materials and Methods

Na⁺-ions in a higher concentration
→ competition between
Na⁺- and Ca²⁺-ions
for the free O₂ atoms
of polyguluronate
chains

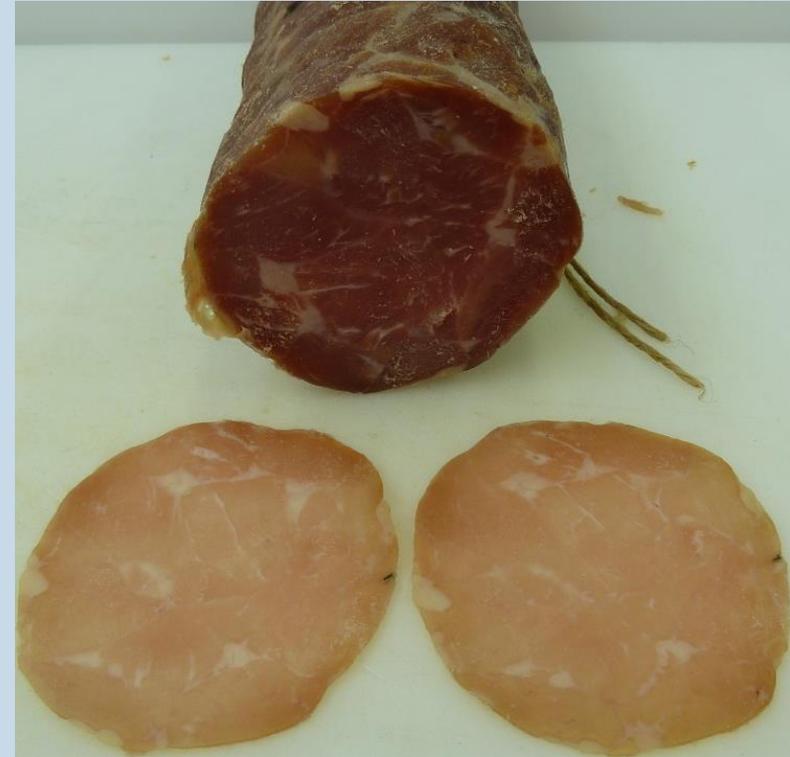


Flow chart showing the manufacturing steps

3. Materials and Methods



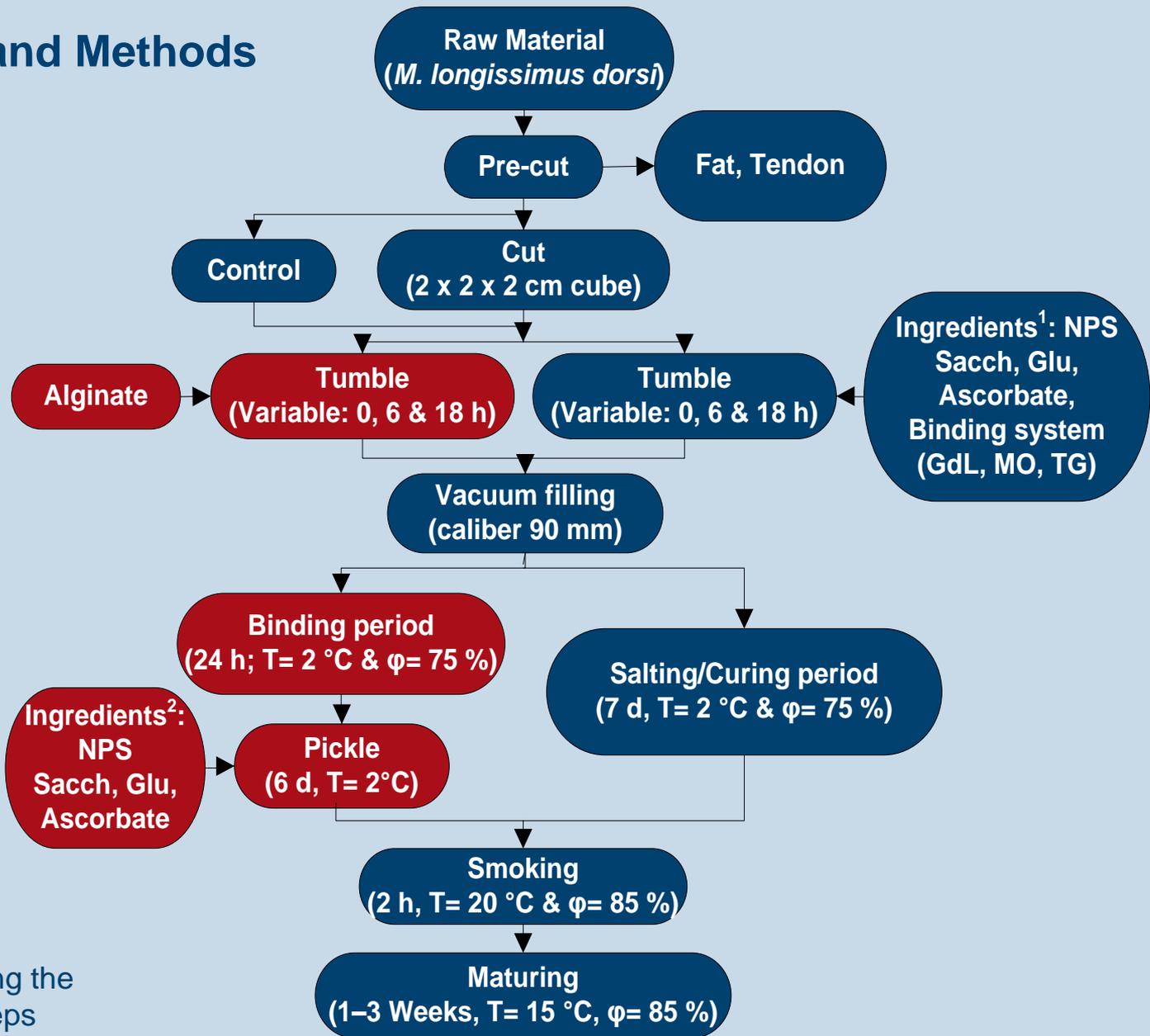
High concentrations of sodium compete with the calcium cations for the free O₂ molecule of polygluronate chains leading to prevention of gelation



First, realizing the chelation of the Ca²⁺ ions

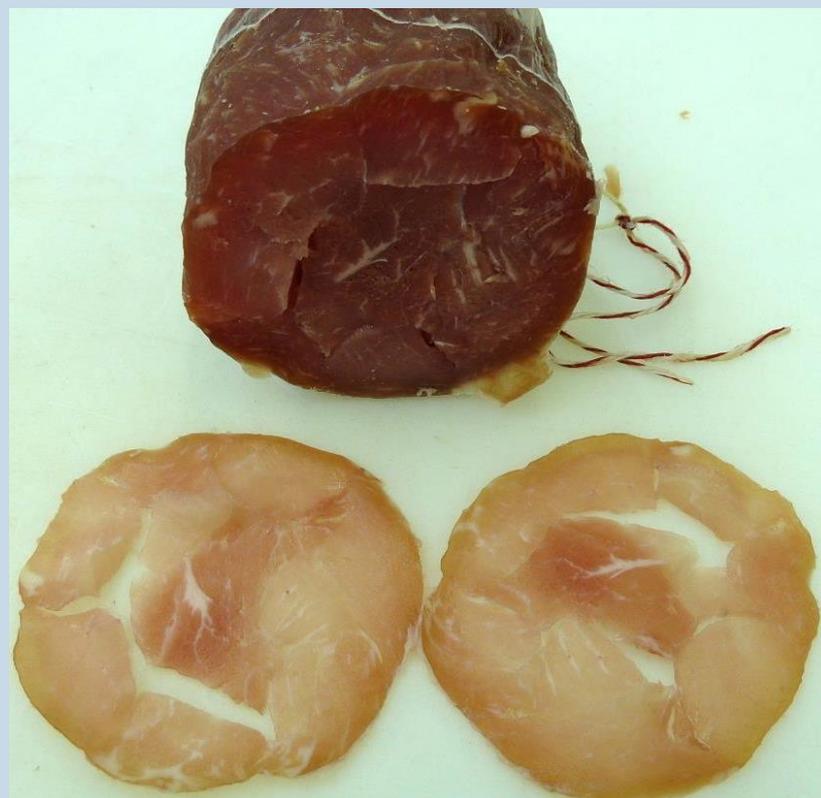
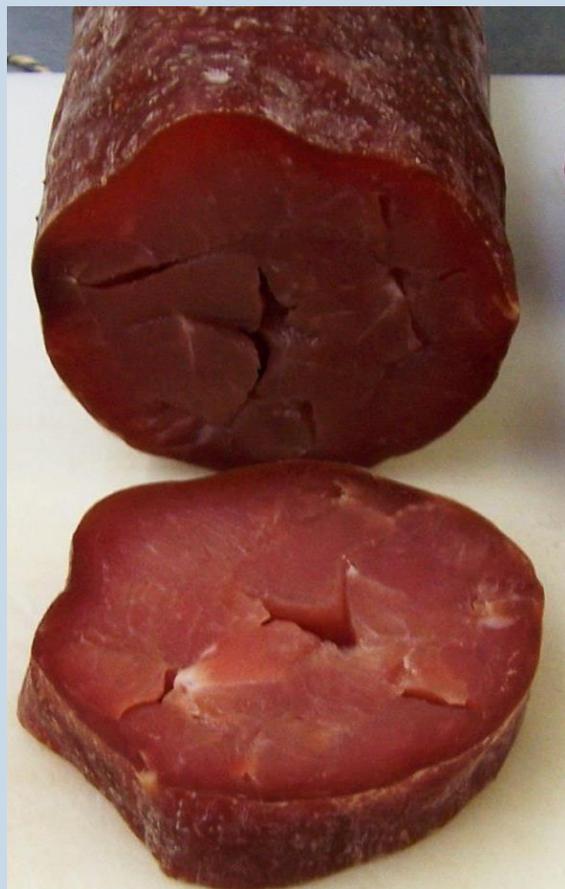
Then, curing and drying

3. Materials and Methods



Flow chart showing the manufacturing steps

3. Materials and Methods; Without binding system



- Binding and appearance unacceptable
- Preparation of thin slices not possible

3. Materials and Methods

- **Physicochemical analyses:**
 - NaCl, water, nitrite and nitrate
 - a_w - and pH-value

- **Sensory evaluation:**

- Local separation
- Coherence
- Binding site recognizable
- Saltiness
- Sourness
- Glutinousness

- **Microbiological analysis:**
 - Mesophilic aerobic bacteria
 - *Enterobacteriaceae*
 - *Lactobacillaceae*
 - Yeasts and fungi

Scoring scale	Quality rating
5	Very well
4	Well
3	Satisfactory
2	Less satisfactory
1	Not satisfactory
0	Deficient

4. Results and Discussion – Market analysis

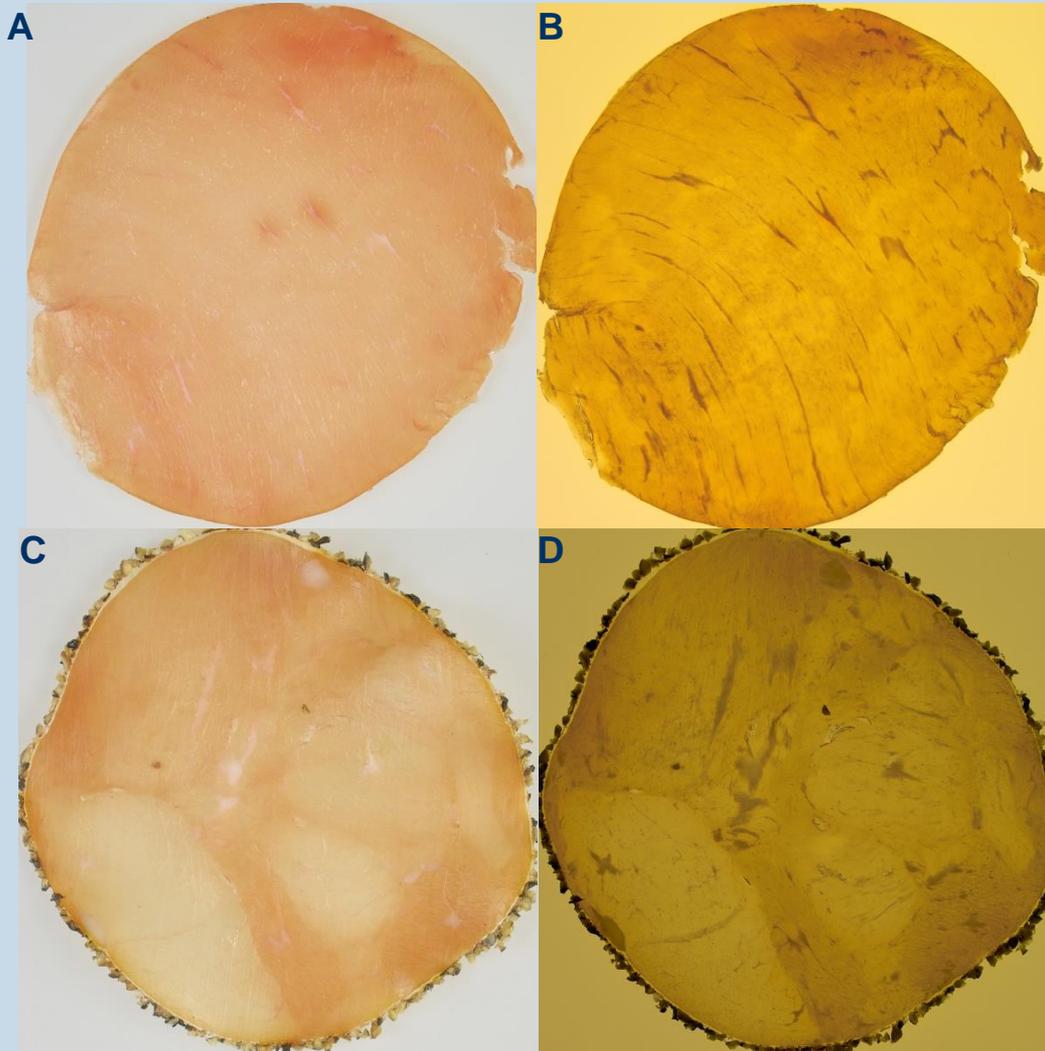
Dry-cured ham products were acquired from the retail

Samples were both packed (list of ingredients) and in slices examined and photographed on the light table

The investigations were focused on the presence of “binding sites” or structures, which are indicative for formed dry-cured ham

Product	Number	Conspicuous
Tenderloin ham	10	1
Nussschinken	3	0
Dry-cured ham and light products	8	1
Dry-cured turkey ham	4	4
Cattle products	3	0

4. Results and Discussion – Market analysis



A and B reference sample under different lighting

C und D: conspicuous
E: Declaration

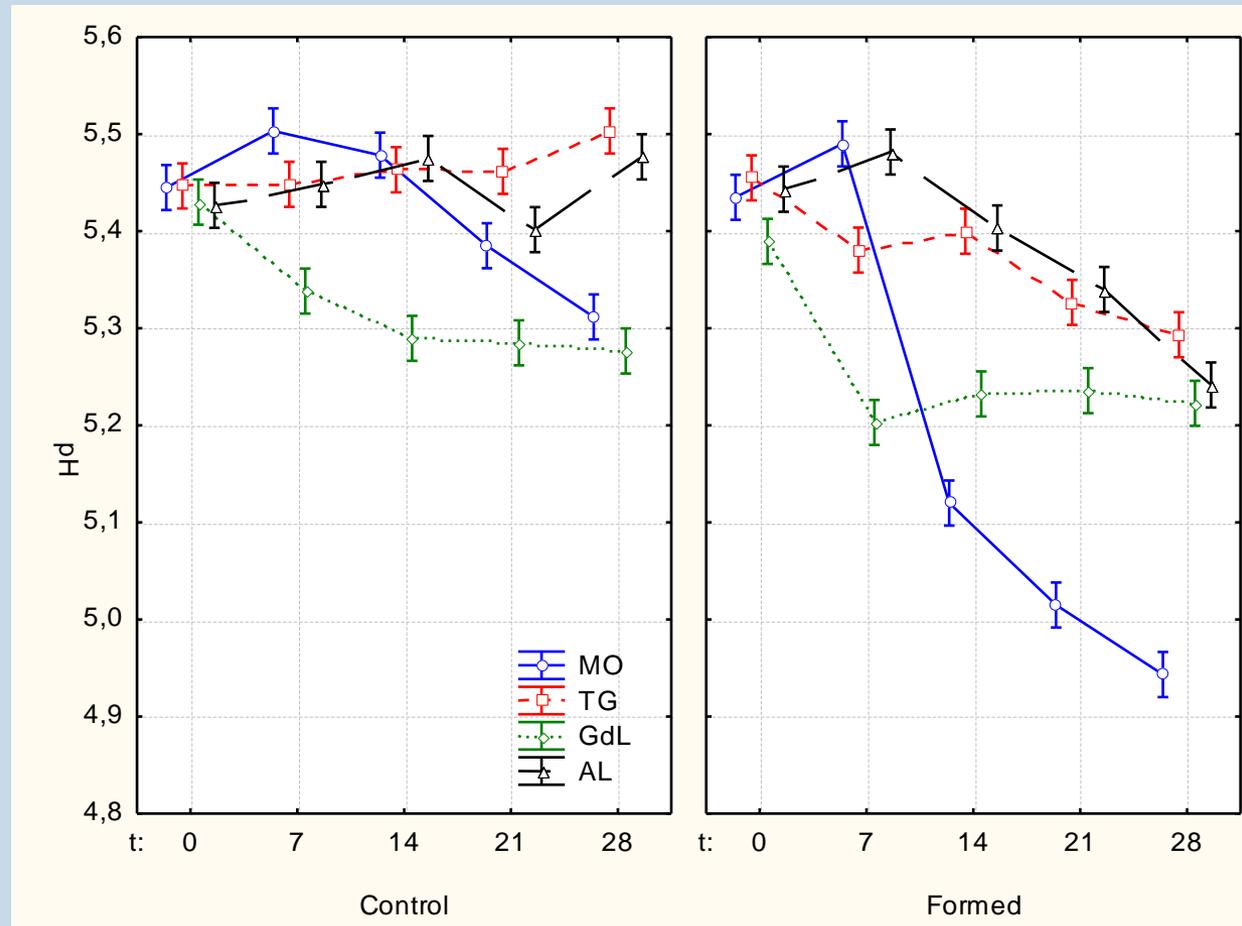


$H_2O = 51,93 \%$
 $a_w = 0,89$

According to guidelines for fresh and processed meat:
Frühstücksschinken: max. 65 %

4. Results and Discussion – pH-value

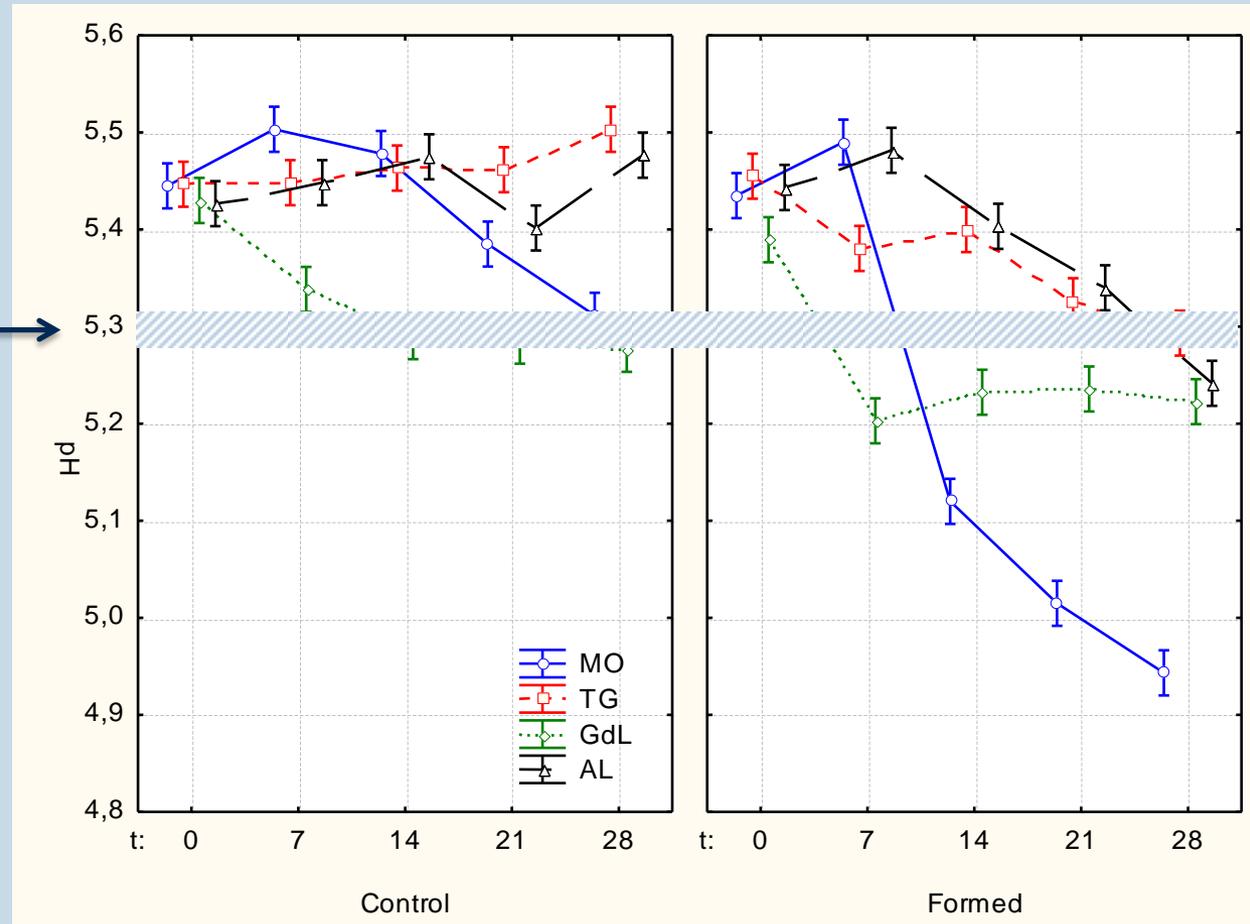
- Influencing factors:
 - t
 - BS
 - Control/Formed
 - Interactions
- The pH of the GdL and MO samples is of crucial importance for the binding strength of meat pieces.



Changes in pH of dry-cured hams during processing

4. Results and Discussion – pH-value

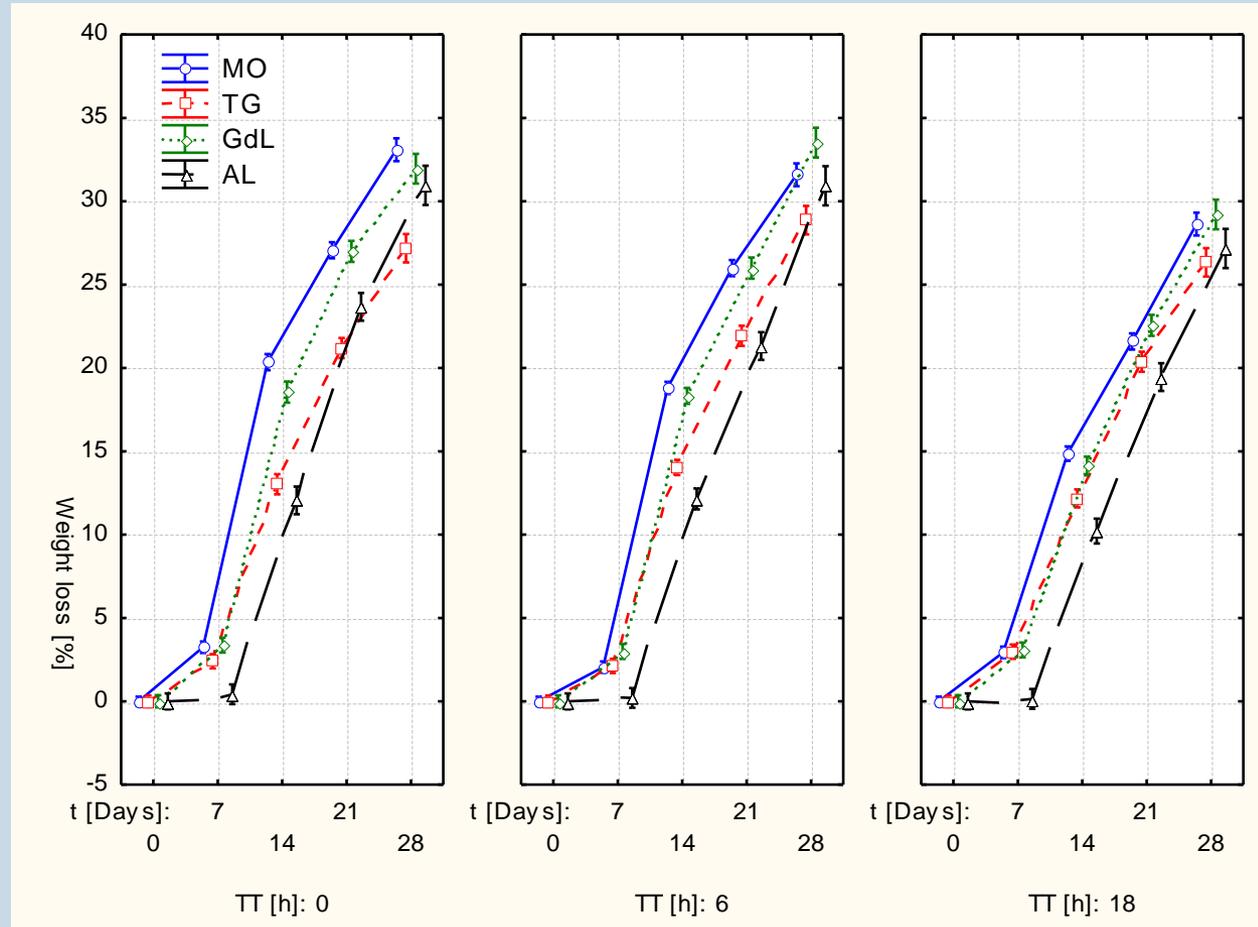
IEP of the myofibrillar proteins
(Honikel, 2007)



Changes in pH of dry-cured hams during processing

4. Results and Discussion – Weight loss

- Influencing factors:
 - t
 - TT
 - BS
 - Control/Formed
 - Interactions



Weight loss (%) of dry-cured hams during processing

4. Results and Discussion – Weight loss

- It is known that the tumbling process causes a damage of the cellular structure of the meat
- ➔ This leads to a strong mobilization of fibrillar muscle proteins, further to a better swelling of the proteins and finally to an increased water holding capacity (Müller, 2007)

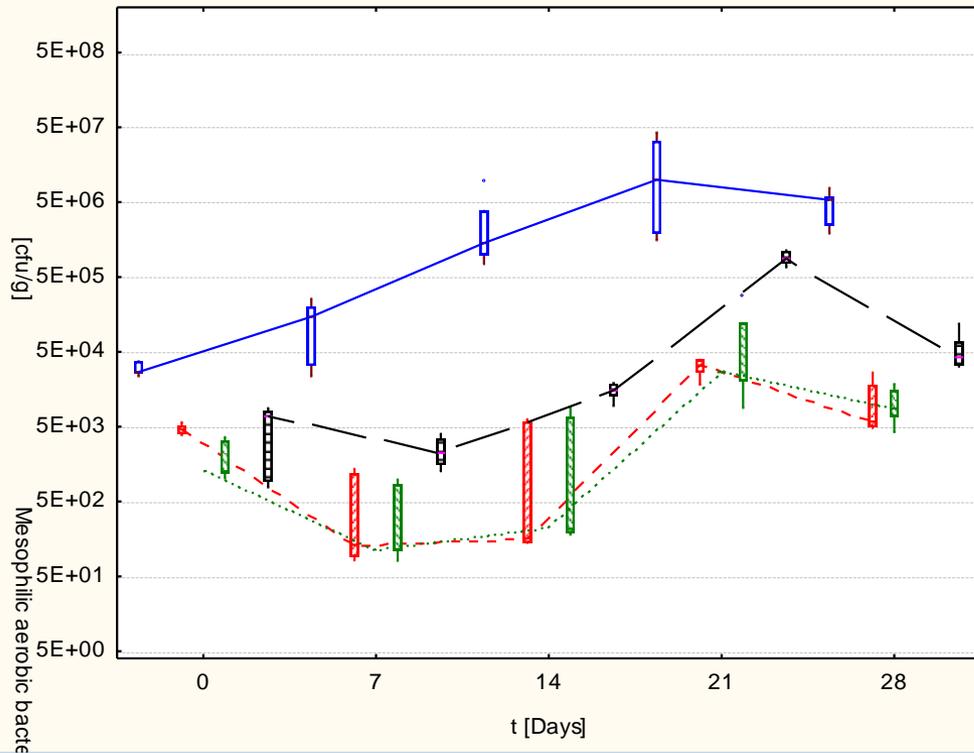
Comparing the binding systems the results allow a ranking

MO (17.97 %) > **GdL** (16.71 %) > **TG** (14.07 %) > **AL** (13.47 %); $p < 0,05$

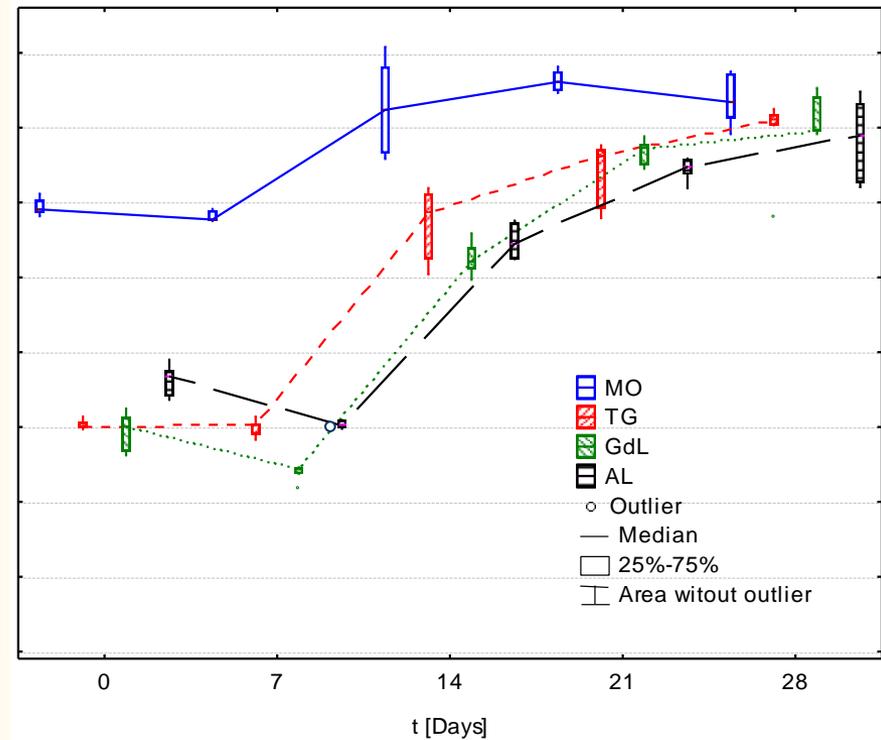
- ➔ The acidulation induces the pH drop, thus partial denaturation of myofibrillar proteins and consequently some water release

4. Results and Discussion – Microbiological analysis

Control



Formed



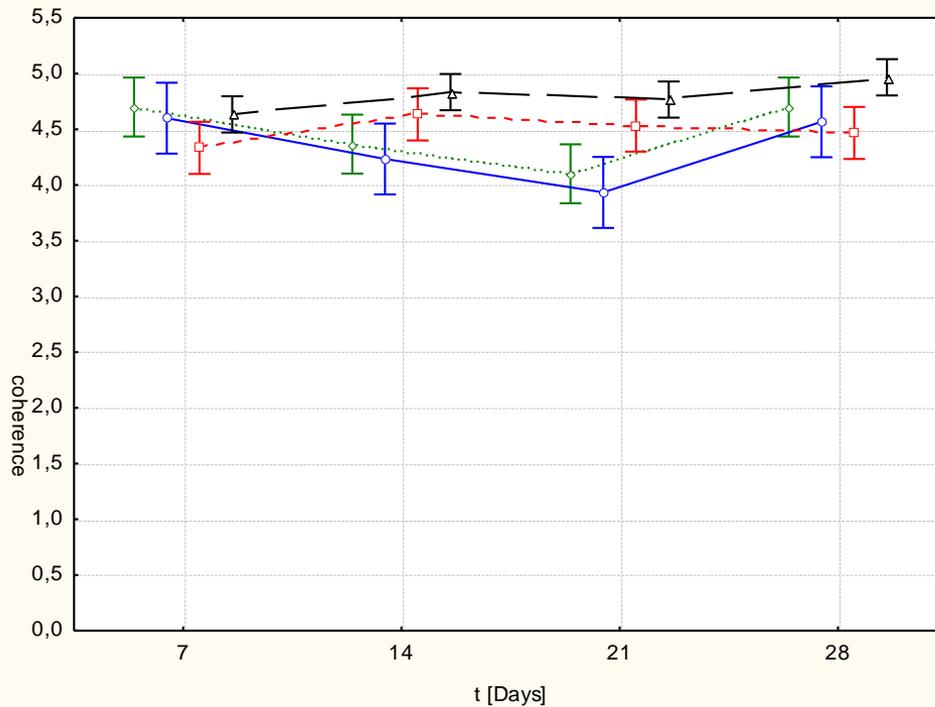
Changes during processing in the counts (CFU/g) of mesophilic aerobic bacteria

- LAB dominated the microflora and correlated ($R = 0.73$) with the MAB during the manufacturing period
- The counts of MAB and LAB in formed samples were 2 to 4 log cycles higher

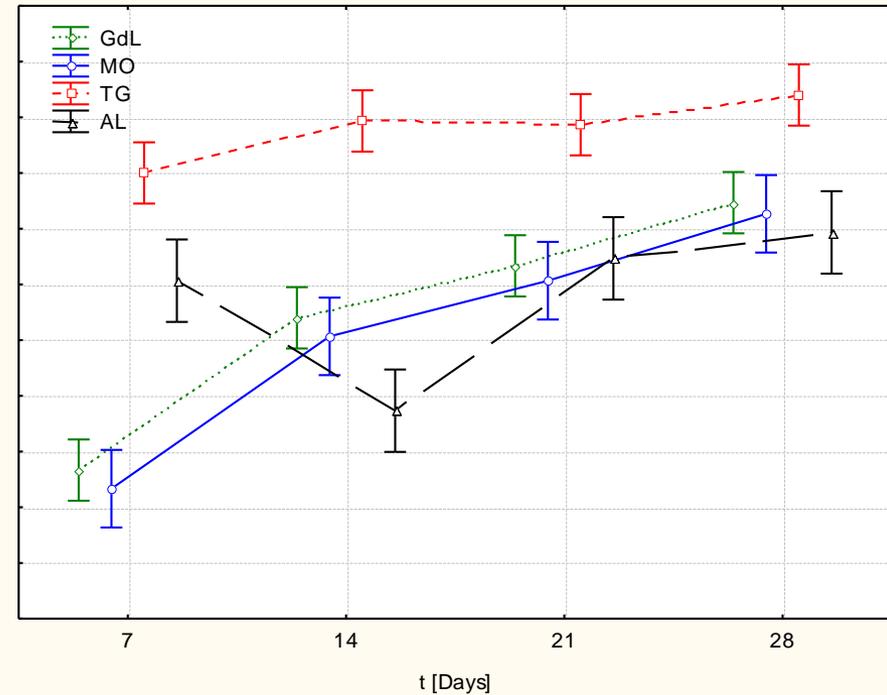
4. Results and Discussion – Sensory evaluation

Characteristic: Coherence

Control



Formed

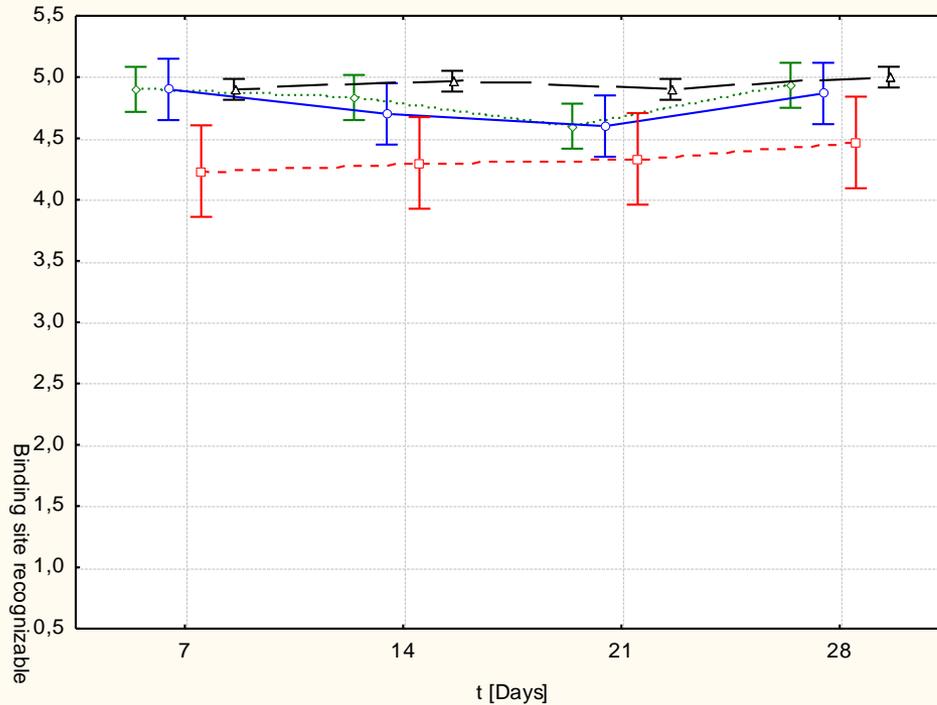


Influencing factors: t, BS, Control/Formed, Interactions

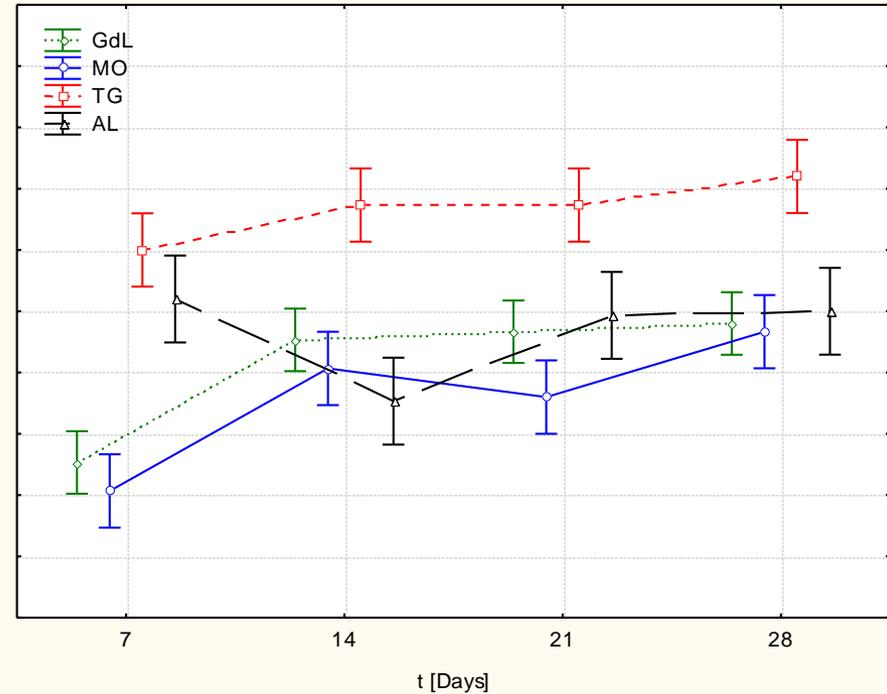
4. Results and Discussion – Sensory evaluation

Characteristic: Binding site recognizable

Control



Formed



Influencing factors: t, BS, Control/Formed, Interactions

4. Results and Discussion – Sensory evaluation

after 7 Days

after 14 Days

after 21 Days

after 28 Days



All samples with a TT of 18 h, above: GdL; below: MO

- Three weeks maturing is sufficient to guarantee the cohesion of the pieces of meat
- Visual recognition of the pieces of meat increases with increasing maturation
- The goodness of the cohesion increases with increasing maturation

4. Results and Discussion – Physicochemical analyses

	after 21 Days			after 28 Days		
Parameter	TT 0 h	TT 6 h	TT 18 h	TT 0 h	TT 6 h	TT 18 h
H ₂ O [%]	61,58±0,39	61,53±0,69	63,92±0,10	59,34±2,16	57,81±0,28	59,34±0,16
a _w	0,94±0,01	0,93±0,00	0,93±0,01	0,92±0,01	0,92±0,00	0,93±0,00
NaCl [%]	3,62±0,09	3,62±0,10	3,38±0,06	3,76±0,1	3,94±0,18	3,73±0,17
NaNO ₂ [mg/kg]	2,3±1,0	2,5±0,1	3,0±0,7	1,9±0,1	2,1±0,7	2,9±0,2

- For ensuring the cohesion of the individual pieces of meat, the weight loss by drying, depending on the TT should be at least 22%

5. Summary

The market analysis showed:

- ❖ Formed dry-cured products are available on the market. Not all of these products are declared as such.

The experimental results showed:

- ❖ The production of formed dry-cured ham from smaller meat pieces is possible
- ❖ The formed dry-cured hams were identified by trained sensory panel as such.
- ❖ Using raw materials with a low germ content and substantially free of pathogenes, and fresh meat with typical flora produced according to good manufacturing practice (GMP), the microbiological stability can be guaranteed.

**Thank you
for your attention**