Danish Meat Research Institute

DANISH TECHNOLOGICAL INSTITUTE

Report

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Novozymes

Meat protein extract in chopped ham

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Summary

Background

Novozymes wanted to invest the effects on yield, functionality and sensory aspects of a meat protein extract (MPE) added as a meat replacer in a sodium reduced ham.

Conclusion

This experiment showed, that MPE could be used up to 5% in a slightly salt reduced chopped ham without impairing yield, sliceability, sensory properties and texture in any way.

Products with 10% addition of MPE were still acceptable regarding sliceability, texture and sensory properties, but with higher cooking loss compared to a reference, though still acceptable.

At 15% or 20% addition levels of MPE, the hams became brown, soft and exudative, with huge holes in the core. The taste was very intense, but not in an unpleasant way.

It is hypothesised, that levels above 5-10% MPE will be possible in salt reduced hams, if the whole amount of salt is added as ‘free’ salt and not bound in the MPE matrix. By doing that, the sodium and chloride ions are free to extract and activate the muscle proteins.

Materials and methods

Layout

Content (% in product)	Batch 1	Batch 2	Batch 3	Batch 4	Batch 5
Meat	80	75	70	65	60
Brine	20	25	30	35	40
MPE[1)]	0	5	10	15	20
Salt from MPE	0	0.5	1.0	1.5	2.0
Salt from brine	2.50	1.88	1.25	0.63	0.00
Salt in total	2.50	2.38	2.25	2.13	2.00

[1)] Included in brine, 10% salt added

Raw material

Topside ham muscle, chopped through two kidney-plates. Approx. chunk size 3 x 3 x 3 cm. 15.00 kg of meat in each batch. The MPE was from pork raw material (Carnad, Løgstør).

Brine compositions

	Brine 1 - 20% gain	
	%	Kg
Water	83.02	2.491
Vacuum salt	9.00	0.270
Nitrite salt	6.00	0.180
Phosphate	1.80	0.054
S. Ascorbate	0.18	0.005
Total	100	3

	Brine 2 - 25% gain		Brine 3 - 30% gain	
	%	Kg	%	Kg
Water	63.95	2.398	49.83	2.242
Vacuum salt	4.40	0.165	1.08	0.049
Nitrite salt	5.00	0.188	4.33	0.195
Phosphate	1.50	0.056	1.30	0.059
S. Ascorbate	0.15	0.006	0.13	0.006
MPE	25.00	0.938	43.33	1.950
Total	100	3.751	100	4.501

	Brine 4 - 35% gain		Brine 5 - 40% gain	
	%	Kg	%	Kg
Water	38.39	2.015	28.84	1.730
Vacuum salt	2.43	0.128	0.00	0.000
$NaNO_2$	0.0023	0.00012	0.0021	0.00013
Phosphate	1.20	0.063	1.05	0.063
S. Ascorbate	0.12	0.006	0.11	0.007
MPE	57.86	3.038	70.00	4.200
Total	100.0023	5.25012	100.0021	6.00013

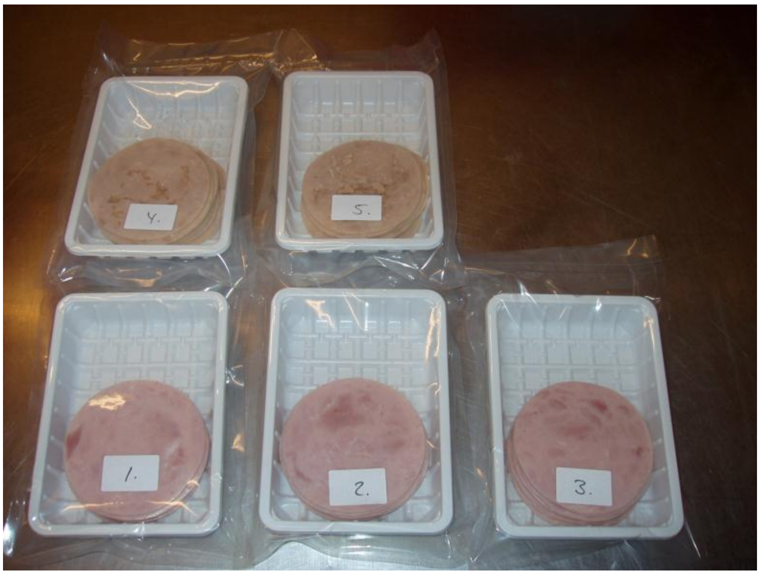
Tumbling	The brine incl. MPE was prepared one day prior to tumbling. Meat and brine were added batchwise to each chamber in a three-chamber tumbler. Tumbling was done under vacuum for 6 hours, 6 rounds/min, 5 min rotation, 5 min rest.
Stuffing	The batter was stuffed in casings (4 x 3.5 kg) and in cans (5 x 0.34 kg for determination of gelling %).
Heat treatment	The raw ham was pasteurized on racks in a cooking cabinet at 80°C until core temperature of 75°C, then chilled until 2°C.
Setting	After chilling, the hams were stored for 6 days at 5°C before slicing and analyses resembling a typical setting period in the industry.
Slicing	Two hams from each batch were sliced and packed in MAP with 30% CO_2/ 70% N_2.
Storage	Sliced and unsliced hams were kept at 5°C.

Analyses

Sliceability, cooking loss, gelling percentage	From each batch 50 slices were cut in 2 mm thickness to determine sliceability. Before slicing, the hams in casings were peeled, and the liquid removed from the surface to determine cooking loss (the industrial method for determining cooking loss). From the five cans from each batch, the cooked out gel was removed and weighed to determine gelling percentage (the scientific based method for determining cooking loss).
Sensory assessment	The hams from each batch were assessed sensorically by five people experienced in judging meat products and/or products with MPE or hydrolysate addition.
Adhesion	10 slices of 5 mm thickness from each batch were tested for adhesion properties at 5°C in a texture analyzer with tensile grips. From the centre of each slice, samples of 4 x 6 cm were cut with small incisions on each of the longest sides. The exact protocol is obtainable upon request.
Chemical composition	Protein, fat, water, salt and pH were determined in duplicate for each batch. The exact protocol is obtainable upon request.

Results

Photographs



Slices from the five batches of hams with either 0%, 5%, 10%, 15% or 20% added MPE (batch 1, 2, 3, 4 and 5).

Sliceability, cooking loss, gelling percentage

Results from cooking loss, gelling percentage and sliceability are seen in table 1.

Table 1. Cooking loss determined after peeling of the cooked hams (n=4), gelling percentage determined on cooked, canned hams (n=5) and sliceability of cooked hams (n=50) added 0%, 5%, 10%, 15% or 20% MPE.

MPE (%)	Cook loss (%)		Gelling (%)		Sliceability	Remarks
	Avg.	Std.	Avg.	Std.	(%)	
0	0,1	0,1	4,4	0,4	100	
5	0,3	0,0	4,2	0,4	100	Casing adheres to product
10	1,2	0,1	8,3	0,8	100	
15	0,2	0,1	14,8	2,5	0	
20	6,9	1,0	11,7	1,5	0	

Avg./Std.: average and standard deviation.

From table 1 it can be seen, that both cooking loss, gelling percentage and sliceability are the same with 0% and 5% MPE. At 10% MPE the hams are 100% sliceable, but the gelling percentage has doubled and the cooking loss is four times bigger. At 15% and 20% MPE the hams are no longer sliceable, the gelling percentage is 50% larger, and the cooking loss for the 20% addition is more than 5 times bigger. The data is inconsistent above 10% addition of MPE. That is not explainable, but indicating that the meat/brine/MPE structure and functionality are altered compared to the lower amounts of MPE.

The differing loss percentages between the 'industrial' comparable cooking loss and the 'academic' gelling percentage are due to the fact, that the flexible casing will keep some of the non-bound moisture in pockets inside the product, whereas the cans are letting out all the non-bound water on the product surface. Since most sliced ham products are packed in flexible casings, the number for cooking loss is the one most resembling industrial values. Typical cooking losses in the industry are between 0.1-2% depending on product type.

Sensory assessment

Comments from the panel of 5 judges are seen in table 2.

Table 2. Shared comments on colour, texture, appearance, smell and flavour from 5 judges for ham added 0%, 5%, 10%, 15% and 20% MPE.

MPE (%)	Comments	Acceptable
0	Pink, good cohesion, weak flavour	Yes
5	Pink, good cohesion, more flavour	Yes
10	Pink/light brown shades, softer, some gel, rounded flavour	Yes
15	Brown, holes in core, soft, exudative, meat stock flavour	No
20	Brown, holes in core, soft, exudative, intense meat stock flavour	No

As seen from table 2, the colour is fading from pink to brown with increasing amounts of MPE. The changes being visible from 10% MPE, which is still overall acceptable. The colour change is probably due to a reduction in meat pigment. When the meat fraction is replaced with MPE with no ability to form the pink nitrosomyochrome between added nitrite and iron in the meat pigment, then the pink colour is fading.

At 15% MPE the colour, appearance, texture and flavour are no longer acceptable with reference to a cooked ham product. At 20% MPE the flavour is still very intense and full, but with almost no bitter notes.

Adhesion

Results from adhesion-tests are shown in figure 1.

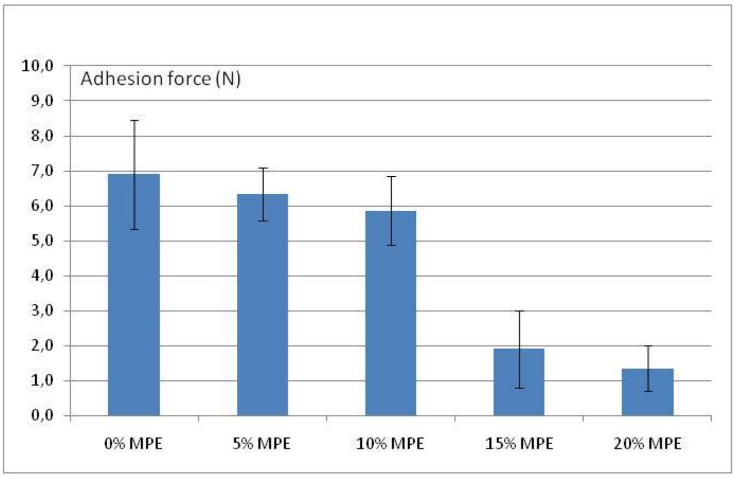


Figure 1. Force used for tearing apart slices of 5 mm thickness of cooked ham added 0%, 5%, 10%, 15% or 20% MPE.

From figure 1 it can be seen, that until 10% MPE the adhesion of the slices is unchanged. At 15% and 20% MPE the ham slices are almost non-coherent.

Chemical composition

Results on proximate analyses of the hams are seen in table 3.

Table 3. Protein, fat, water, salt and pH of cooked ham with 0%, 5%, 10%, 15% and 20% MPE (n=2).

MPE (%)	Protein (%)	Fat (%)	Water (%)	Salt (%)	pH
0	18,9	1,7	76,1	2,5	6,0
5	19,4	1,9	75,7	2,3	6,1
10	20,0	1,5	75,5	2,2	6,1
15	20,7	1,7	74,8	2,0	6,1
20	22,1	1,6	73,6	1,8	6,2

Measuring accuracy: Protein ± 0,46; Fat ± 0,41; Water ± 0,35; Salt ± 0,09; pH ± 0,1.

With 0% MPE the amount of salt is the same as calculated from the recipes. With increasing amounts of MPE, the protein content is increased, the fat content stays the same, water and salt are lowered and pH is increased.

Discussion

In both academia and industry it is a common rule of thumb, that the lowest amount of salt necessary to activate muscle protein for optimal gelling and water binding is between 1.7% and 2% without phosphates and approx. 0.3% lower in recipes with phosphates.

During meat manufacturing salt is added to the meat either in a bowl chopper, via injection brine or in a tumbler. The sodium and chloride ions are functioning on muscle proteins by

- extracting the salt soluble muscle protein fragments, actin and myosin, to the surface of the meat particles
- activating them by increasing the cavities between the fragments thereby creating more room for water molecules and a bigger surface.

In the subsequent heat setting, a muscle protein gel is formed, binding meat pieces, water and fat in the matrix. Often this structure is supplemented with other structures from gelatine and additives like starches and functional proteins.

To be able to activate the muscle proteins, the added sodium and chloride ions have to be available. If they are bound by the amino ends in the MPE, they cannot activate the muscle proteins.

This might be a plausible explanation of the results in this experiment. With 10% MPE, 1.25% of the salt is added in a ‘free form’, not bound in the MPE. This is close to the lower limit for activation mentioned above. And the batch with 10% MPE is still acceptable. At 15% MPE, the amount of ‘active’ salt is too low for gelation and water binding. If the aim is to manufacture products with reduced sodium chloride, a solution might be using MPE without salt, thereby being able to add all the salt as an ‘active’ ingredient.

Conclusion

This experiment showed, that MPE could be used up to 5% in a slightly salt reduced chopped ham without impairing yield, sliceability, sensory properties and texture in any way.

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