DANISH TECHNOLOGICAL INSTITUTE

Report

Pulsed Electric Fields for accelerated drying of fermented pepperoni

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Background

Pulsed Electric Fields (PEF) have previously shown an effect on meat. As an example, Astráin-Redín et al. (2019) showed that the drying time of Spanish dried sausages (Longaniza) could be reduced by up to 47%, depending on particle size and casing. ELEA has also observed accelerated drying of PEF treated meat. DMRI is carrying out a project for the Danish meat industry, searching for new technologies that may improve the quality and cost of pepperoni products. If successful, PEF treatment of meat raw material could reduce the drying time of pepperoni, hence increase production capacity and lower energy consumption.

Objective

The objective of the current investigation is to test if PEF treated meat dries faster than non-treated meat. As the product quality of a potential new PEF pepperoni process must be unaltered, the specification of a typical and major current product recipe was used.

Test design

The tests were designed to answer the following question:

Does PEF treatment influence quality parameters such as product drying rate, pH, colour, and sensory properties of pepperoni?

Lean meat raw materials (chopped diaphragm + mince) were PEF treated at 4°C, and frozen. Subsequently, 6 pepperoni batters (1 reference + 5 PEF treatments) were produced, and sausages were prepared for drying as described in Annex 1.

Production

Raw materials
Non-frozen meat raw materials, max. 4 days post mortem, were sourced from the slaughterhouse in Ringsted.

The raw materials were divided into 6 batches of which 5 were PEF treated (diaphragm and mince only). One untreated batch served as reference.

Afterwards, all raw materials were frozen at -18°C.

Pepperoni preparation
All raw materials were tempered to -4°C.

On the day of production, 6x19 kg of meat batter were made according to the recipe in Annex 1 and the specified PEF treatments.

- Batch 1, reference (no treatment)
- Batch 2, Electric field strength of 3 kV/cm at 10 kJ/kg
- Batch 3, Electric field strength of 3 kV/cm at 20 kJ/kg
- Batch 4, Electric field strength of 3 kV/cm at 30 kJ/kg
- Batch 5, Electric field strength of 1 kV/cm at 20 kJ/kg
- Batch 6, Electric field strength of 1 kV/cm at 30 kJ/kg

12 sausages from each batch were hung on sticks and placed in trolleys. Two sausages from each batch were used for pH measurements (but not in the subsequent quality assessment). All sausages were marked with both batch number and sausage number. The sausages from each batch were distributed on different sticks on the trolly to compensate for possible drying speed differences caused by location on the trolly.

Weight loss for each sausage was registered with intervals of 2-4 days until 25% weight loss for all sausages in a batch had been achieved. Once sausages had finished, they were vacuum-packed.

Analysis

From each batch, 3 random sausages were subjected to pH (duplicate) and colour (Lab) analysis (6 slices x 4 replicates).

A sensory triangle test was carried out to investigate if any of the three sausages were identical to the reference. It is important when asking if the samples are identical to increase the number of panellists, to ensure the level of statistical significance.

Ten panellists were asked to perform three repetitions for each new sausage compared to the reference sausage. Then the panellists received three samples, where two were identical and one was odd – they were asked to point out the odd sample. Afterwards, the panellists were asked to make a CATA (Check-All-That-Apply) on both kinds of the two samples to investigate which attributes contributed to detecting a difference between the samples (e.g. colour, taste, texture, etc.). All samples were coded, and the panel received the samples in randomized order.

Results

The pH values of the 6 batches at the end of drying are illustrated in Figure 1.

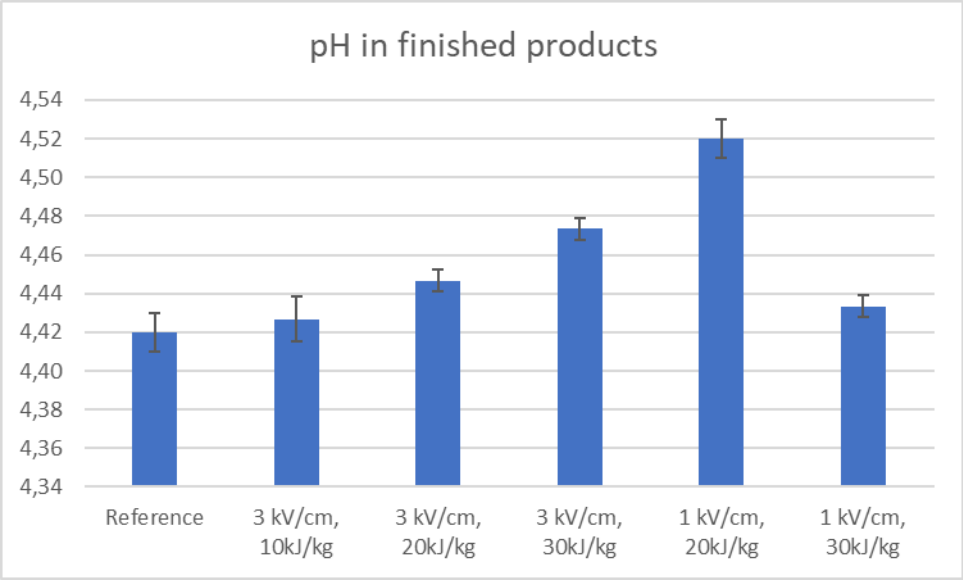

Figure 1. pH values of sausages (finished products) subjected to varying PEF treatments.

As it is evident, it appears that some PEF treatments alter the pH by up to 0.1 pH value.

It is, however, uncertain if this observation de facto expresses a PEF effect. First, an interval of maximum 0.1 pH value is quite narrow: The error on the pH measurement itself is 0.08, and 0.1 in pH difference is rarely of practical importance when making fermented sausages. Secondly, although a pattern seems apparent, it is not valid for batch 6. For batch 2-4 (3 kV/cm), the pH increase seems to be related to the energy applied. However, the effect reaches a maximum in batch 5, which was subjected to 20 kV only. Had the field strength and not the applied energy been the decisive factor, batch 6 should have been much higher.

A possible explanation for the observed differences could be the order of sausage stuffing. Stuffed sausages were hung on trolleys and from the first to the last batch approx. 4 hours went by. Although the temperature was only 12°C in the stuffing room, this may have given the first batches a head-start in the fermentation process. Batch 6 was stuffed after lunch, which is why the raw materials were kept in the cold room before use.

It is evaluated that the small and somewhat systematic increase in pH is due to the resting time before the actual fermentation period was initiated.

Figure 2 illustrates the colour observed by the laboratory measurements (Minolta). As apparent, the numbers do not differ. This is consistent with the observations in the sensory tests described below.

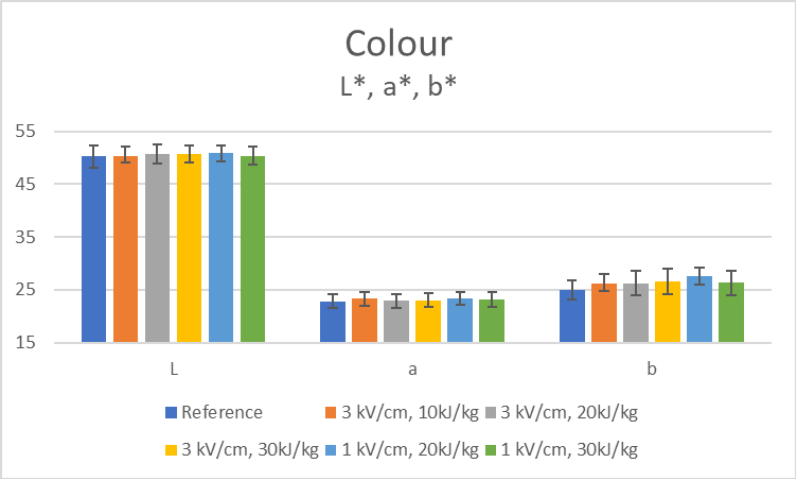

Figure 2. Colour measurements (Lab) of pepperoni treated by PEF.

Figure 3 shows the drying loss for PEF treated pepperoni. No differences can be detected in relation to PEF treatments. At day 7, batch 4-6 differ from the rest. However, while 10 sausages were weighted for each of the other days (for unrelated reasons), only 4 sausages from each batch were weighted at day 7. The few samples in the data set for day 7 are hence believed to be the cause of these low values.

The fact that PEF treatments do not seem to influence the drying loss is unexpected. In a small test trial made at the university of Zaragoza in 2010, DMRI found that meat PEF treated (2.5 and 4.5 kV/cm @ 150 µs) appeared to dry faster when used for fermented sausages. Likewise, an article by Astráin-Redín et al. (2019) showed that the drying time of Spanish dried sausages (Longaniza) could be reduced by up to 47%, depending on particle size and casing. DIL has also observed accelerated drying of PEF treated meat.

An issue, which may be of importance, is the treatment time. In the work by Astráin-Redín it was found that the optimal treatment for accelerated drying was 1 kV/cm, 30 kJ/kg and 200 µs. In the current work, a pulse length of 20 µs was applied. It is therefore still an open question, if longer pulse lengths will reduce the drying time.

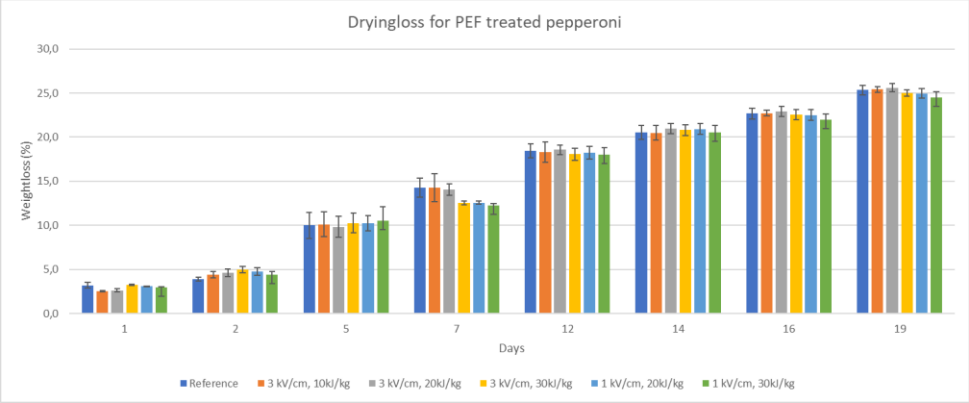

Figure 3. Drying loss for PEF treated pepperoni.

Conclusion

In this experiment, it was investigated if PEF treatment of meat could accelerate the drying time when producing pepperoni sausages. It was found that PEF treatment caused no changes neither in drying-rate, in colour (Lab) and pH, nor in sensory analysis of texture, colour, and taste.

The pulse length was not varied, which is why it is uncertain whether it could have had an effect as previously reported in the literature.

References

Astráin-Redín, L., Raso, J., Cebrián, G. *et al.* (2019). Potential of Pulsed Electric Fields for the preparation of Spanish dry-cured sausages. *Sci Rep* **9,** 16042

Vestergaard, C. (2010). Pulsed Electric Field treatment of cured meat. DMRI report 8/11 2010, Proj. 2000204.

Recipe

	%	g
Backfat	**8**	**1.520**
Diaphragm	**31**	**5.890**
70/30 mince (2062)	**55,7**	**10.583**
Ascorbate	**0,04**	**7,6**
Dextrose	**0,3**	**57**
Nitritesalt (0,6%)	**1,65**	**313,5**
Vacuumsalt	**1,23**	**233,7**
Water	**0,261**	**50**
Spicemix	**1,592**	**302**
Paprika Oleoresin	**0,119**	**22,6**
Starterculture F-SC-111	**0,018**	**3,4**
Rosemary extract	**0,09**	**17,1**
Total	**100**	**19.000**

1. Meat and fat raw materials are to be used at approx. -4°C.
2. The fat is ground coarsely and set aside.
3. The starter culture is dissolved in 10 ml water.
4. The meat and diaphragm are grounded coarsely.
5. The additives and spices are mixed with the meat in a mixer. Mixing for 5 min. at low speed.
6. Salt and fat are added, and the batter is mixed for 10 min at low speed.
7. The mixture is shredded to 3 mm and filled into 54 mm fibrous casings, which are closed with metal clips. Filling weight 1000 ± 50 g.
8. The products are hung on a stick and placed in trolleys. All sausages are marked with both batch number and sausage number.
9. Sausages are fermented in a smoking chamber at low air speed. pH is measured at 0, 24 og 72h. Smoking and drying should not begin before pH 4.8 has been reached.

Date	Smoke +/-	°C	% RH	Time (h)
	-	24	65	2
	-	24	95	3x24
	+	20	85	9
	-	15	80	Until 25% weight loss

Estimated drying time for 25% weight loss is 20 days.