



International 58th Meat Industry Conference “Meat Safety and Quality: Where it goes?”

## The sensory quality of meat, game, poultry, seafood and meat products as affected by intense light pulses: A systematic review

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### Abstract

The effect of intense light pulses (ILP) on sensory quality of 16 different varieties of meat, meat products, game, poultry and seafood are reviewed. Changes induced by ILP are animal species, type of meat product and fluences applied dependent. ILP significantly deteriorates sensory quality of cooked meat products. It causes less change in the sensory properties of dry cured than cooked meat products while fermented sausage is least affected. The higher fluence applied significantly changes the instrumental color values of meat, poultry, game and meat products. The use of ILP on seafood regarding its influence on sensory quality is promising.

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### 1. Introduction

A number of thermal and non-thermal decontamination and preservation methods have been, and continue to be developed in order to sustain meat safety and quality. The fact that not only the shelf life but also the quality of food

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is important to consumers gave birth to the concept of preserving foods using non-thermal methods. Non-thermal methods of food preservation are being developed to eliminate or at least minimize the quality degradation of foods that results from thermal processing. They are expected to induce only minimum quality degradation of food. It is therefore necessary to evaluate changes in sensory attributes of foods<sup>1</sup>.

Intense light pulses (ILP), also known as pulsed light<sup>2</sup>, pulsed white light<sup>3</sup> and pulsed UV light<sup>4</sup> are included among the emerging technologies that are intensely investigated as an alternative to thermal treatment for killing pathogenic and spoilage microorganisms. Most of the literature concerning the application of ILP for the preservation of foods mainly deals with microbiological inactivation and few data are reported on sensory analysis<sup>5</sup>. Therefore, the aim of this review was to systematically present the effects of ILP on sensory quality of 16 different varieties of meat, meat products, game, poultry and seafood. Since meat purchasing decisions are influenced by color more than any other quality factor, special attention was paid to the effect of ILP on this.

## 2. Materials and methods

Samples preparation, ILP equipment used and treatments applied, five-point-scale scoring sensory method sensory evaluation by a professional panel, instrumental color measurements and statistical analysis performed were all explained in previous publications<sup>6,7,8,9</sup>.

## 3. Results and discussion

### 3.1. Five-point-scale scoring method

ILP treatment did not significantly change appearance and total score values of the beef samples<sup>8</sup>. The color score also remained unchanged regardless of the level of fluence applied, which is in contrast of the findings of Hierro et al.<sup>10</sup> where the color of beef was assessed by panel members as slightly lighter after the treatment of 11.9 J/cm<sup>2</sup>. The application of 1-pulse (3.4 J/cm<sup>2</sup>) in our investigation<sup>8</sup> significantly decreased the score for beef odor while the same happened only after 8.4 J/cm<sup>2</sup> when applied to beef *carpaccio* in the experiments of Hierro et al.<sup>10</sup>. The beef odor was assessed as acceptable in both studies even after the highest fluency rate was applied. According to our results, the odor of beef meat is a bit more sensitive to the ILP than the odor of pork meat. For the poultry, the only sensory attribute affected by the ILP treatment was odor but not to such extent that it could also affect the pondered average values of the total sensory quality for the chicken and turkey meat<sup>8</sup>. A similar finding was published by Paskeviciute et al.<sup>11</sup> where UV light dose higher than 6 J/cm<sup>2</sup> had only some moderate effect on odor of chicken. The odor scores significantly decreased in all game meat samples after the 17 J/cm<sup>2</sup> treatment but they were most easily observable in deer meat, and essentially contributed to the significant change of its pondered average value of total sensory quality. The effect of the treatment on odor was least pronounced in kangaroo meat<sup>8</sup>.

The 17 J/cm<sup>2</sup> treatment resulted in significant quality degradation in both ready-to-eat cooked meat products evaluated. The sensory quality of Parisian sausage and cooked ham deteriorated after the 17 J/cm<sup>2</sup> treatment to such an extent that they were assessed as unacceptable products, with unpleasant odor similar to the one found in scalding facilities in slaughterhouses, terrible taste even regardless of smell, untypical yellowish and brownish color, strong aftertaste and poor texture<sup>7</sup>. Our findings are quite the opposite of what was previously reported by E. Hierro et al.<sup>5</sup> where the test panelists did not find significant differences in any of the parameters evaluated among pulsed and non-pulsed ham slices.

Dry-cured meat product, Parma ham and bacon, showed a greater resistance to the effects of ILP than the cooked meat products examined. There were no statistically significant differences in any of the attributes evaluated between 1-pulse treated and untreated samples of Parma ham<sup>7</sup>. In the case of bacon, the same treatment caused significant difference only in odor, although assessors noted that the odor of both, treated and control bacon samples, was not so pronounced. When the higher fluence of 17 J/cm<sup>2</sup> was applied to Parma ham and bacon their odor and taste significantly decreased to the level of neither good nor poor, as assessed by the panelists. However,

changes in their texture and juiciness followed<sup>7</sup>. This was in agreement with the previously observed changes in dry cured loin immediately after the ILP treatment of 11.9 J/cm<sup>2</sup> when odor and flavor also significantly decreased<sup>12</sup>.

The sensory quality of 1-pulse treated fermented sausage was not significantly different to the untreated sample<sup>7</sup>, which is in concurrence with the findings of Ganan et al.<sup>12</sup> where also no significant differences were observed in *salchichón* treated with different fluences. When the fermented sausage was exposed to 5-pulses treatment its temperature raised by 12°C and the texture and juiciness was significantly affected.

All of the seafood samples were assessed as very acceptable, with the total score value greater than 4.5, whether they were ILP treated or not<sup>9</sup>. Even though significant changes in odor were assessed after the 5-pulses treatment, it was still described as pleasant and acceptable. We could not confirm the development of sulphur notes in tuna induced by the fluences higher than 8.4 J/cm<sup>2</sup><sup>10</sup>. All the other sensory attributes evaluated remained unaffected by the ILP treatments<sup>9</sup>. Ozer and Demirci<sup>13</sup> also noticed that ILP treatment of 5.6 J/cm<sup>2</sup> did not affect the quality of salmon fillets.

### 3.2. Instrumental color measurement

The instrumental color values of beef meat were not affected by 1-pulse treatment, since no significant differences were observed<sup>8</sup>. Treatment of 5 pulses significantly decreased redness in beef, while no significant differences were observed for lightness and yellowness. The changes in redness, although significant, were not sufficient to be noted by our sensory panel. In beef *carpaccio* subjected to ILP, Hierro et al.<sup>10</sup> also observed decreases in a\* values but they were accompanied by significant differences in b\* value when the samples were treated with fluences equal to or higher than 8.4 J/cm<sup>2</sup>. Pork meat a\* and b\* values significantly decreased after the treatment of 17 J/cm<sup>2</sup>. Chicken color values were not significantly changed irrespective of the level of treatment<sup>8</sup>. This is in agreement with the results of Keklik et al.<sup>14</sup> indicating that mild and moderate pulsed light treatments also did not affect the color of chicken samples, although extreme ILP treatment did increase the lightness (L\*), redness (a\*), and yellowness (b\*) of samples significantly. The a\* value of treated turkey samples were significantly lower than that of the untreated samples with the significant difference observed among the fluences assayed<sup>8</sup>. The redness gradually decreased as fluence increased. Similar ILP color resistance to that observed in chicken meat was observed only in rabbit meat samples. Deer meat suffered significant decrease in redness value after the 5-pulses treatment while the kangaroo meat was significantly lower in L\* (after 1-pulse) and in b\* (after 5 pulses)<sup>8</sup>.

Pulsed light lightened cooked ham after the higher treatment was applied<sup>7</sup>. The a\* value gradually decreased as fluence increased while only the highest fluences significantly affected the b\* value, in the same way as was observed by Hierro et al.<sup>5</sup>. The lightness of Parisian sausage remained unaffected while redness and yellowness suffered significantly with observed difference among the fluences assayed. The significant increase in b\* values of cooked ham after the ILP treatment was already reported<sup>15</sup> as it was in other cooked-meat products like bologna<sup>5</sup> and chicken frankfurters<sup>4</sup>.

In Parma ham, lightness (L\*) was significantly lower in samples treated with 17 J/cm<sup>2</sup> compared to control and samples treated with 3.4 J/cm<sup>2</sup> while in fermented sausage and bacon it remained unaffected by the ILP<sup>7</sup>. The lightness of dry-cured loin also endured, while it was significantly higher in *salchichón* (fermented sausage) in samples treated with 11.9 J/cm<sup>2</sup> as reported by Ganan et al.<sup>12</sup>. The a\* value significantly decreased after the 5-pulses treatment in Parma ham, fermented sausage and bacon while the b\* value significantly increased only in bacon<sup>7</sup>. It has been reported that when cured meat products are exposed to light, discoloration appears as a decrease in a\* values and an increase in b\* values, with or without a change in L\*<sup>16</sup>.

Pulsed light darkened tuna but only after the fluence of 17 J/cm<sup>2</sup> was applied while a\* and b\* values were not significantly different to the control samples<sup>9</sup>. This is contradictory to the results of Hierro et al.<sup>10</sup> where 8.4 J/cm<sup>2</sup> significantly increased L\* and decreased a\* and b\* values in tuna *carpaccio*. The lower dose of 3.4 J/cm<sup>2</sup> significantly affected none of the color values in tuna in our study<sup>9</sup>, similar to the results of Figueroa-García et al.<sup>17</sup> with catfish or of Cheigh et al.<sup>18</sup> with flatfish where no changes were observed in the CIELAB parameters at fluences lower than 2 J/cm<sup>2</sup>. The color of flounder and crab were not significantly affected<sup>9</sup>.

#### 4. Conclusion

Our study indicated that the sensory quality changes induced by intense light pulses are different and depend on animal species, type of meat product and ILP dose applied. Only the odor of all the meat, poultry and game samples suffered significant changes after the pulsed light treatment. Higher doses of ILP can significantly compromise the instrumental color values of meat, poultry and game. The results for cooked meat products are not promising because ILP significantly deteriorated their quality. ILP caused fewer changes in the sensory properties of dry cured than in cooked meat products. Fermented sausage was least affected by ILP of all the meat products. All of the seafood samples were assessed as very acceptable, with the total score value greater than 4.5, whether they were ILP treated or not. The use of pulsed light on seafood regarding its influence on sensory quality is quite positive.

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