Searching for a cure

TEAGASC research has found that plasma technology has potential as an alternative source for curing meat.

Plasma is considered an emerging non-thermal technology. Plasma can be described as the fourth state of matter and results from applying energy (heat, voltage or light) to a gas, initiating a breakdown of individual gas molecules into free electrons, ions and metastable species.

Plasma-activated water

When plasma is applied to water-based liquids, it changes their characteristics (pH and electrical conductivity) and the resulting liquids are called plasma-activated water (PAW). Depending on the nature of the discharge gas, reactive oxygen species (ROS – ozone, O_3; hydrogen peroxide, H_2O_2; hydroxyl radical, ·OH) and reactive nitrogen species (RNS – $ONOO^-$, peroxynitrite; NO_3^-, nitrate; NO_2^-, nitrite, and the corresponding acids, nitrogen oxides NO_x) are generated in the PAW.

Potential in meat products manufacture

Recently, applications of this technology have been used in food products such as fresh produce, grains and meats with the aim of inactivating enzymes and foodborne pathogens. Nitrites have been used as a curing agent since they were discovered to play a role in the development of the distinctive cured meat colour, in the inhibition of lipid oxidation, and in the control of spoilage and pathogenic microorganisms.

The growing concern among consumers about the potential carcinogenic risks of synthetic curing agents, and the increased popularity of 'all-natural' and 'clean-labelled' food products, have led the food industry to search for alternative curing methods and ingredients. Teagasc researchers are investigating the application of plasma technology as a potential source of nitrite for viable application in the meat industry. A study carried out by Teagasc researchers examined the quality characteristics of plasma-cured beef jerky, and evaluated its suitability as an alternative nitrite source in the production of cured meat products (**Figure 1**).

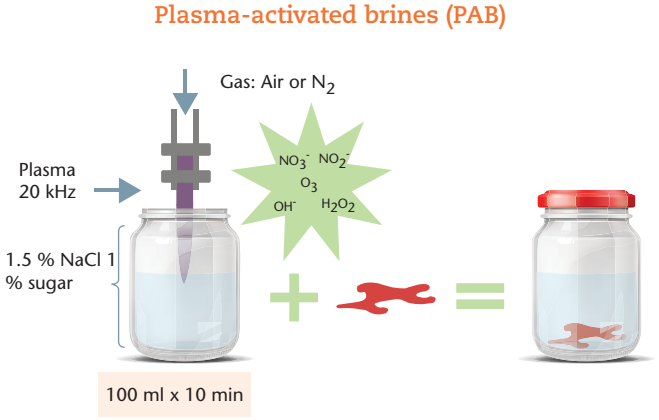


FIGURE 1: Scheme of the methodology used to generate the plasma-activated brine for the curing of jerky.

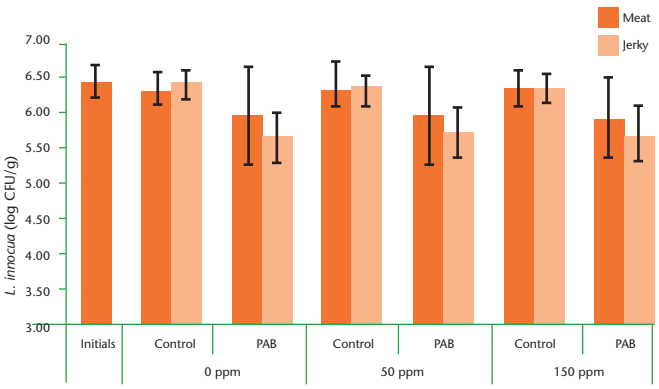
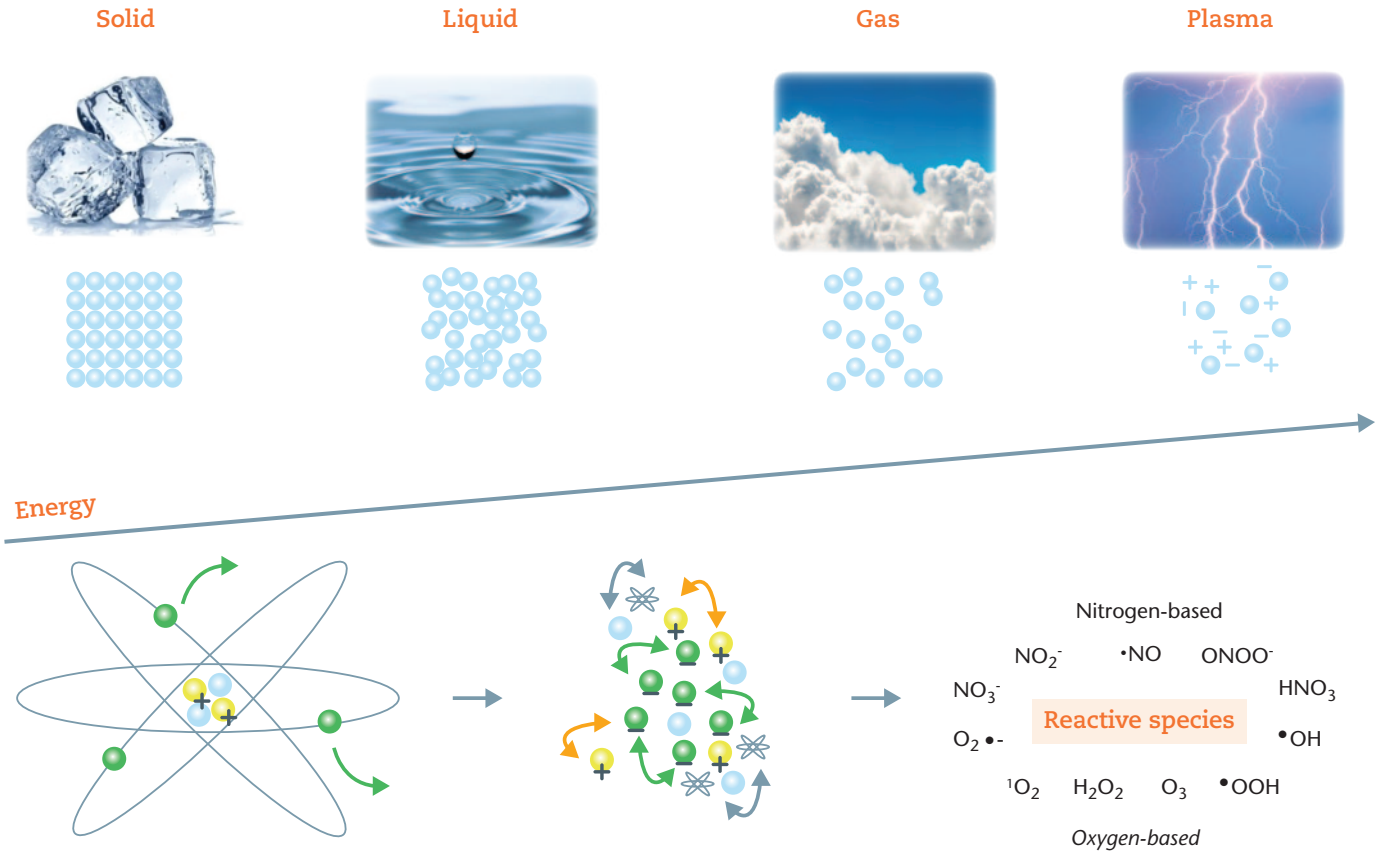


FIGURE 2: Population of L. innocua *(CFU/g) in the meat after curing and in the jerky: control (no plasma) and plasma-activated brine (PAB) with addition of sodium nitrite at 0, 50 and 150 ppm.*



Plasma can be described as the fourth state of matter and results from applying energy to a gas.

Results showed that brine solutions produced by the air plasma system contained sufficient nitrites to be used as a nitrite source for curing beef jerky. When beef jerky was cured with air plasma, no differences were observed in the texture and lipid oxidation of jerky compared to the control samples cured with higher concentrations of added, chemical-based nitrites. In terms of colour, a significant increase in the redness of plasma-cured jerky was observed.

The research also monitored the effect of the plasma curing on meat inoculated with *Listeria innocua* during the curing process.

A significant reduction of 0.85 log CFU/g in the spiked population of *L. innocua* was achieved in jerky produced in plasma brine, compared to the traditionally cured jerky (**Figure 2**). These results showed that plasma technology has the potential to be used as an alternative nitrite source with minimal impact on product quality; moreover, the results of the microbiological study showed that further optimisations of plasma technology could be a successful strategy for meat decontamination.

Acknowledgments

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References

Inguglia, E.S., Oliveira, M., Burgess, C.M., Kerry, J.P. and Tiwari, B.K. (2020). 'Plasma-activated water as an alternative nitrite source for the curing of beef jerky: influence on quality and inactivation of Listeria innocua'. *Innovative Food Science and Emerging Technologies*, 59: 102276.

Pegg, R.B., Shahidi, F. (2000). *Nitrite Curing of Meat: The N-Nitrosamine Problem and Nitrite Alternatives*. Trumbull, Conn.: Food & Nutrition Press.

Yong, H.I., Lee, S.H., Kim, S.Y., Park, S., Park, J., Choe, W., *et al.* (2019). 'Color development, physiochemical properties, and microbiological safety of pork jerky processed with atmospheric pressure plasma'. *Innovative Food Science and Emerging Technologies*, 53: 78-84.

Authors

Elena Sofia Inguglia
PhD Student, Food Chemistry and Technology Department, Teagasc Food Research Centre, Ashtown, Dublin 15

Márcia Oliveira
Postdoctoral Researcher, Food Chemistry and Technology Department, Teagasc Food Research Centre, Ashtown, Dublin 15

Brijesh K. Tiwari
Principal Research Officer, Food Chemistry and Technology Department, Teagasc Food Research Centre, Ashtown, Dublin 15
Correspondence: brijesh.tiwari@teagasc.ie