Nonthermal Plasma

INTERVENTION SUMMARY	
Status	Moving from research to applications
Location	Packaging, raw meats, smallgoods, RTE meals
Intervention type	Surface only
Treatment time	Variable with product type, 10 s to 10 min
Regulations	FDA has issued no rules on the use of cold plasma on foods or food contact surfaces. Applications will require data on effect on foods for direct exposure and any effects on packaging that may transfer to foods.
Effectiveness	RTE meat product – 1.6 log reduction in *Listeria* Sliced ham – 8 log reduction in *Listeria* Raw chicken meat – 2.4 log reduction in *Campylobacter* Raw chicken skin – 0.9 log reduction in *Campylobacter*
Likely cost	Not known
Value for money	Difficult to ascertain
Plant or process changes	Medium, new equipment can operate in-line
Environmental impact	minimal
OH&S	Unknown
Advantages	Short process time, small energy requirements, reactive gases convert to original gas within a short space of time
Disadvantages or limitations	Surface only, complicated technology with numerous factors affecting the outcomes on each individual product. May produce adverse colour effects on raw meat products.

Nonthermal Plasma

Nonthermal Plasma (NTP), also commonly called cold plasma, has been used widely in various applications such as low-temperature plasma chemistry, removal of gaseous pollutants, in gas-discharge lamps or surface modification. NTP usage has expanded to impact on microbial inactivation, ready-to-eat food preparation, biofilm degradation and healthcare (1). The product may be directly exposed to the plasma or exposed in an indirect fashion where the product is placed out of reach of shortliving reactive species (1). The effectiveness of NTP treatment is affected by a number of variables within the technology itself; the plasma source (plasma jets, dielectric barrier discharges, corona discharges or microwave discharges); direct or indirect application; process gas used; type of excitation; gas flow rate (2). The specific characteristics of the generated plasma are also important in determining the effectiveness against microorganisms including degree of ionization, electron density, electron temperature, reactive oxygen species and the UV-A, UV-B and UV-C radiation (2). While these aspects of the technology impact on the effectiveness, NTP is surface acting only with a low penetration depth and as such the surface of the product either food surface or manufacturing surface, also impacts on the effectiveness of NTP.

NTP has been used on beef jerky with a 3.0 log reduction in *Staphylococcus* counts (3) and the RTE meat product, Bresaola, with a 1.6 log reduction of *Listeria* (4). Smallgoods such as sliced ham have demonstrated an 8 log reduction in *Listeria*. *E. coli* was reduced by only 0.55 log on pork loins using a DPD plasma production system (7). The effect of the surface of the product is highlighted by examining the overall microbial reduction with chicken breast having a 2.45 log reduction compared to chicken skin with a 0.9 log reduction of *Campylobacter*. The total aerobic count on pork loin remained the same after 20 days storage following NTP treatment (5). A European consortium has been developing an in-line system “Meatpack” that utilizes NTP and Modified atmosphere packaging to achieve reduced pathogen counts and increased shelf life of raw meat products (6).

As colour is an important consumer measure of freshness and quality the effect of NTP on colour of various products has been examined. Only slight colour changes were noted in the RTE meat product breseaola after plasma treatment for *Listeria* control (4). Treatment of bacon produced decreased L* values but slightly increased a* and b* values. Indirect NTP treatment of pork loin resulted in altered appearance, colour, and acceptability (7). Within the “Meatpack” study the surface colour of lamb was affected by the plasma treatment whereas the appearance of pork loin and turkey slices were less affected (6).

NTP can be utilized for in-package decontamination of foods including fresh produce, meats and fish (8). This relies on the packaging itself to act as a dielectric and has been assessed for multiple packaging types with significant reductions in microbial load on the food products. Possible changes to the packaging after exposure to NTP should be examined including the transfer of low molecular weight volatile compounds, monomers and oligomers from the packaging to the food (8). Further value for NTP technologies is in the application to food production surfaces to prevent biofilm formation and for decontamination of surfaces to reduce cross contamination. A reduction of 3 – 4 log on polystyrene inoculated with *Staphylococcus* has been demonstrated (3) suggesting an inline decontamination of packaging may be useful.

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'Meat Pack'
http://cordis.europa.eu/result/rcn/169548_en.html

Research institutes such as CSIRO have cold plasma systems that may be accessible for trials on specific products.

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