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# COLD PLASMA: A REVIEW

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**Abstract**
Old an innovative non-thermal food processing method called plasma utilizes, reactive gases to destroy contaminating bacteria on fruits, vegetables, meats, and poultry. This adaptable sanitizing technique only needs electricity and a carrier gas like air, oxygen, nitrogen, or helium; chemical antimicrobials are not necessary. UV light and reactive chemical byproducts of the cold plasma ionization process are the main mechanisms of action. Many different types of low pressure treatment chambers and atmospheric pressure-operated cold plasma systems are being developed. The relatively new technique, the diversity and complexity of the required equipment and the mostly unstudied effects of cold plasma treatment on the sensory and nutritional properties of treated foods are the main drawbacks of cold plasma. Additionally, depending on the kind of cold plasma produced, different cold plasma systems have different antibacterial mechanisms of action. A deeper comprehension of these chemical processes is necessary for optimization and scaling up to commercial treatment levels. However, this technological field exhibits potential and is the focus of intensive research to increase efficacy.

**Keywords:** Plasma, Novel technology, Microorganisms, Packaging, Food processing

## 1. Introduction

The safety of food is one of the top issues facing the food sectors, regulatory agencies, and consumers. Because they negatively affect the public's health and economy, pathogenic germs and microbes that spoiling are a significant issue for the food manufacturing industry (Afshan and Hosseini, 2012) [1]. The ultrasound, irradiation, high hydrostatic pressure (HPP), pulse electric field (PEF) and other revolutionary cold processing technologies are described. However, these procedures call for expensive, specialized equipment and trained workers (Yun, 2010) [2]. Among the most cutting-edge technologies being researched for the eradication of microbes elimination is cold plasma (Sharma, 2009) [3]. Cold plasma, which has a temperature between 30 and 60 degrees Celsius and is typically employed in the food processing sectors, is plasma created at room temperature (Misra, 2011) [4].

The main method of food processing still employed in the food industries is thermal processing, which has been around for more than 200 years. Researchers are looking at alternatives to thermodynamic food processing because using high heat causes unfavorable impacts such as changes in texture, nutrient loss, color and among others

## 2. Creation of plasma

A fully ionized gas made up of atoms in an excited state with a neutral charge, photons, free electrons, and other varying components is referred to as plasma. Because there are exactly as many positive as negative ions in plasma, it has a net charge of zero (Kudra and Majumdar, 2009) [5]. Plasma is thought to be the fourth material state, following the solid, liquid, and gaseous states and plasma, for maintaining this particular property (Misra, 2011) [6].

## 3. Plasma varieties

Plasma is typically divided the two categories: Plasma both thermal and non-thermal, which are distinguished due to the method of creation. High pressure, high temperature, and heavy electrons are needed for thermal plasma formation. Plasma with a non-thermal or ambient temperature is produced at temperatures between 30 and 60 °C using little energy. Using electricity or applying radio frequency waves to a gas at reduced pressure

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and giving it a nature that is thermodynamically non-equilibrium, NTP can be created. There are a few common methods for producing plasma under atmospheric pressure, such as corona discharge, and gliding arc discharge, dielectric barrier discharge, that are related to the food industry and need for mild conditions (Misra, 2011) [7].

**4. Physics and Sources of Plasma**

In this article, the term "cold plasma" refers to the thermally inert plasma when thermodynamically; heavier species and electrons are not in equilibrium. The plasma can also atmospheric pressure, categorize as high-pressure and low-pressure plasma depending on the pressure circumstances. Plasma is created during atmospheric pressure plasma at standard atmospheric pressure, negating that there is expensive reaction chambers for pressure maintenance. Any energy that can ionize gasses, thermal, including electrical, radioactive (gamma radiation), optical (UV light) and X-ray electromagnetic radiation, can be used to create plasma. However, CP creation frequently uses electric or electromagnetic fields [13].

**5. Mechanism for inactivating microorganisms**

During plasma treatment, bacteria are subjected to intense radical bombardment of the cell's surface, which results in their lyses. Radical bombardment causes wounds on the cell's exterior that the microbial life cannot quickly heal, which causes the living cell to be quickly destroyed. "Etching" is the phrase for this (Pelletier, 1992). Electrostatic forces that have accumulated on the external surface of the live cell are what trigger lesion formation. Non-thermal plasma effectiveness is influenced by the type of substrate and the type, load, and physical condition of the microorganisms (Stratakos and Koidis, 2015).

**6. Cold plasma technology's potential for digesting food**

The unique processing of fresh foods, processed food products, and packaging has shown significant promise for the cold plasma technology. With the use of this technology, heat-sensitive foods can be processed while keeping their physical, chemical, textural, and functional qualities.

**7. Packaging**

Because it improves adhesive characteristics, polymerization, and aids in superior printability, plasma technology has a lot of potential for food packaging (Pankaj et al., 2013). Low surface energy exists in PET polymers. which needs to be triggered to improve good adhesion, dyeing capabilities, and printing. Using PET several positive qualities, including transparency, strength, formability, gas barrier property, chemical resistance. Understanding how the crystal structure of PET films changes in response to surface energy is made possible by cold plasma treatment (Jacobs, 2011). the energetic packing method was created to protect the food products' integrity & lengthen their shelf lives. The technology alters interactions between products, packaging materials, and even interior headspace through physical, chemical, and biological processes.

**8. CONCLUSION**

In the recent era, cold plasma is an emerging innovative technology. For its distinctive qualities, such as treating patients at low to moderate temperatures for a brief length of time, this aids in preserving the purity and excellence of food goods. Equipment sanitization with Cold plasma has demonstrated efficacy for killing foodborne germs in packaging materials and fresh vegetables. It facilitates catalysis as well, certain production procedures operate as active packaging and delay the oxidation process that causes fruits and vegetables to turn brown. Since it is a cold treatment, food's texture, sensory, and functional qualities are well-preserved. Hence, Cold Plasma is a method that will soon be promoted for food processing.

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