MAXIMIZING YIELD AND EFFICIENCY IN MEAT PROCESSING OPERATIONS

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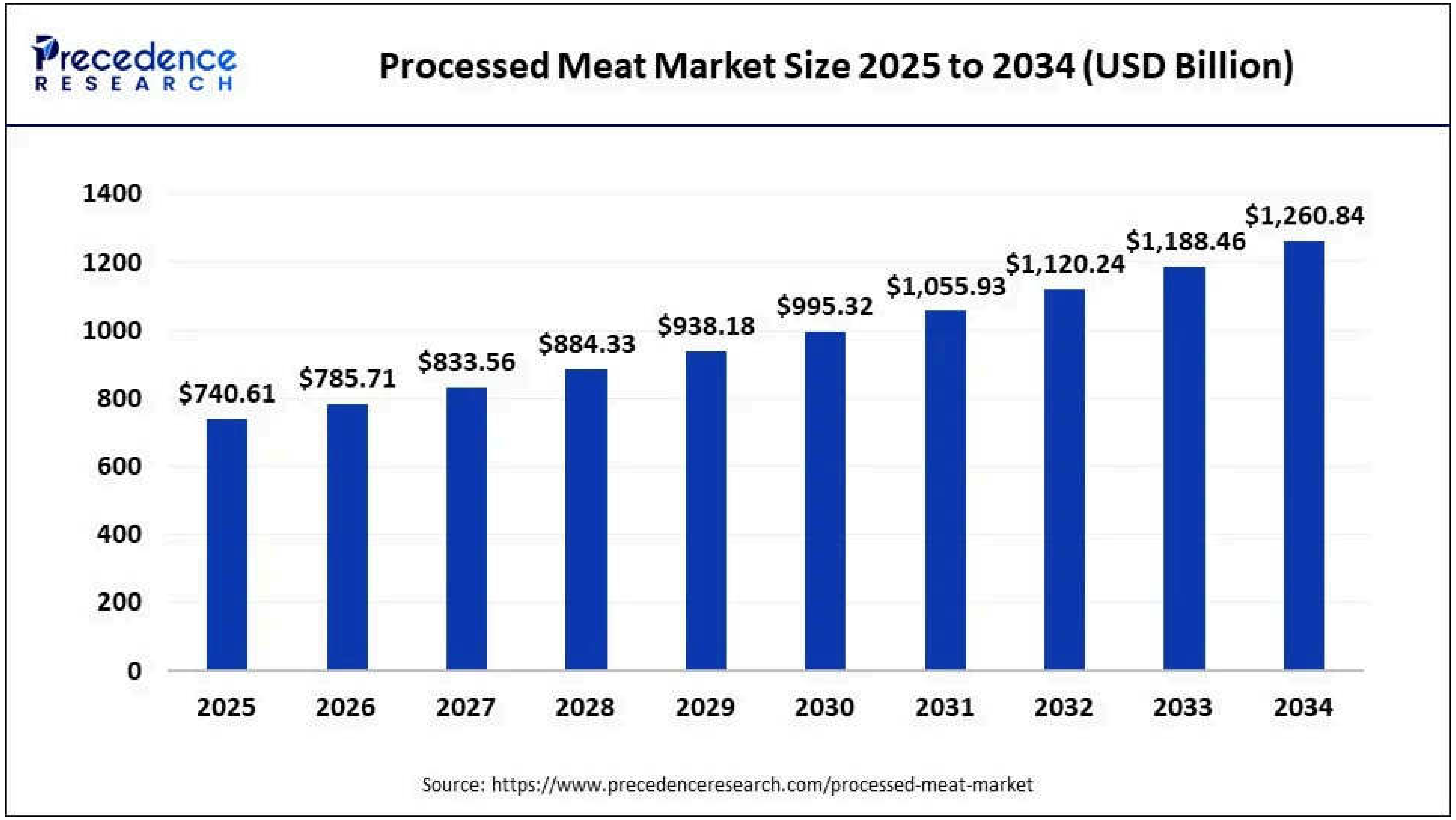
17 October 2025

Processed Meat Size and Forecast 2025 to 2034



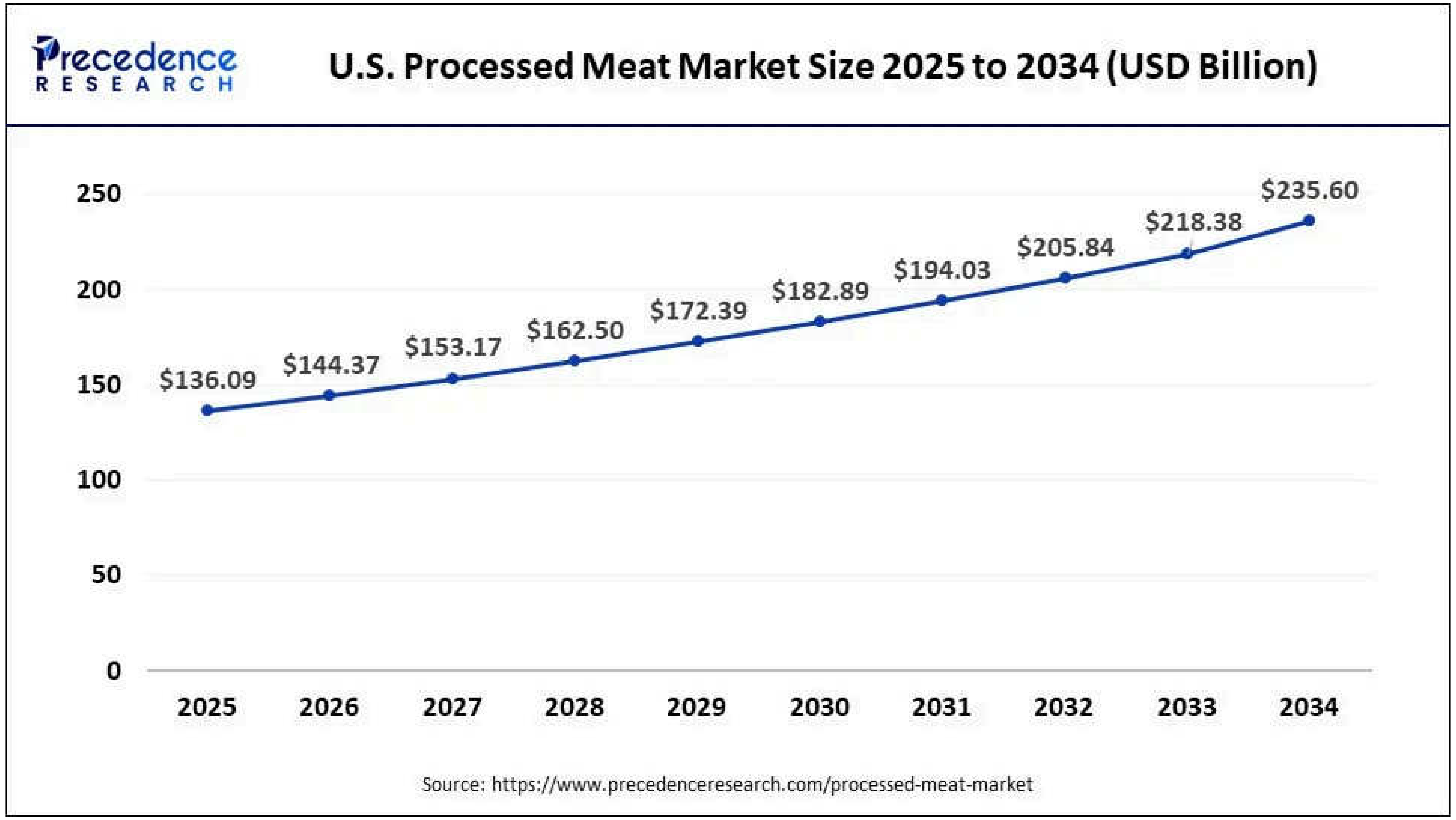
The global processed meat market size is expected to be worth USD 698.10 billion in 2024 and is anticipated to reach around USD 1,260.84 billion by 2034, growing at a solid CAGR of 6.09% over the forecast period 2025 to 2034.The rapid expansion of fast-food chains such as Burger King, KFC, McDonald's, Subway, and Taco Bell has significantly influenced the increase the demand of the processed meat market.

AI innovating the Meat Processing Market

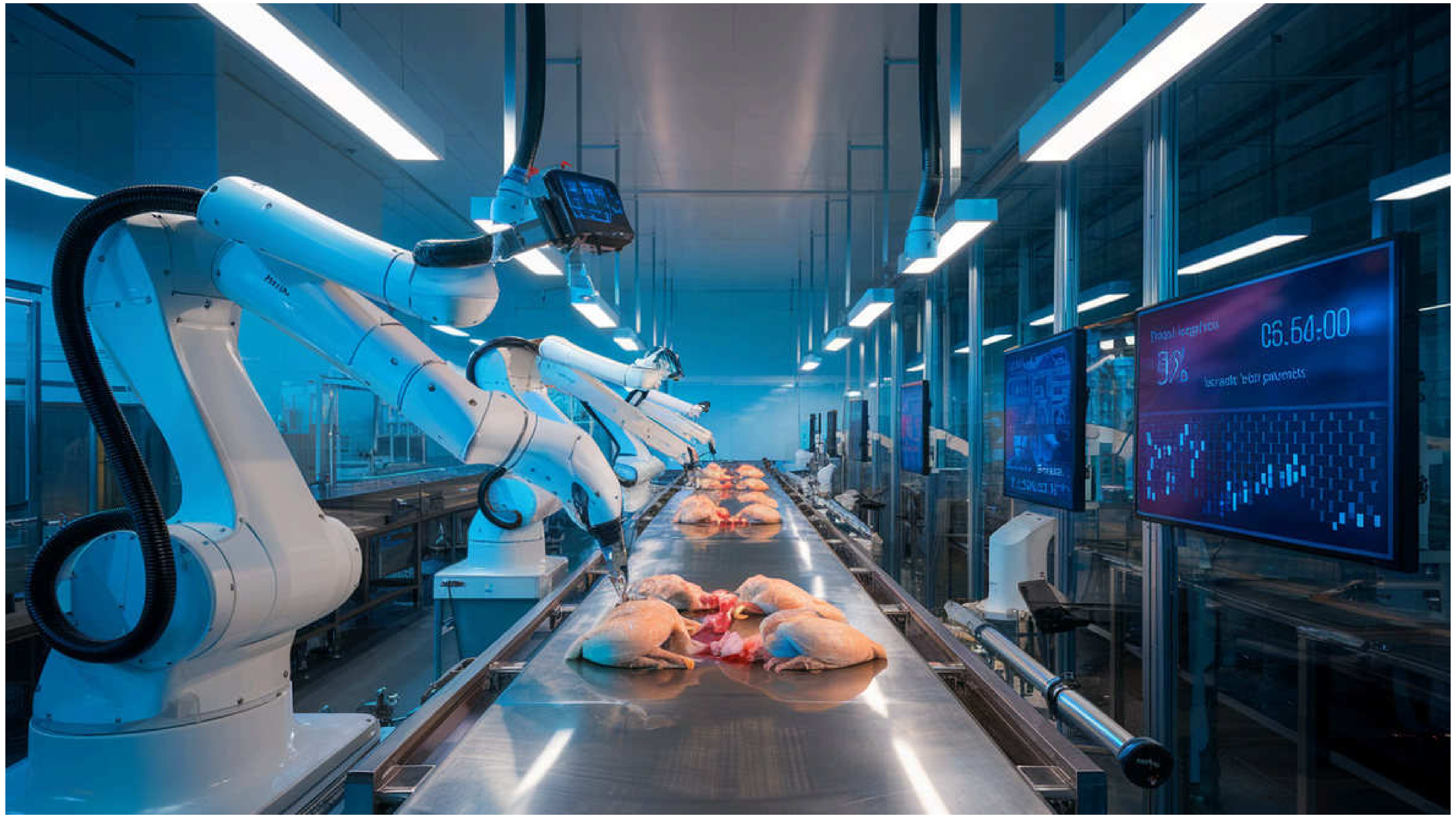
Case Study: BioCraft Pet Nutrition (Oct 2023)
-Launched AI/ML tool for R&D (to achieve cell proliferation and nutrient production)
-Collects & processes scientific data
-Maps cellular biochemical machinery
-Supports cell growth & nutrient production

AI in Processed Meat Industry

- Boosts efficiency & product quality
- Precise carcass classification
- Automates processing tasks
- Accurate meat quality assessment
- Optimizes cutting processes
- Identifies flavor combinations
- Retail: demand forecasting, assortment & pricing



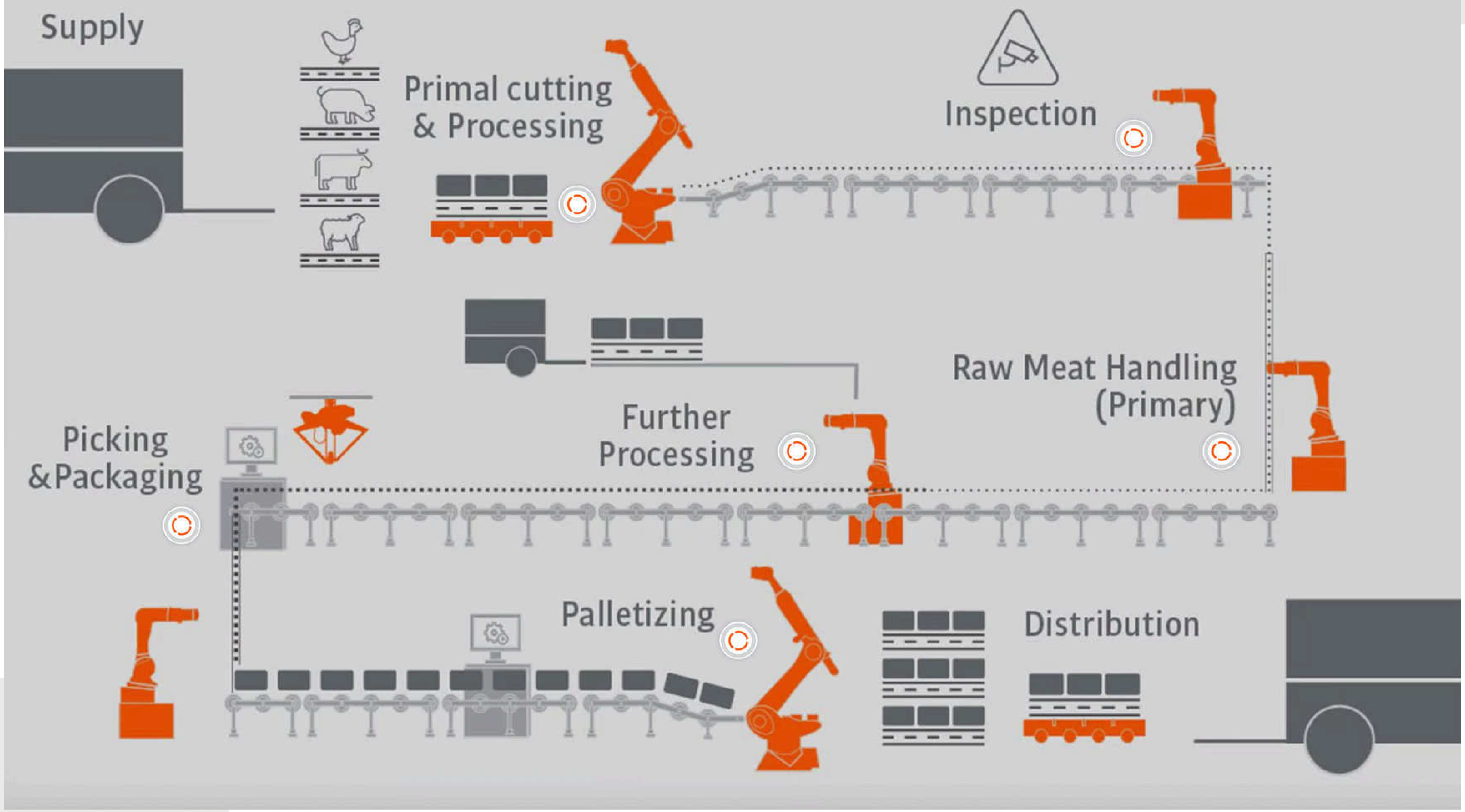
Automation in meat processing



What robot technology can achieve in meat processing???

The demands on the meat processing industry are increasing every year. Automation systems that cover the entire process chain in meat processing are a decisive factor when it comes to high food quality and hygiene standards, as well as a small CO_2 footprint. This includes tasks such as cutting meat of all animal species, stamping, inspections, further processing steps such as marinating, and packaging and palletizing.

OPTIMAL SYSTEMS FOR EVERY PROCESS STEP IN THE MEAT INDUSTRY



Inspection

Integrated camera technology and image processing systems are used in the automated inspection of unpackaged meat products:

-The meat is checked by means of a camera.

-By measuring the marbling of sliced meat, muscle and fat content can be calculated and the price of the food can be accurately determined.

-Additionally, the system searches for blood, foreign bodies, bone residues, etc. to ensure clean further processing and utmost hygiene.

-Samples are taken to check the quality of the food, especially to exclude germs and bacteria.

These robots are used:

Processing of the pieces of meat

- The raw meat is now cut into ready-to-eat or ready-to-pack pieces.
- Poultry processing involves trussing whole chickens or preparing individual parts such as breasts and drumsticks.
- After that, the steaks, pork ribs, legs, cutlets, etc. are either further processed or packaged.

Possible further processing

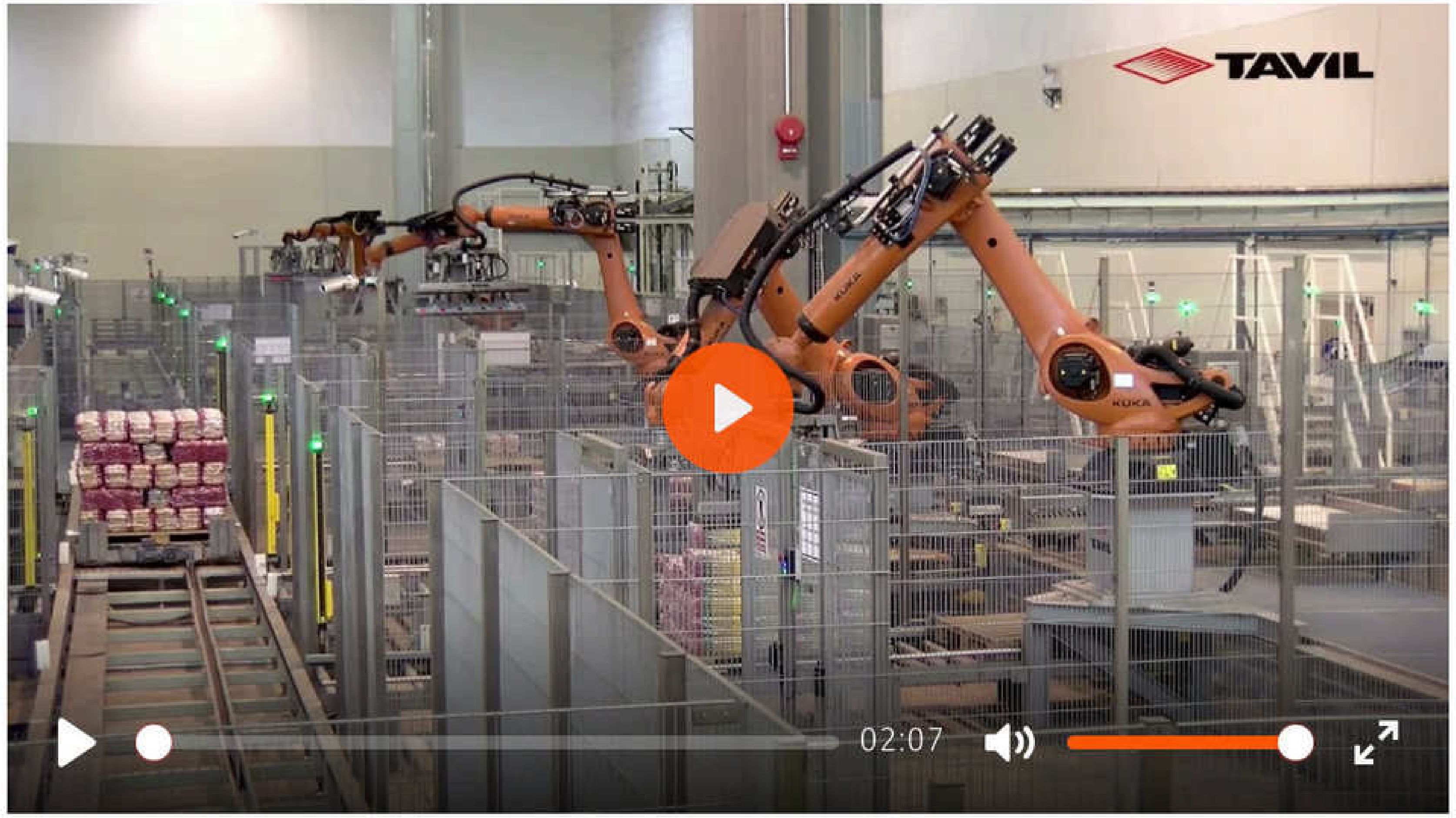
Cut meat products are often further processed by employees in meat processing plants. One process that is used is ultrasonic cutting. Some examples are:

- Meat is marinated and/or put on skewers.
- Sausages are hung in racks to be smoked.
- Boiled sausage is sliced.
- Discarded meat scraps are further processed into animal feed.
- Alternative proteins are produced.

Packaging

- Robots package the meat in portions, e.g. in plastic trays, thermoform packaging or tubular bags. The sealing process is also automated.
- During packaging, the **aesthetic positioning of the food** plays an important role.
- **Correct labeling** for the supermarket is also carried out automatically.
- The packs are then placed in boxes, with the robot taking over the entire process from holding the box open to folding it.

Palletizing



In the final step, the **boxes are sorted on pallets** and prepared for transportation to butcher shops and supermarkets.

Innovative food processing techniques

01

cold plasma

02

high-pressure processing

03

ultrasound

04

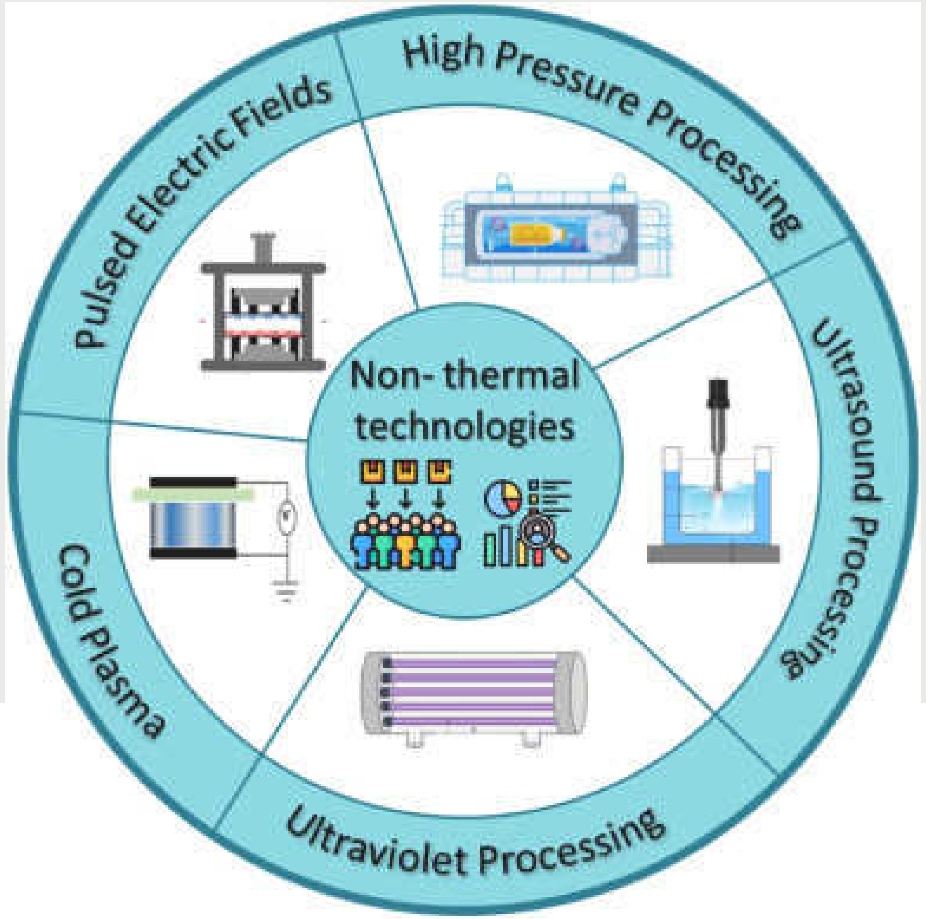
pulsed electric fields

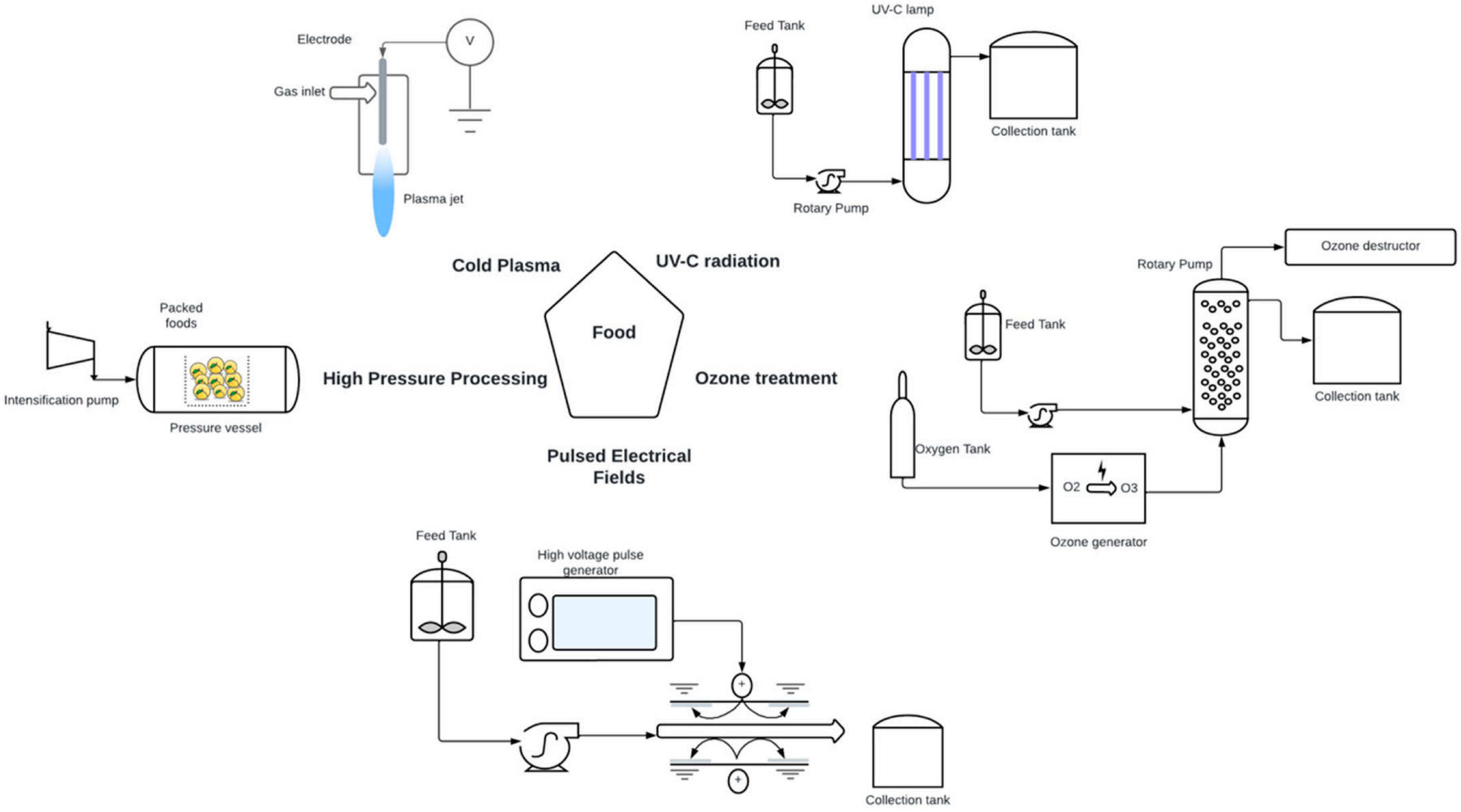
05

sous vide

06

microwave heating

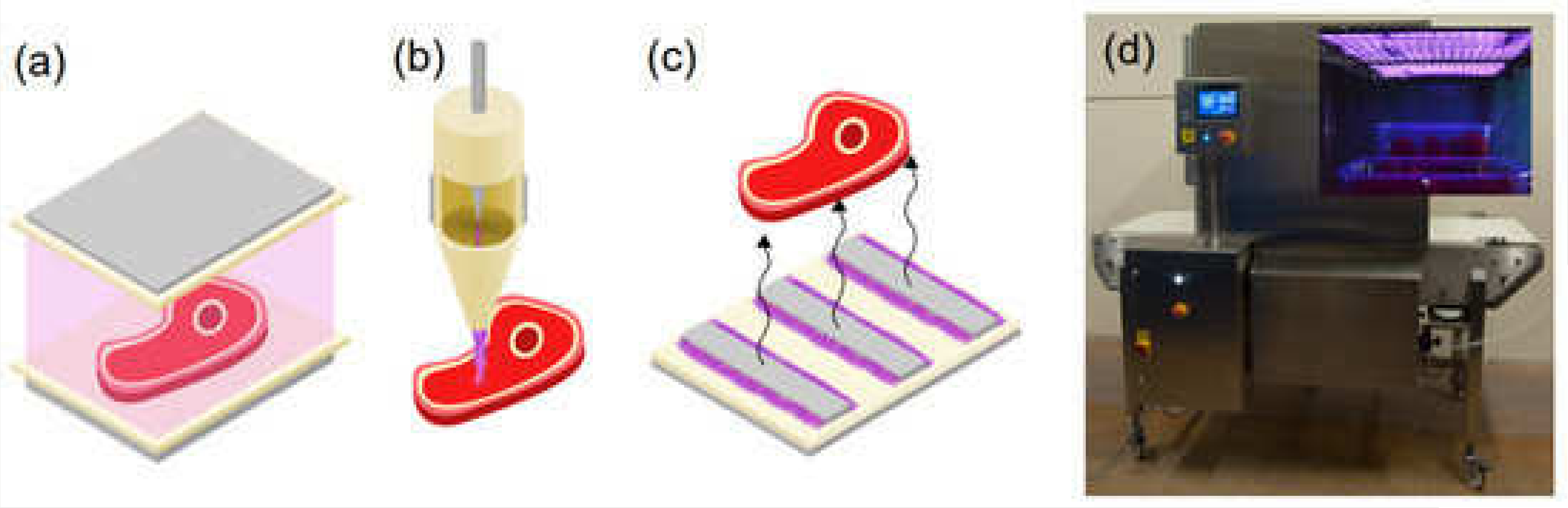


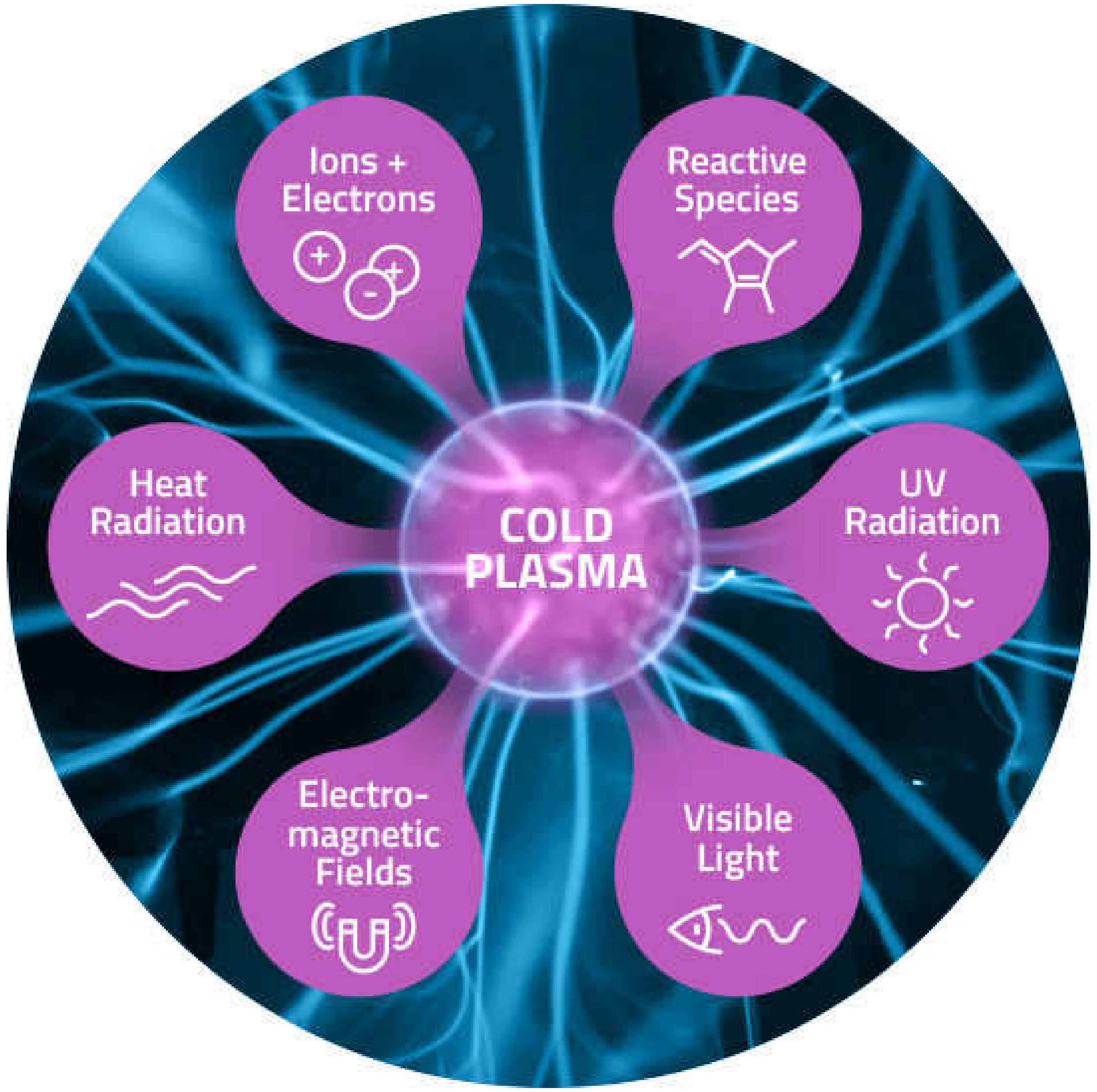


Electrode
V
Gas inlet
Plasma jet
Feed Tank
UV-C lamp
Collection tank
Rotary Pump
Cold Plasma
UV-C radiation
Food
High Pressure Processing
Ozone treatment
Pulsed Electrical Fields
Packed foods
Intensification pump
Pressure vessel
Ozone destructor
Rotary Pump
Feed Tank
Collection tank
Oxygen Tank
O2
O3
Ozone generator
Feed Tank
High voltage pulse generator
Collection tank

The Cold Plasma (CP) or Low-Temperature Plasma

technique is an emerging non-thermal food processing technology that is gaining significant interest in slaughterhouses and meat processing plants because it effectively reduces product loss in several ways:





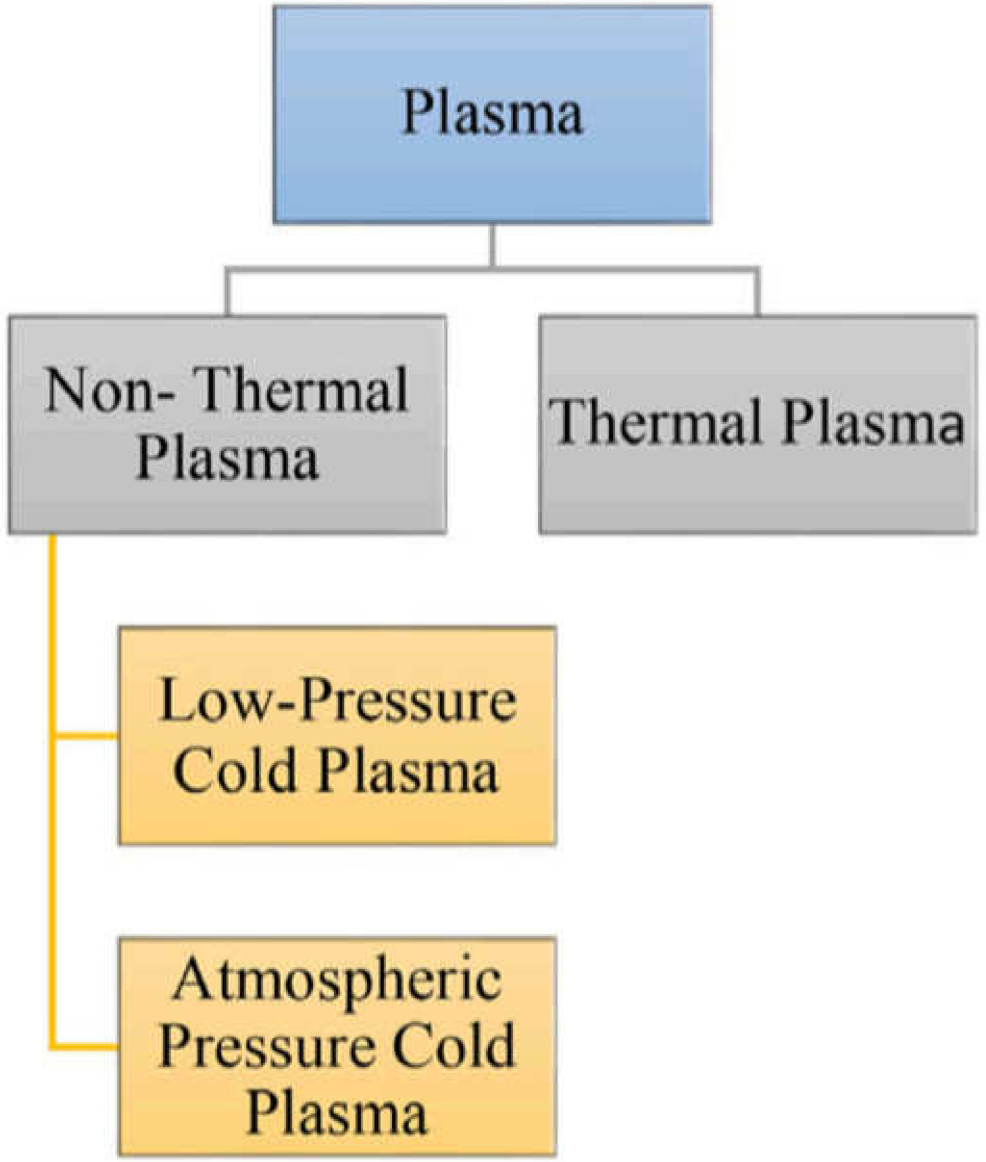
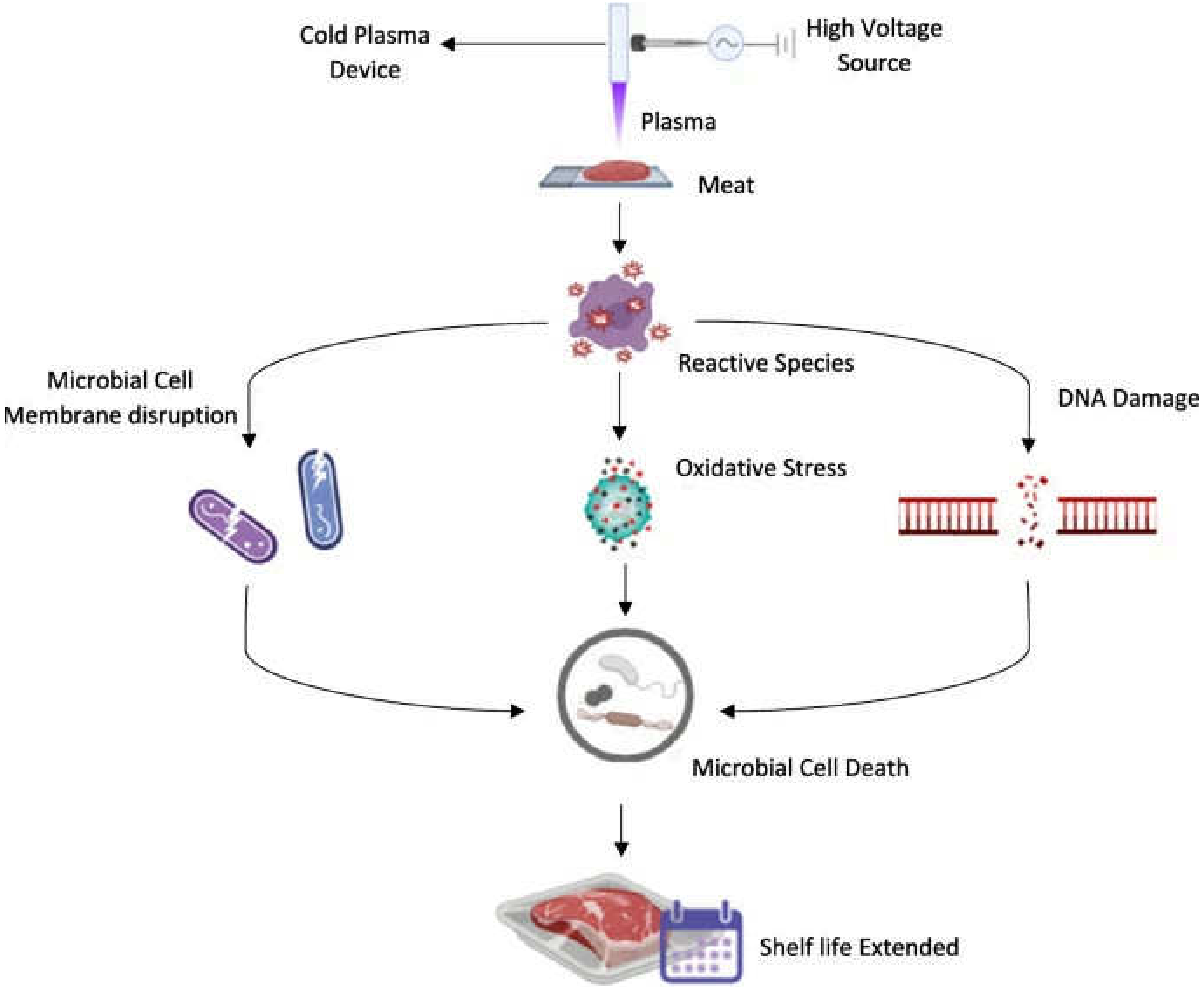


FIGURE 1 Types of plasma



Mechanism of microbial inactivation by Cold Plasma Technique (CPT)

Cold Plasma

Microbial Decontamination and Shelf-Life Extension:

- Reduces Spoilage: Cold plasma is highly effective in eliminating and inhibiting the growth of pathogenic and spoilage microorganisms (such as bacteria, fungi, and viruses) on the surface of meat and food contact surfaces.

- Mechanism: The plasma generates Reactive Oxygen and Nitrogen Species (ROS/RNS) which damage the cell membranes, proteins, lipids, and DNA of the microorganisms.

- Result: The significant reduction or elimination of microbes extends the shelf life of meat products, thereby reducing the chances of the meat being discarded due to premature spoilage.

Cold Plasma

Preservation of Meat Quality:

- Non-Thermal Process: CP operates at near-ambient temperatures, meaning it does not negatively affect the nutritional value or sensory attributes (color, flavor, aroma, texture) of the meat, unlike conventional high-heat treatments.

- Reduced Lipid Oxidation: Some studies show that cold plasma can help control lipid oxidation in meat, which is a key cause of rancidity and quality deterioration, thus helping to maintain quality for longer.

Versatility in Application:

- Surface Sterilization: It can be applied to raw meat products, ready-to-eat products, and even food packaging and equipment surfaces within the slaughterhouse and processing plant, which helps minimize cross-contaminationthroughout the production chain.

Cold Plasma

Microbial Decontamination and Shelf-Life Extension:

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TABLE 1 Operating principles and characteristics of different CP generation systems in use for food decontamination

S. no.	Plasma type	Working principle	Characteristics	References
1.	Dielectric barrier discharge (DBD)	A dielectric barrier layer separates two independent metal electrodes (copper, aluminum, brass, steel) from which plasma is generated (ceramic, quartz, polypropylene, or glass). It can prevent sparks by managing current, and it may be used with AC or DC voltage supplies in a wide pressure range (104–106 Pa)	• Operating Pressure—.1–1 atm • Voltage—1–100 kV (AC) frequency-few Hz to MHz (50 Hz-1 MHz) • Gap Between electrodes—.1 mm to several cm • Dielectric layer—glass, ceramics, quartz, or polymer layer	Kogelschatz (2003) Misra et al. (2016)
2.	Gliding arc discharge	The plasma is generated by two aluminum electrodes that are separated by a plasma generator that includes the other two copper electrodes. The top of the nozzle is where the gas enters	• Voltage—10 kV and 50–450 mA power levels • Plasma area—12 cm × 15 cm × 1 cm • Feed gas—air at approximately 300 L/min	Niemira et al. (2005) Moreau et al. (2007)
3.	Plasma Jet	A powered electrode generates plasma, which flows to another surface. DBD jets, dielectric-free electrode jets, DBD-like jets, and single electrode jets are the four types of plasma jets	• Voltage—20 kV DC with frequency 58 kHz and 1.0–1.5 A power levels • Plasma Area—6 mm × 35 mm	Laroussi and Akan (2007) Lu et al. (2012) Choi et al. (2016)
4.	Radio frequency discharge	Plasma is created at the tip of a needle electrode and expands outside the ceramic nozzle to the grounded ring electrode, which is connected to the above two RF voltage (frequency of 13.56 MHz is commonly used) electrodes. Electrodes do not limit the spatial distribution of RF plasma	• Frequencies-typically in the RF range (1 kHz–103 MHz; usually 13.56 MHz) with a power range of 0-300 W • RF volume (l × b × h) – 160 mm × 160 mm × 325 mm	Hertwig et al. (2015) Niemira (2012b) Singh et al. (2019)

5.	Microwave discharge	The plasma is generated in three structures (open, closed, and resonance) using a magnetron with a cooling mechanism	The microwave generated has a characteristic frequency of 2.45 GHz and a power range of 50–1000 W	Won et al. (2017)
6.	Corona discharge	It is a self-maintained discharge that occurs at the tip of a pointed electrode where a heterogeneous electric field exists	Three arrange of pins were used with different AC voltage 1 pin—8.56 kV 4 pin—8.20 kV 7 pin—6.48 kV Electrode distance—15 mm	Scholtz et al. (2015) Kasih et al. (2020)
7.	Resistive barrier discharge	The high resistivity sheet acts as a dispersed resistive ballast, preventing the discharge from becoming localized and causing the current to rise to high values, turning the discharge into an arc	• Operating pressure-1 atm • Feed gas-He • Voltage-3 kV • Total power −50 to 300 W • Gap-spacing of up to 5 cm, depending on the treatment parameters	Laroussi (2021) Laroussi et al. (2002)
8.	Plasma needle	The plasma needle creates a 2–3 mm plasma at the tip of a fine, sharpened steel wire that is coaxial within a grounded metal cylinder (1 cm diameter)	System-RF-driven (.2–.5 kV, 13.56 MHz) • Total power consumption—20 mW to 3 W • Feed gas—primarily He (.3 L/min)	Stoffels et al. (2002)

Inactivation of microorganisms in various food products using cold plasma

Food	Plasma source	Treatment time	Log reduction	References
Cereals				
Rice	Dielectric barrier discharge	20 min	Microbial concentration decrease from 4.08–4.11 to 2.68–2.84 log CFU/g	Lee et al. (2019)
Korean rice cake	Dielectric barrier discharge	20 min	*E. coli* CFU/g was reduced by 2.01 to 2.03 log CFU/g, *S. Typhimurium* CFU/g was reduced by 2.08 to 2.12 log CFU/g, and *Listeria monocytogenes* CFU/g was reduced by 1.98 to 2.17 log CFU/g. 2 log CFU/g *Penicillium chrysogenum*	Han et al. (2020)
Wheat	Sulfur hexafluoride cold plasma	15 min	3-log for both species; *A. parasiticus* and *Penicillium*	Selcuk et al. (2008)
Nuts and dry fruits				
Almonds	Dielectric barrier discharge	30 s	1.8–5 log for *E. coli*	Deng, Ruan, et al. (2007)
Hazelnuts and peanuts	Low pressure cold plasma (with air)	10 min	2 log reduction of *A. parasiticus*	Basaran et al. (2008)
Pistachio nuts	Low pressure cold plasma with sulfur hexafluoride	10 min	5 log reduction of *A. parasiticus*	Basaran et al. (2008)
Almonds	Air-based Radiofrequency cold plasma jet	20 s	1.34 log reduction of *E. coli* O157:H7	Niemira (2012a)
Fruits and vegetables				
Apple juice	Needle/plate plasma system	40 s	5 log reduction of *E. coli*	Montenegro et al. (2002)
Red apples	Gliding arc cold plasma	3 min	3.7 log reduction of *E. coli, S. Stanley*	Niemira and Sites (2008)

Animal products				
Sliced Ham	Radio frequency powered cold plasma	120 s	.25–1.73 log reduction of *L. monocytogenes*	Song et al. (2009)
Table Egg	Resistive barrier discharge prototype	90 min	4–5 log reduction of *S.Enteritidis*, *L. monocytogenes*	Ragni et al. (2010)
Chicken meat	He-O_2 cold plasma	4 min	>3.5 log reduction of *Listeria innocua*	Noriega et al. (2011)
Chicken skin	Pulsed gas plasma discharge	24 s	Up to 8 log reduction of *E. coli*, *C. jejuni*	Noriega et al. (2011)
Sliced Ham	Atmospheric pressure cold plasma	120 s	Up to 1.73 log reduction of *L. monocytogenes*	Lee et al. (2011)
Chicken Breast Pork Loin	Atmospheric pressure cold plasma jet	2.5 min each side	.66 log reduction of *S. Typhimurium* 1.33 of *S. Typhimurium*	Kim et al. (2013)
Frozen and unfrozen pork	Corona discharge cold plasma jet	120 s	About 1.5 log reduction of *E. coli* And 1 of *Listeria*	Choi et al. (2016)
Lamb meat	Dielectric barrier discharge plasma	1 min	.8 log reduction of *B. thermosphacta*	Patange et al. (2017)
Beef jerky packed in a commercial package	Flexible thin-layer cold plasma system	10 min	2–3 log reduction of *Escherichia coli* O157:H7, *Salmonella*, *Listeria monocytogenes*, *Aspergillus flavus*, *and Typhimurium*	Yong et al. (2017)

Limitation of using cold plasma

-The difficulty in achieving regulatory approval and process validation.

-Its complex reactive species chemistry.

-More complicated interaction of these species with the multi-component nature of food (proteins, fats, water, etc.).

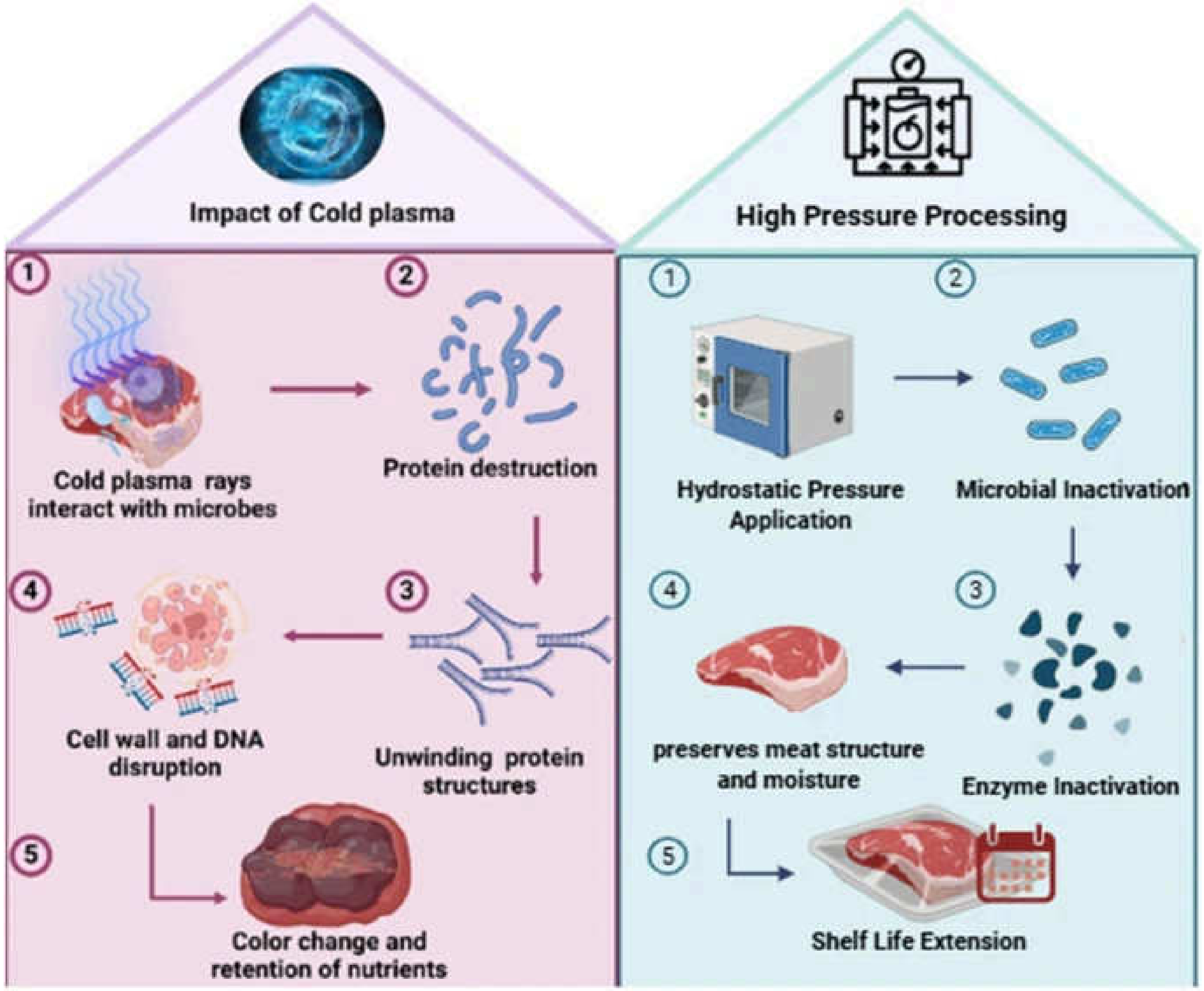
-Controlling the plasma reaction chemistry is difficult because of the wide range of moisture concentrations in foods.

Additionally, the application of cold plasma has been observed to cause several negative consequences, including:

- **Decreased pH, fruit hardness, and color.**
- **Increased acidity and off-flavor production.**
- **Wilting and discoloration (specifically noted in spinach leaves).**

Consumer Acceptance

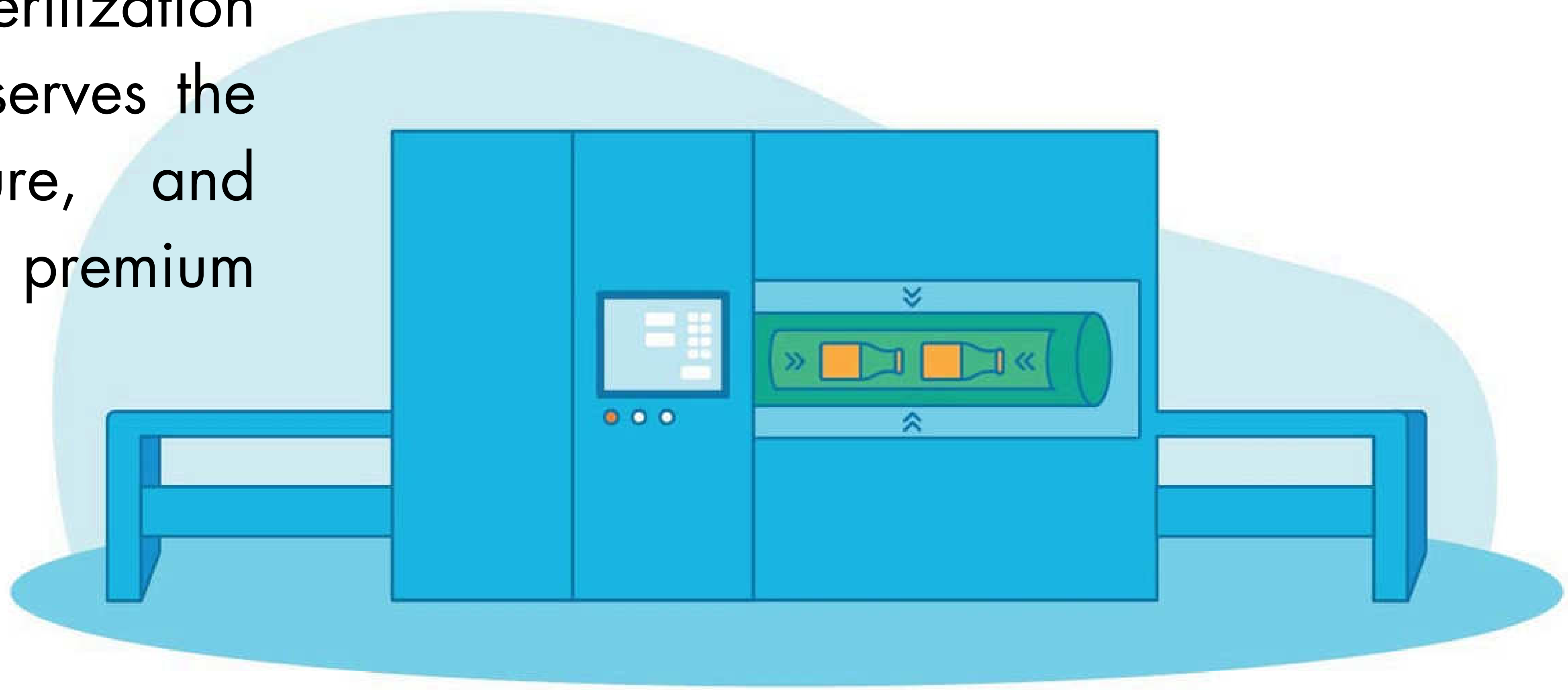
New technologies are accepted or rejected by consumers for a variety of reasons, including ethical, safety, and environmental concerns. Many breakthrough processes and technologies struggle to obtain widespread market acceptability due to a lack of understanding of customer perception. As a result, in the early stages of food product development, analyzing consumers' perspectives is critical.



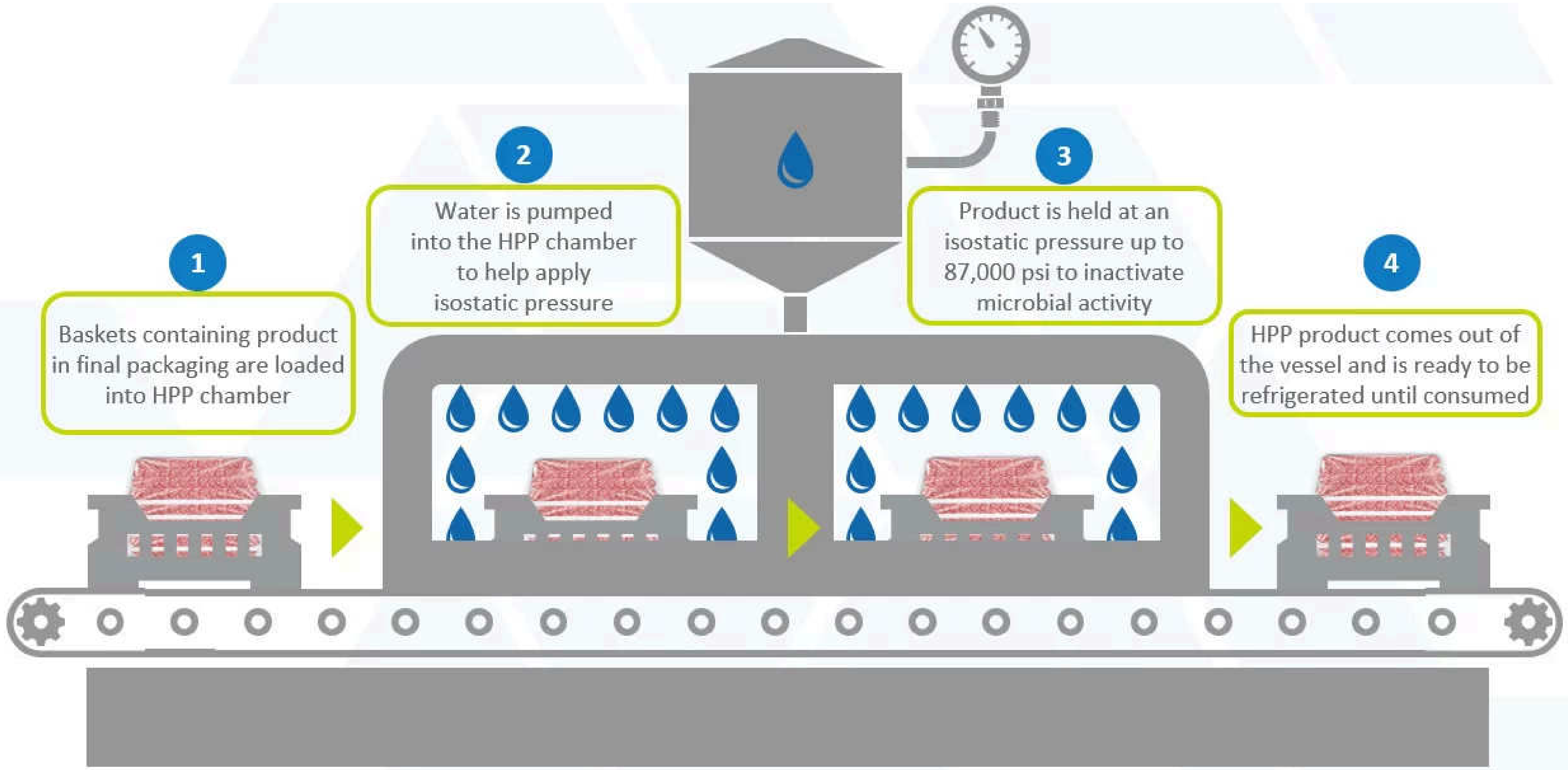
Impact of cold plasma and high-pressure processing on meat quality

High-Pressure Processing (HPP)

A non-thermal preservation method where food is subjected to extremely high pressure (up to 600 MPa) to inactivate harmful microorganisms inactivate harmful bacteria like *Listeria*, *Salmonella*, and *E. coli.* and enzymes. It achieves sterilization without using high heat, which better preserves the food's nutritional value, flavor, texture, and freshness. It's widely used today for premium products like ready-to-eat meats.



How Does HPP Work?



Key Benefits of HPP

Enhances Food Safety	Extends Shelf Life	Enables Clean Labels	Reduces Food Waste	Maintains Taste, Texture and Nutritional Value	Protects Brand Reputation
5-log reduction of pathogens	2-10x longer	No preservatives or chemicals	Improves end channel profitability	Non-thermal processing method	Decreases risk of product recalls

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Modeling the protective effect of water activity of a meat emulsion matrix model on *Listeria monocytogenes* inactivation by high pressure processing

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Fig. 1. High Pressure Processing (HPP) equipment used in the experiments.

Table 2
Combinations of selected variables for laboratory validation of the mathematical model created.

Pressure (MPa)	Time (s)	a_w
540	350	0.972
420	400	0.940
580	200	0.960

Source: Ferreira *et al.* (2025)

Table 4
Results of inactivation of *L. monocytogenes* ATCC 19111 after HPP according to combinations of factors proposed by CCRD.

Trial	Pressure (MPa)[a]	Time (s)[a]	a_w[a,b]	Inactivation log (N_0/N)[c]
1	440 (−1)	229 (−1)	0.948 (0.946) (−1)	0.85 (±0,02)[10]
2	560 (1)	229 (−1)	0.948 (0.946) (−1)	1.95 (±0,25)[6,7,8,9,10]
3	440 (−1)	371 (1)	0.948 (0.946) (−1)	1.04 (±0,09)[9,10]
4	560 (1)	371 (1)	0.948 (0.946) (−1)	2.66 (±0,06)[4,5,6,7]
5	440 (−1)	229 (−1)	0.972 (0.969) (1)	2.34 (±0,09)[5,6,7,8,9]
6	560 (1)	229 (−1)	0.972 (0.969) (1)	4.76 (±0,31)[1,2]
7	440 (−1)	371 (1)	0.972 (0.969) (1)	3.86 (±0,05)[1,2,3,4]
8	560 (1)	371 (1)	0.972 (0.969) (1)	5.18 (±0,51)[1]
9	400 (−1.68)	300 (0)	0.96 (0.959) (0)	0.74 (±0,02)[10]
10	600 (1.68)	300 (0)	0.96 (0.959) (0)	4.04 (±0,57)[1,2,3]
11	500 (0)	180 (−1.68)	0.96 (0.959) (0)	1.54 (±0,13)[7,8,9,10]
12	500 (0)	420 (1.68)	0.96 (0.959) (0)	3.69 (±0,86)[2,3,4,5]
13	500 (0)	300 (0)	0.94 (0.940) (−1.68)	1.07 (±0,22)[8,9,10]
14	500 (0)	300 (0)	0.98 (0.975) (1.68)	4.45 (±0,58)[1,2]
15	500 (0)	300 (0)	0.96 (0.959) (0)	2.73 (±0,30)[3,4,5,6,7]
16	500 (0)	300 (0)	0.96 (0.959) (0)	2.38 (±0,13)[5,6,7,8,9]
17	500 (0)	300 (0)	0.96 (0.959) (0)	2.42 (±0,13)[5,6,7,8]
18	500 (0)	300 (0)	0.96 (0.959) (0)	3.02 (±0,54)[3,4,5,6]

Values with different superscript numbers are statistically different according to Tukey's test ($p < 0.05$).

[a] The parenthesis mean the coded values for trials according to CCRD.

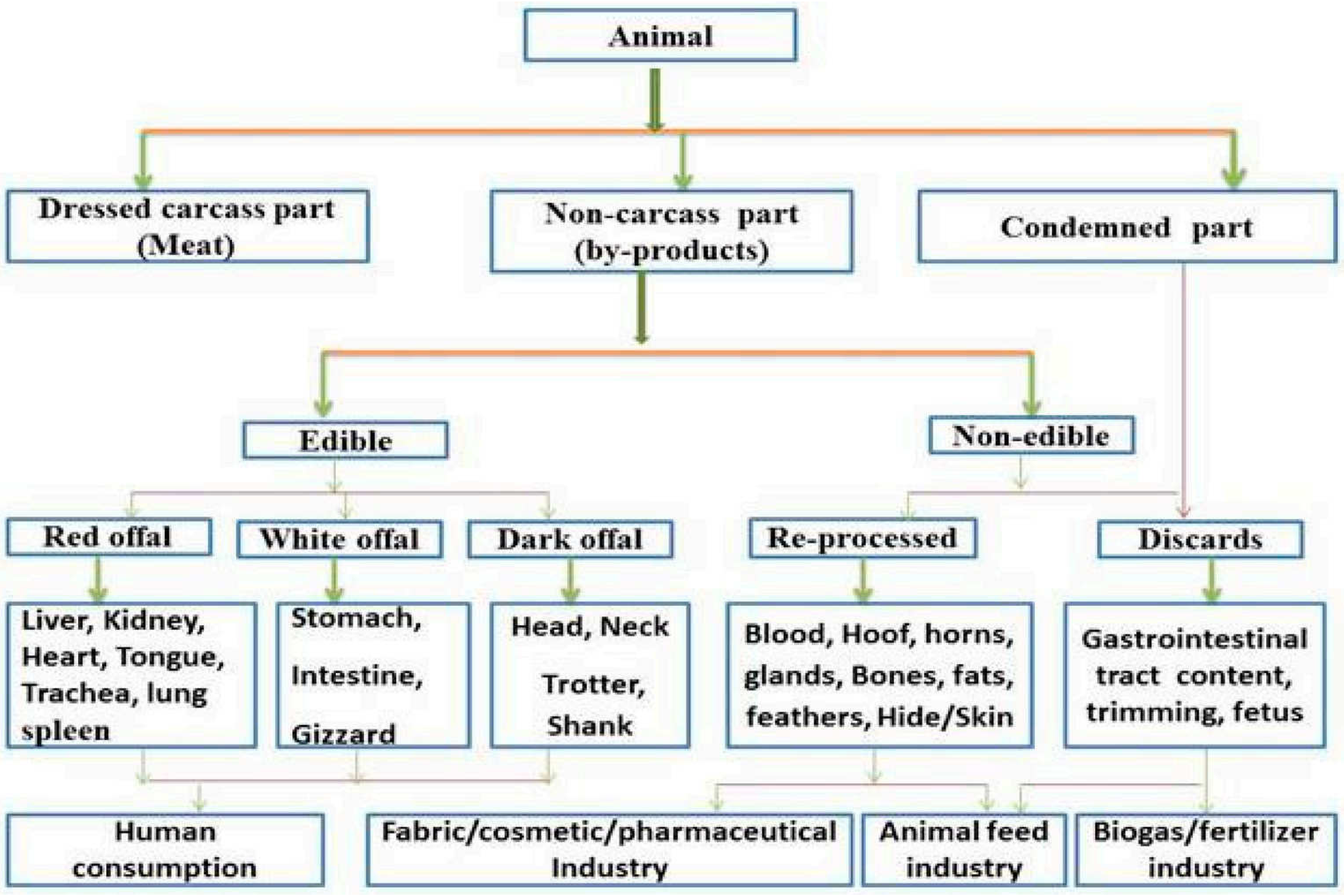
[b] The column of a_w reports target theorical values according to CCRD; in parenthesis, is reported the actual measured value.

[c] The mean standard deviation.

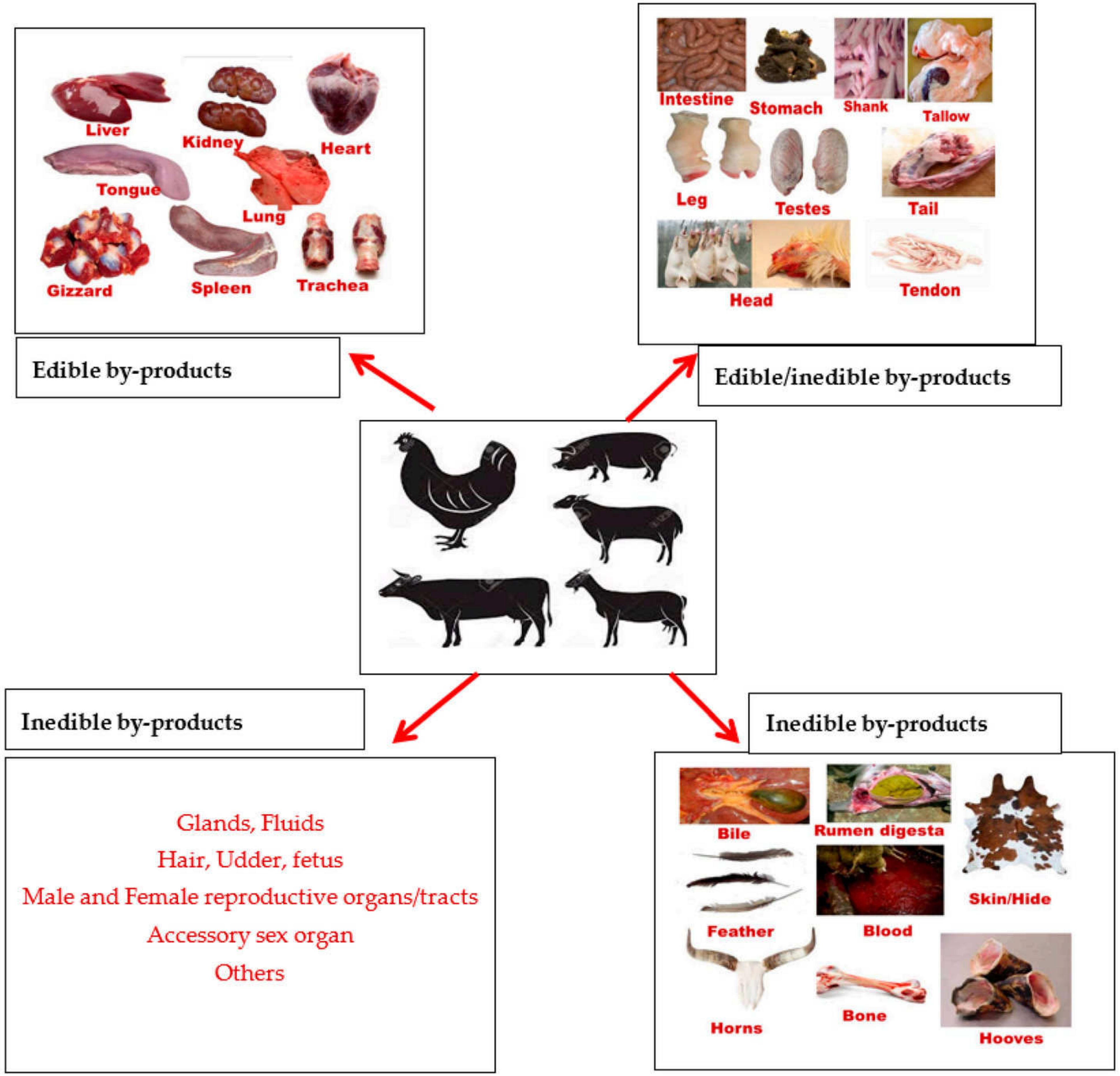
Source: Ferreira *et al.* (2025)

Utilization of by-products in meat processing

The effective utilization of these by-products not only enhances the economic viability of the meat industry but also significantly mitigates its environmental footprint, transforming potential pollutants into profitable commodities. Meat processing by-products can be broadly classified into two main categories: edible and inedible.



Classification of animal by-products.
Source: Alao *et al.* (2017)



General descriptions of edible and inedible by-products.

Source: Alao *et al.* (2017)

Common uses of animal by-products

Animal By-Products	Reprocessed Products	Major Uses
Hides and Skin	Cured hides & skin. Leather & Textiles	Leather clothes, belts, car and household upholsteries, bags, footwear, drums, luggage, wallets, sports goods, gelatine etc.
Hoof and horns	Hoof & horn meal Gelatin and keratin extraction	Combs, buttons, plates, souvenirs, Fertilizer, Collagen, glue, gelled food products, foaming in fire extinguishers
Bone	Extraction of collagen Bone meal	Cutlery handles, Shortening, bone gelatine, bone meal, Collagen
Blood	Pharmaceutical products Blood meal	Catgut, tennis strips, blood sausages or pudding, fertilisers, animal feeds, emulsifier and stabilizer
Intestine	Sausage casings Surgical sutures Musical instruments	Sports guts, musical strings, prosthetic materials, collagen sheets, burn dressing, strings for musical instruments, sausage casings, human food, pet food, meat meal, tallow, casings
Organs & Glands	Pharmaceuticals Medicinal Xenotransplantation	Heart stimulant, heparin, corticotrophins, enzymes, steroids, oestrogen, progesterone, insulin, trypsin, parathyroid hormone
Hair/Wool	Textiles Extraction of keratin	Cloths or woven fabrics, mattress, keratin, carpets, knitted apparels, insulators

Edible By-Products: A Source of Nutrition and Delicacy

A significant portion of the materials separated from the carcass during processing is fit for human consumption and is often referred to as offal or variety meats.

Organs → Rich in essential nutrients, organs such as the liver, kidneys, heart, and lungs. High content of vitamins and minerals.

Blood → Source of protein and iron, utilized in the production of blood sausages, black pudding, and various other food products. Processed to extract plasma use as a binder and emulsifier in meat products.

Fat → Tallow from beef and lard from pork, are used as cooking fats, shortening, and in the production of margarine. Ingredients in the manufacturing of soaps and cosmetics.

Edible By-Products: A Source of Nutrition and Delicacy

Intestines and Stomachs → Serve as natural casings for sausages.Stomachs, or tripe, are a popular ingredient in many soups and stews globally.

Bones → A source of gelatin, broth, and bone marrow, bones are widely used in the food industry. Gelatin is a crucial ingredient in desserts, confectionery, and pharmaceutical capsules.

Inedible By-Products: A Trove for Industrial and Agricultural Applications

Materials not typically consumed by humans find a multitude of uses in other industries, contributing significantly to a circular economy model.

Hides and Skins → the leather industry, producing goods ranging from footwear and apparel to upholstery.

Rendering → Tallow and Grease: Used in animal feed, soap production, and increasingly, as a feedstock for biofuel production.

Rendering → Meat and Bone Meal (MBM): A high-protein ingredient in animal feed, particularly for poultry and swine, as well as in pet food. It also serves as an organic fertilizer.

Inedible By-Products: A Trove for Industrial and Agricultural Applications

Pharmaceutical and Biomedical Applications →

Glands and organs are sources of hormones like insulin and heparin. Collagenis used in cosmetics and medical applications (wound dressings and drug delivery systems).

Pet Food →

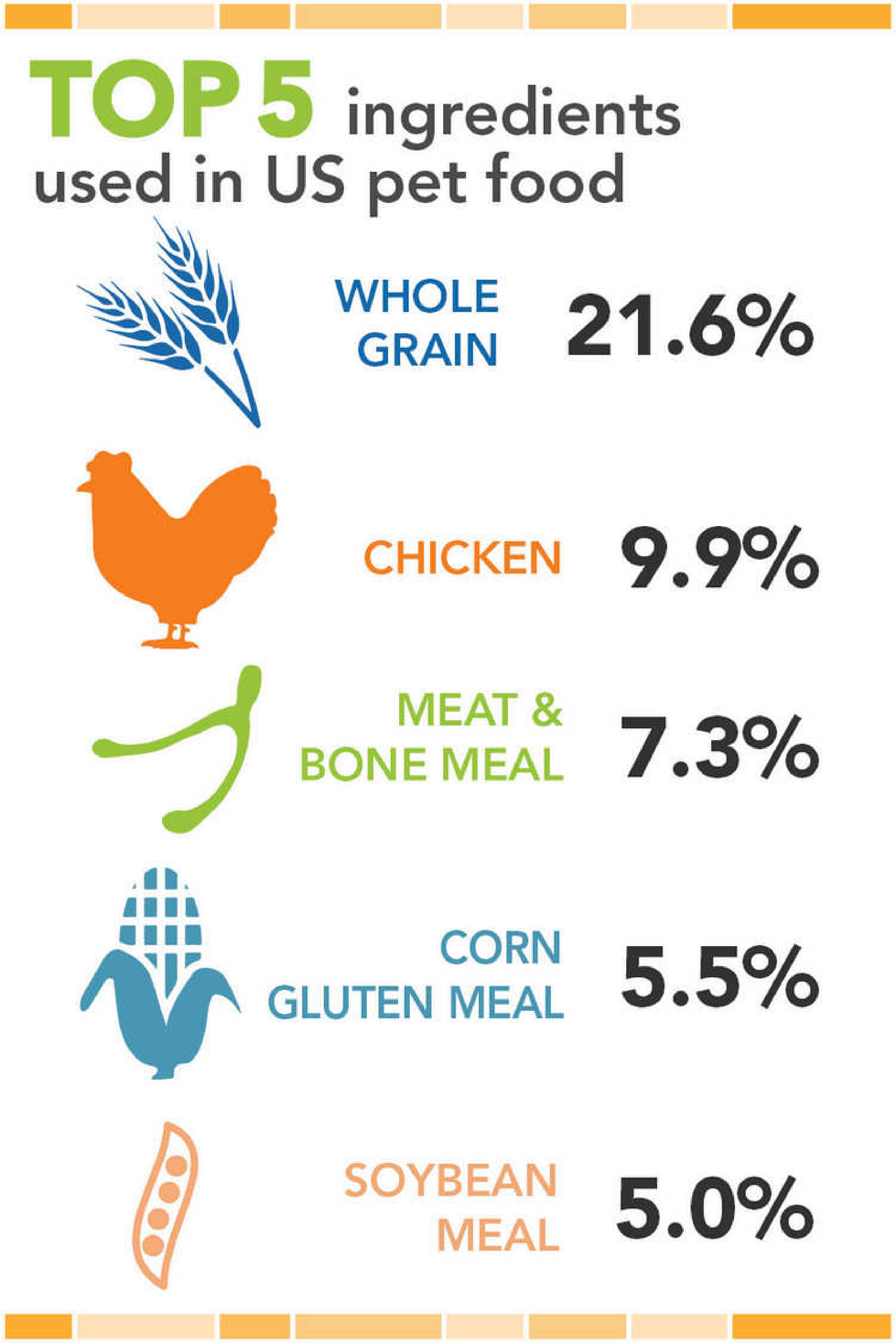
a major consumer of meat by-products, utilizing nutrient-rich organs, meat trimmings, and rendered products to create balanced and palatable diets for companion animals.

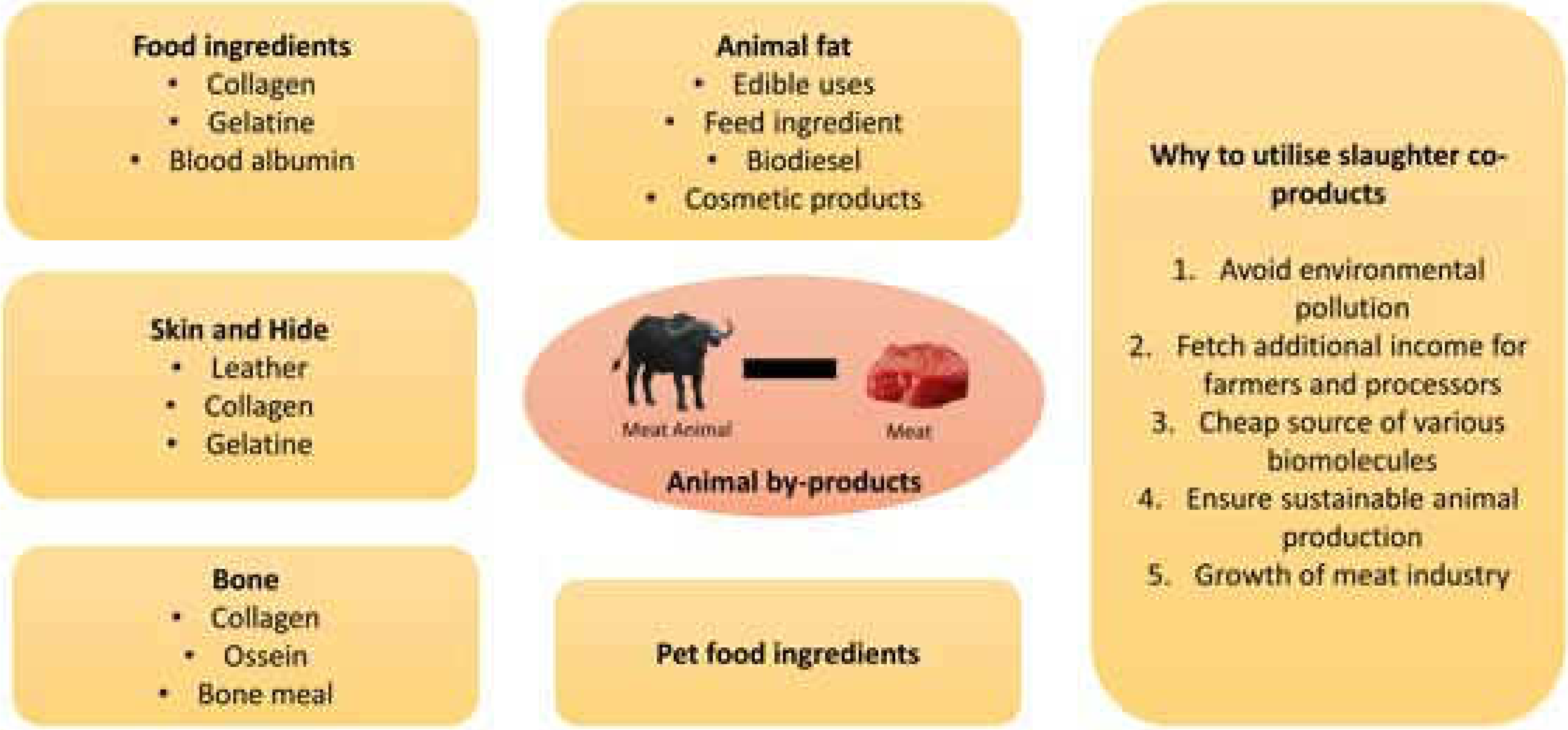
Bioenergy →

anaerobic digestion of certain meat processing wastes, such as manure and stomach contents, can produce biogas, a renewable energy source.

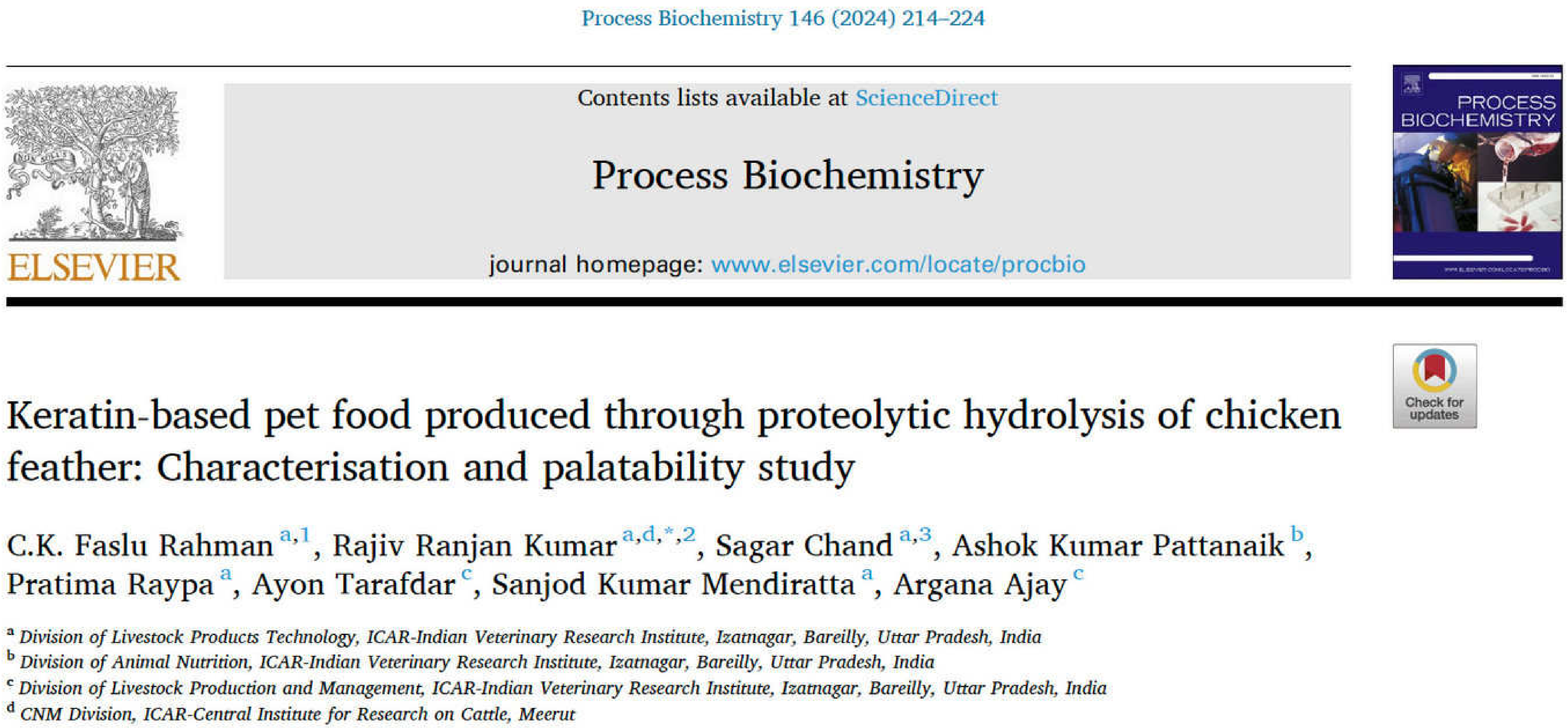
The pet food connection

One of the largest markets for meat plant by-products is the pet food industry. Those meat scraps and organ meats that don't make it into human food often become the protein foundation for dog and cat foods.




Food ingredients
Collagen
Gelatine
Blood albumin
Animal fat
Edible uses
Feed ingredient
Biodiesel
Cosmetic products
Why to utilise slaughter co-products
1. Avoid environmental pollution
2. Fetch additional income for farmers and processors
3. Cheap source of various biomolecules
4. Ensure sustainable animal production
5. Growth of meat industry
Skin and Hide
Leather
Collagen
Gelatine
Meat Animal
Meat
Animal by-products
Bone
Collagen
Ossein
Bone meal
Pet food ingredients

Case studies: real-world applications of yield improvement techniques



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Keratin-based pet food produced through proteolytic hydrolysis of chicken feather: Characterisation and palatability study

C.K. Faslu Rahman [a,1], Rajiv Ranjan Kumar [a,d,*,2], Sagar Chand [a,3], Ashok Kumar Pattanaik [b], Pratima Raypa [a], Ayon Tarafdar [c], Sanjod Kumar Mendiratta [a], Argana Ajay [c]

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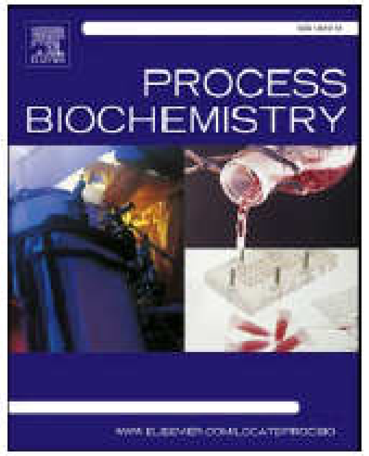

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Keratin-based pet food produced through proteolytic hydrolysis of chicken feather: Characterisation and palatability study

C.K. Faslu Rahman [a,1], Rajiv Ranjan Kumar [a,d,*,2], Sagar Chand [a,3], Ashok Kumar Pattanaik [b], Pratima Raypa [a], Ayon Tarafdar [c], Sanjod Kumar Mendiratta [a], Argana Ajay [c]

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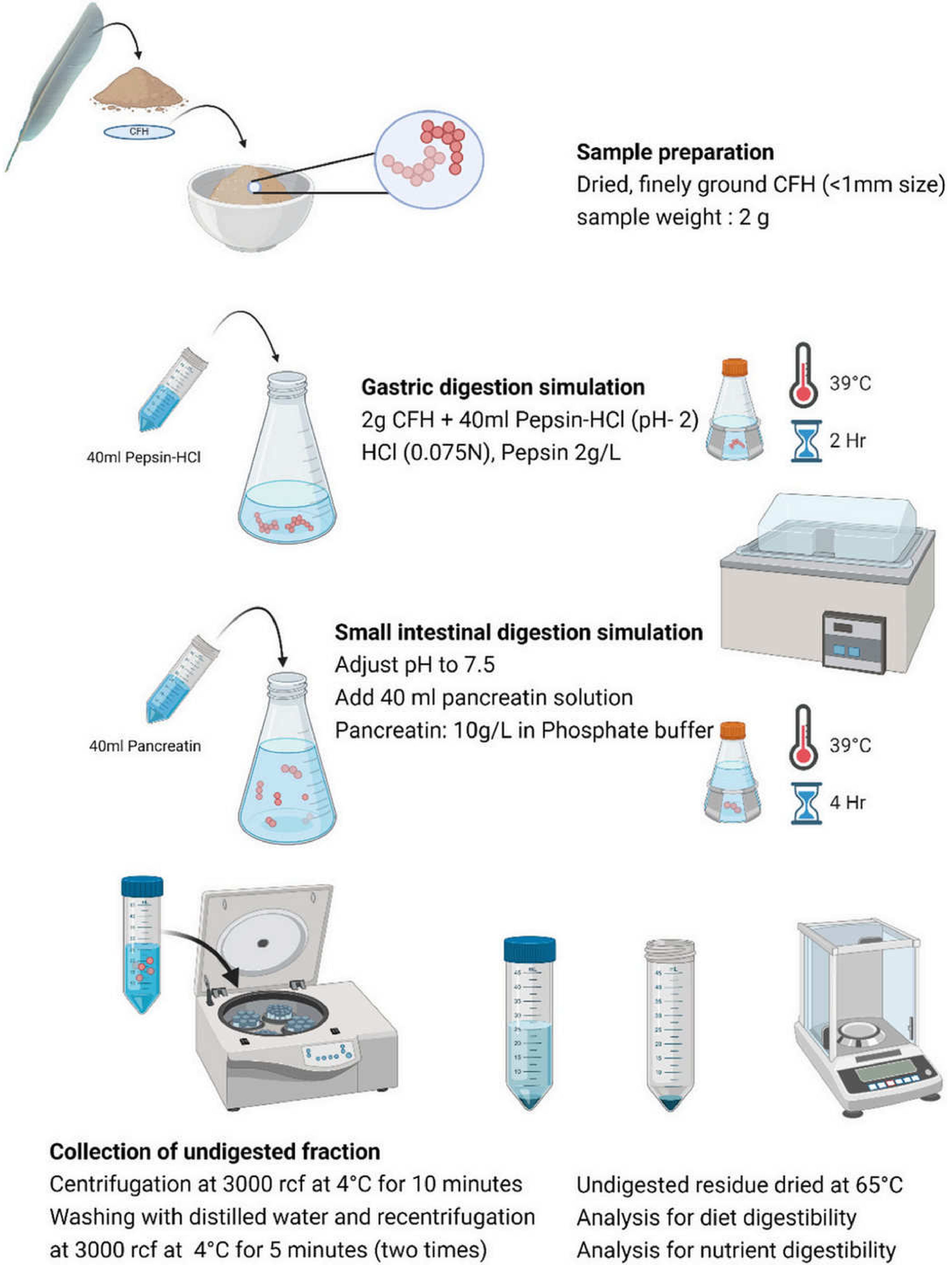
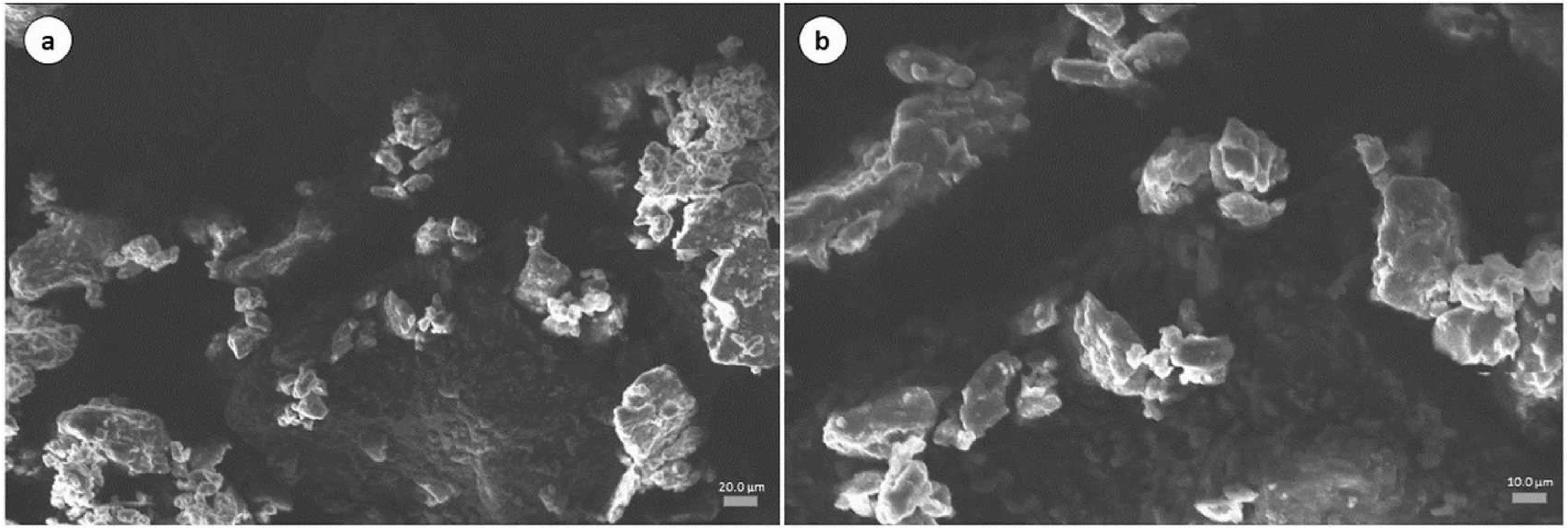
a) Raw white broiler chicken feathers b) Grounded white broiler chicken feathers
c) Chicken feather hydrolysate from white broiler chicken d) Chicken feather hydrolysate incorporated pet food.

In vitro digestion of chicken feather hydrolysate to assess the digestibility

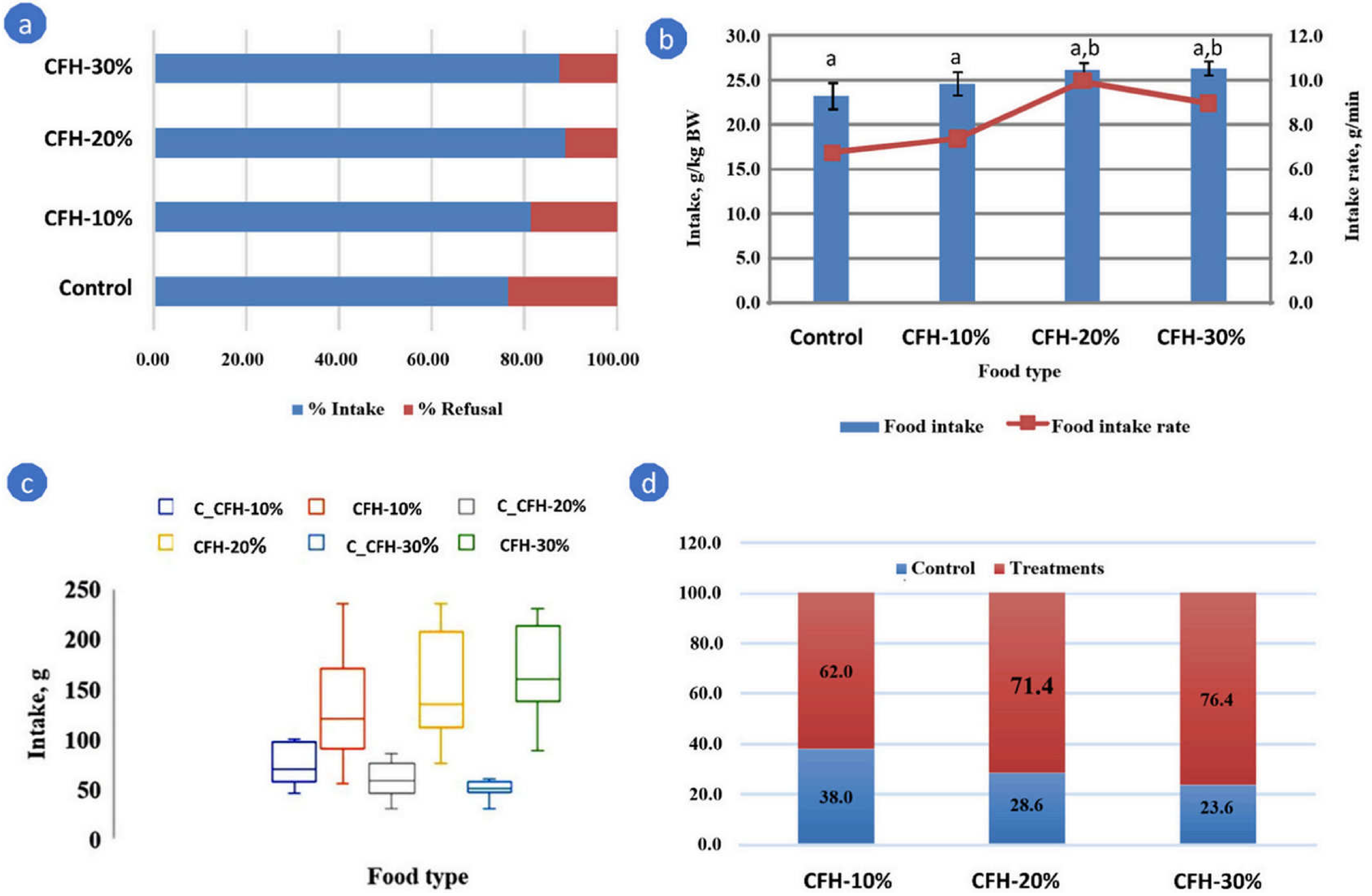




Scanning Electron Micrograph at a) 500x magnification b) 1000x magnification, showing ruptured particles of CFH.

Table 1
Amino acid profile of CFH (values expressed as the percentage of total amino acid).

Sl No	Amino acid	Percentage Amino acids in CFH	Percentage of Amino acids in native broiler chicken feather [16]	Percentage of Amino acids in Feather meal [33]	Percentage of Essential Amino Acids in Feather Meal [34]	Percentage of Amino acids in Soya Bean Meal [29]
	Crude Protein	**82.12**	**86.6**	**86.8**	**86.4**	**46.5**
1	Histidine	1.51	0.06	0.61	0.34	1.21–1.32
2	Serine	0.57	12.40	10.70		
3	Arginine	27.46	4.42	5.98	5.42	3.49–3.78
4	Glycine	0.04	6.85	7.12		
5	Aspartic acid	5.03	5.55	6.11		
6	Glutamic acid	5.56	9.65	9.41		
7	Threonine	0.08	4.34	4.25	3.43	1.89–2.03
8	Alanine	2.26	3.54	4.31		
9	Proline	14.48	4.52	8.88		
10	Cysteine	1.14	7.68	4.19	4.00	0.66–0.75
11	Lysine	4.39	1.21	1.45	1.67	2.99–3.22
12	Tyrosine	2.27	1.45	2.47		
13	Methionine	3.87	0.32	0.45	0.42	0.60–0.69
14	Valine	0.27	4.21	6.88	5.57	2.24–2.67
15	Isoleucine	2.45	3.30	4.34	3.26	2.15–2.78
16	Leucine	2.51	5.62	7.58	6.72	3.66–3.92
17	Phenylalanine	0	0.85	4.25	3.26	2.35–3.0



(a): Food acceptability by dogs as percent intake and refusal during the single-bowl test. (b) Quantity and rate of food intake by dogs during the single-bowl test. (c) Overall consumption pattern of the three experimental foods compared to the control food by dogs during the two-bowl test. d) Comparative preferential food consumption of the three experimental foods compared to the control food by dogs during the two-bowl test.

Table 4
Water activity, Instrumental colour analysis, cooking yield, and spoilage indices of control and selected pet foods.

Parameter	Control	20 % CFH- Pet food
a_w (Water Activity)	0.52 ± 0.01^{a}	0.50 ± 0.01^{a}
L*	24.64 ± 0.62^{a}	24.01 ± 0.52^{a}
a*	5.96 ± 0.19^{a}	5.56 ± 0.16^{a}
b*	9.03 ± 0.19^{a}	7.33 ± 0.18^{b}
Cooking Yield (%)	91.32 ± 0.17^{a}	92.54 ± 0.26^{b}
Free Fatty Acids (% oleic acid)	0.35 ± 0.01^{a}	0.30 ± 0.01^{b}
TBARS (mg Melonaldehyde/kg)	0.69 ± 0.07^{a}	0.80 ± 0.48^{a}
Tyrosine Value (mg/100 g)	8.14 ± 1.0^{a}	10.37 ± 0.16^{b}

Mean±S.E with different superscripts in the same row differ significantly ($p<0.05$), a_w- Water activity, L*- Lightness, a*- redness, b*- yellowness TBARS- Thiobarbituric acid reactive substances. $^{a,\ b}$ mean values within column with different superscripts are significantly different ($P<0.05$).

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Effects of different antioxidants on quality of meat patties treated with in-package cold plasma

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Table 1

Effects of adding different antioxidants on microbiota populations ($\log_{10}$ CFU/g fresh meat) in IPCP-treated chicken breast patties.

	Control	0.02% BHT	1% Carnosine	1% Rosemary	1% Pine Bark	1% Pomegranate
0 Day						
Non-CP	2.42^{h}	2.30^{h}	2.46^{h}	2.41^{h}	2.28^{h}	2.25^{h}
CP	2.45^{h}	2.37^{h}	2.41^{h}	2.27^{h}	2.40^{h}	2.35^{h}
5 Day						
Non-CP	4.80^{bc}	4.92^{b}	4.50^{cde}	4.61^{bcde}	4.90^{b}	5.22^{a}
CP	4.45^{de}	4.28^{e}	4.71^{bcd}	3.63^{g}	4.39^{de}	3.97^{f}

[a–h] Means with no common superscripts are significantly different at $P < 0.05$ (SE = 0.42, $n = 6$).

Table 2
Effects of adding different antioxidants on pH of IPCP-treated chicken breast patties.

	Control	0.02% BHT	1% Carnosine	1% Rosemary	1% Pine Bark	1% Pomegranate
0 Day						
Non-CP	5.91^{fgh}	5.90^{fghi}	6.52^{b}	5.86^{ghijk}	5.88^{ghij}	5.80^{jk}
CP	5.66^{m}	5.77^{kl}	6.35^{c}	5.69^{lm}	5.70^{lm}	5.64^{m}
5 Day						
Non-CP	6.06^{de}	6.14^{d}	6.65^{a}	5.98^{ef}	5.93^{fg}	5.80^{jk}
CP	5.91^{fgh}	5.94^{fg}	6.46^{b}	5.81^{ijk}	5.82^{hijk}	5.70^{lm}

$^{a–m}$Means with no common superscripts are significantly different at $P < 0.05$ (SE = 0.07, n = 6).

Table 4

Effects of adding different antioxidants on TBARS (mg malondialdehyde/kg meat) in IPCP treated chicken breast patties.

	Control	0.02% BHT	1% Carnosine	1% Rosemary	1% Pine Bark	1% Pomegranate
0 Day						
Non-CP	0.70^{kl}	0.59^{l}	0.70^{kl}	0.70^{kl}	0.70^{kl}	0.70^{kl}
CP	1.89^{d}	1.60^{efg}	1.67^{def}	1.75^{de}	1.01^{ij}	1.75^{de}
5 Day						
Non-CP	1.40^{gh}	0.89^{jk}	1.21^{hi}	0.95^{j}	1.49^{fg}	0.87^{jk}
CP	3.32^{a}	2.16^{c}	2.70^{b}	2.38^{c}	1.51^{fg}	2.24^{c}

$^{a–l}$Means with no common superscripts are significantly different at $P < 0.05$. (SE = 0.11, n = 6).

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Inactivation of *Escherichia coli* O157:H7, *Salmonella*, *Listeria monocytogenes*, and Tulane virus in processed chicken breast via atmospheric in-package cold plasma treatment

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Table 2

Effect of atmospheric dielectric barrier discharge cold plasma treatment (ADCPT) on the inactivation of *E. coli* O157:H7, *Salmonella*, *L. monocytogenes*, and Tulane virus on whey protein-coated boiled chicken breast cubes.

Microorganisms	Initial microbial concentration	Microbial reduction
E. coli O157:H7	4.6 ± 0.2 log CFU/cube	3.9 ± 0.3 log CFU/cube
Salmonella	4.7 ± 0.1 log CFU/cube	3.7 ± 0.3 log CFU/cube
L. monocytogenes	5.1 ± 0.2 log CFU/cube	3.5 ± 0.6 log CFU/cube
Tulane virus	3.4 ± 0.0 log PFU/cube	2.2 ± 0.3 log PFU/cube

Microbial reduction was calculated as log (N/N_0) where N is the microbial count after ADCPT (CFU/cube or PFU/cube) and N_0 is the initial microbial count prior to the treatment (CFU/cube or PFU/cube).

Results are expressed as the mean ± standard deviation ($n = 6$).

The treatment time and treatment voltage applied to the electrodes were 3.5 min and 39 kV, respectively.

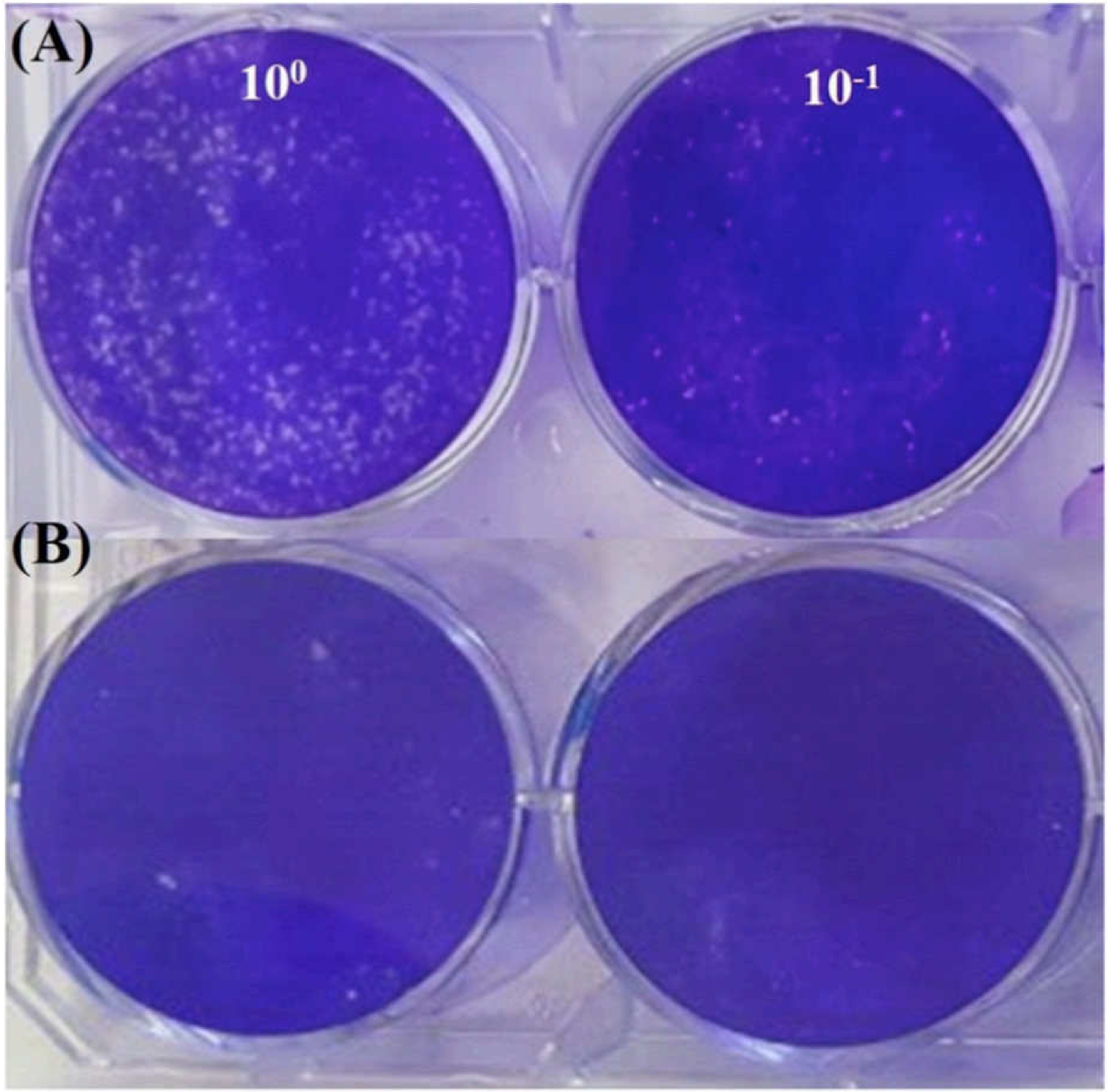

Fig. A1. Plaque assay of Tulane virus on whey protein-coated boiled chicken breast cubes in a plastic container (A) without and (B) with atmospheric dielectric barrier discharge cold plasma treatment. The titer was obtained from plates with no dilution (1×10^0) or 1×10^{-1} dilution. The treatment time and voltage were 3.5 min and 39 kV, respectively.

THANK YOU