



Poultry meat quality preservation by plant extracts: an overview

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ABSTRACT

Poultry meat is appreciated by consumers for its nutritional value, low fat content, versatility of use in various cuisines and affordable prices. However, its susceptibility to spoilage due to multiple pre-slaughter and processing factors poses challenges for the meat industry, especially in developing countries. To improve the safety of poultry products, synthetic preservatives like nitrites, butylated hydroxytoluene and sulphites are used. Currently, these additives/preservatives have, however, raised concerns about their impact on human health, prompting a shift from consumers toward natural alternatives, such as medicinal and aromatic plants. Therefore, this paper delves into the potential of plant extracts as natural preservatives for improving the quality and shelf-life of chicken meat and processed products. It provides an overview of the various plant extracts and essential oils that have demonstrated antimicrobial, antioxidant and enzyme inhibitory properties, without compromising the sensory attributes of the products. Different incorporation methods are discussed, including direct incorporation or marination in aqueous and/or alcoholic extracts, and the use of essential oils, including for *in vivo* animal feed supplementation. Overall, each method influences the final product quality differently. We further summarised the current knowledge about the mechanisms of action of the plant extracts tested, even though they are not fully elucidated. Despite the benefits of these compounds, some challenges have to be addressed, including standardising the composition of the extracts, harmonising the sensitivity of the bioactive compounds with the processing conditions, ensuring cost effectiveness and obtaining regulatory approvals for their use. The scaling up of production to meet industry demands also presents some technical challenges. Overall, the application of natural plant preservatives not only enhances chicken meat quality, but also could support the meat industry to align with the evolving consumer expectations for sustainable food products.

1. Introduction

Meat, the product of converting animal muscle into a culinary delight, holds immense importance in human diets and cultures worldwide. The transformation of muscle into meat through sophisticated post-mortem physical and biochemical changes that occur in early post-mortem and during ageing, confers the expected sensory qualities by consumers. In

fact, meat is rich in essential nutrients, it provides proteins, vitamins and minerals, which all are crucial for human health (Shah *et al.*, 2014; Geldenhuys *et al.*, 2015). Among the various types of meat, poultry stands out for its advantageous nutritional composition that makes it highly valued for healthy dietary practices (Jilo & Hasan, 2022). It has a lower fat content in contrast to red meat, and is predomi-

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nantly composed of unsaturated fatty acids (Saleh *et al.*, 2020; Hailemariam *et al.*, 2022). Overall, chicken meat and derived products are affordable, exempt of religious constraints, and have valuable technological characteristics, making them widely consumed sources of animal proteins (Liu *et al.*, 2012; Vranić *et al.*, 2014).

Despite these numerous advantages, industry is challenged with the fragile character of chicken meat that can alter in 4 to 8 days, owing to the white muscle structure, the overall health state of the animal and slaughter conditions (Abdel-Salam *et al.*, 2017; Alessandroni *et al.*, 2021). The rate of spoilage is furthermore exacerbated by the post-slaughter handling at the retail phase due to cold chain breaks during transport and inappropriate storage temperatures (Rani *et al.*, 2017).

To reduce the economic losses induced by this deterioration and to satisfy the growing demand of the consumers, preservatives like sodium and potassium nitrites, butylated hydroxytoluene (BHT), sulphites and other chemical products are used to stabilise the biochemical and enzymatic processes, inhibit bacterial growth, prevent lipid oxidation reactions and to enhance the colour, flavour and tenderness properties (Mani-López *et al.*, 2016; Gutiérrez-Del-río *et al.*, 2021; Atwaa *et al.*, 2022). Although these chemical (synthetic) compounds are effective in extending the shelf-life of chicken meat with technological benefits and cost conveniences, they are highly questionable and controversial concerning their potential impact on human health (Thakur *et al.*, 2019; Yu *et al.*, 2021). For example, some of them have been deemed allergenic, like sulphites, carcinogenic like butylated hydroxyanisole (BHA) and BHT, or as precursors to carcinogenic components like nitrates and nitrites that react with certain amino acids during high-heat cooking to form nitrosamines (Drabik-Markiewicz *et al.*, 2010; Muthukumar *et al.*, 2020; Xie *et al.*, 2023). Thus, these compounds are no longer desirable due to the growing concerns by consumers over their intake of chemical ingredients in food. In fact, consumers are becoming more proactive about their health and they have placed emphasis on products with transparent labelling, reduced or absent synthetic ingredients and minimally processed products, while having more expectations that products are locally sourced and/or of natural origin (Fox *et al.*, 2018; Mesías *et al.*, 2021).

Considering the above concerns, incorporating natural preservatives from plants in chicken meat preservation would then offer a multi-

tude of benefits. For the industry, it provides an eco-friendly alternative to synthetic additives, aligning with the growing demand for more sustainable food production. Using plant-derived preservatives can also reduce production costs and improve supply chain efficiency, ultimately boosting profitability. Moreover, it enhances product quality, reducing food waste, while still ensuring safe and healthy products (Seidavi *et al.*, 2021). For consumers, the impact is profound, as they enjoy chicken products that are free from potentially harmful synthetic additives, resulting in improved food safety and overall well-being. This approach supports a healthier, more sustainable food industry, satisfying both producers and consumers (Vinci *et al.*, 2022; Pinto *et al.*, 2023). These aspects constitute the objectives of this review, which aims to provide an overview of the main plants and their compounds that have been identified to have antioxidant, antimicrobial and enzyme inhibitory properties, used to improve the quality and extend the shelf-life of chicken meat and its derived products. We also discuss the different processes of their incorporation, the mechanisms of action, and the challenges encountered when using natural extracts on muscle food products.

2. An overview of the main plants used for chicken meat preservation

Medicinal and aromatic plants have long been part of the cultural heritage of different ethnicities. They find their place in ancestral medicine, cosmetics and culinary recipes (Miara *et al.*, 2019a; Miara *et al.*, 2019b). In the context of traditional (ethnic) methods of meat preservation, different herbs are used to mask unpleasant or improve the odour and taste, along with increasing the shelf-life of the products (Gagaoua & Boudechicha, 2018; Ez zoubi *et al.*, 2022). Broiler meat from battery-farmed chicken presents a mild flavour and subtle taste, sometimes described as bland and insipid by consumers, who prefer local, traditional pasture-raised chicken (Gnakari *et al.*, 2007). However, it has the advantage of easily adapting to different seasonings and absorbing their aroma. This versatility facilitates the incorporation of plants, plant extracts and essential oils as preservatives, thereby enhancing the taste of chicken meat products and prolonging their shelf-life without negative influences on the inherent organoleptic characteristics (Tian *et al.*, 2014; Qi *et al.*, 2022).

Table 1. Summary table of key studies and findings regarding plant extract use in chicken meat preservation.

Plant name	Concentrations	Chicken meat product	Experimental storage parameters	Research output	References
Basil (<i>Ocimum basilicum</i>)	2.5 and 5 mg/ml (solution)	Raw and autoclaved meat	72h – 4°C and 18°C – EO – Sterile petri dishes	<ul style="list-style-type: none"> • Significant effect on normal flora • Reduction of artificially inoculated <i>Salmonella enteritidis</i> • Physicochemical parameters (pH, colour, texture, TBARS, cooking loss) beneficially affected for most of them 	(Stojanović-Radić et al., 2018)
Cinnamon (<i>Cinnamomum verum / cassia</i>)	0.25, 1 and 2% (w/v) EO	Chicken breast fillets	15 days – 4°C – Nanoemulsion with chitosan-pectin solution	<ul style="list-style-type: none"> • Strong <i>in vitro</i> antimicrobial activity against <i>L. monocytogenes</i> and <i>P. deceptionensis</i> • EO nanoemulsion improved the pH, oxidative stability, and colour properties of chicken breasts 	(Wang et al., 2021)
Cinnamon (<i>Cinnamomum verum / cassia</i>)	0.5 % of oil macerate (1g/100ml oil)	Ready-to-eat chicken patties	16 days – 4°C – Gelatine-chitosan nano-emulsion coating infused with EO + sterile polyethylene bags	<ul style="list-style-type: none"> • Better coating characteristics • Stronger antimicrobial activity • Lowest TVC, pH, TVBN and TBARS • Dramatically reduced moisture loss • Shelf-life extension by more than 4 days 	(Qiu et al., 2022)
Coriander (<i>Coriandrum sativum</i>)	1%	Chicken patties	9 days – 4°C – Aqueous extract	<ul style="list-style-type: none"> • Reduction of peroxide, Total carbonyls, metmyoglobin formation • Microbial growth (TPC) inhibited and low TBARS rates • No colour or odour changes after cooking 	(Ahmad et al., 2023)
Citrus (<i>Citrus spp.</i>)	0.1 and 0.2 ml /100g meat	Fresh ground chicken	14 days – 4°C – LDPE and LDPE/EVOH/LDPE films – Citrox® extract	<ul style="list-style-type: none"> • Extension of the microbiological shelf-life by 1–2 days (extract alone) and 3–4 days when combined with an O₂ absorber • No significant changes in colour, but positively significant in odour and taste • Physicochemical parameters slightly affected by the different treatments 	(Mexis et al., 2012)
Clove (<i>Syzygium aromaticum</i>)				<ul style="list-style-type: none"> • Highly effective against microbial growth: TVC, LAB, <i>Enterobacteriaceae</i> and <i>Pseudomonas</i> spp. count 	(Zhang et al., 2016); (Radha Krishnan et al., 2014)
Rosemary (<i>Rosmarinus officinalis</i>)	0.5 and 1%	Raw chicken meat	15 days – 4°C – LDPE bags – Ethanolic extract	<ul style="list-style-type: none"> • Prevention of lipid oxidation (TBARS) • Good extraction yield, overall acceptability and antioxidant potential: DPPH, FICA • Meat colour preservation 	

Plant name	Concentrations	Chicken meat product	Experimental storage parameters	Research output	References
Rosemary (<i>Rosmarinus officinalis</i>)	EO/EtOH 30/70 at different concentrations from 0.1% to 4% w/w	Fresh sliced chicken breast meat	7 days – 4°C – directly sprayed on meat – PET packaging	<ul style="list-style-type: none"> Antibacterial action of volatile components of <i>R. officinalis</i> extracted by hydrodistillation BA production inhibition after just 2 days of storage The antibacterial and anti-BA action was due to the formulation of a new active packaging system with essential oil of <i>R. officinalis</i> 	(Sirocchi et al., 2013)
Rosemary (<i>Rosmarinus officinalis</i>)	EO/tween 80 1% and 2% (w/v) solutions	Fresh minced chicken meat	21 days – 4°C – chitosan/sodium caseinate – PLA film	<ul style="list-style-type: none"> EO films showed antioxidant and inhibition of lipid peroxidation effects: DPPH and TBARS EO film coated meat reported lower concentrations of heptanal, butanoic acid and ethanol 	(Fiore et al., 2021)
Curry (<i>Murraya kœnigii</i>)				<ul style="list-style-type: none"> No significant difference in the cooking yield and proximate composition 	(Najeeb et al., 2015)
Drumstick (<i>Moringa oleifera</i>)	1%	Restructured chicken slices	20 days – 7±1°C – Leaf powders – LDPE bags	<ul style="list-style-type: none"> Significantly lower microbial counts No detection of yeast or mould No significant changes in the sensory parameters, with a good overall acceptability 	
Mint (<i>Mentha spp.</i>)					
Fennel seeds (<i>Fœniculum vulgare</i>)	0.2% v/w	Chicken thighs	16 days – 4±0.5°C – EO – Vacuum packaging	<ul style="list-style-type: none"> TVC reduction for <i>Enterobacteriaceae</i>, <i>Pseudomonas</i> spp, LAB Prolongation of the shelf-life of chicken thighs 	(Kačániová et al., 2019)
Savory (<i>Satureja hortensis</i>)					
Garlic (<i>Allium sativum</i>)	Fresh garlic: 20, 30, 50 g/kg Ground powder: 6, 9, 15 g/kg Garlic EO: 0.06, 0.09, 0.15 g/kg	Raw chicken sausage (thigh meat)	21 days – 3°C – Fresh garlic / garlic powder / garlic EO – Vacuum packaging in polyethylene bags	<ul style="list-style-type: none"> Delay of lipid oxidation (TBA) No changes in the compositional content Reduction of the microbial count Sensory results showed a good overall acceptability even though fresh garlic sausages had stronger flavour 	(Sallam et al., 2004)
Ginger (<i>Zingiber officinale</i>)	3 and 6 %	Chicken breast fillets	12 days – 4°C – EO (nano) emulsion edible coating	<ul style="list-style-type: none"> Significant decrease of TPC Non-significant TBARS effect Better colour preservation Lower cooking loss and good overall acceptability 	(Noori et al., 2018)
Green tea (<i>Camellia sinensis</i>)	0.5 %		200 minutes – Hydroethanolic extract – Vacuum packaging	<ul style="list-style-type: none"> Pro-oxidative effect Less antioxidant than mate 	(Jongberg et al., 2019)
Mate (<i>Ilex paraguariensis</i>)	0.01%, 0.05, 0.1 and 0.5 %	Minced chicken breast	Freezing then mincing	<ul style="list-style-type: none"> No reaction with protein thiols in chicken meat Direct dose-dependent response: protection of the protein thiols 	

Plant name	Concentrations	Chicken meat product	Experimental storage parameters	Research output	References
Hawthorn (<i>Crataegus pinnatifida</i>)	0.5 and 1%	Cooked chicken breast meat	150, 200 and 250°C then overnight storage at 4°C	<ul style="list-style-type: none"> Mitigation of HAA formation, especially at high cooking temperatures No negative changes in structure, appearance, colour and odour 	(Tengilimoglu-Metin et al., 2017)
Laurel bay (<i>Laurus nobilis</i>)	1%	Fresh raw chicken breast slices	16 days – 4±1°C – Ethanolic extract – Sterile plastic bags	<ul style="list-style-type: none"> Significant decrease in chemical parameters (pH, TBVN, TBA) Marked decrease in bacterial counts (aerobic plate, total <i>coliform</i>, and total <i>Staphylococci</i> count) Extension of the chicken meat shelf-life 	(Youssef et al., 2021)
Olive leaf (<i>Olea europaea</i>)	0.25, 0.5 and 1%	Raw poultry meat	15 days – 4±1°C – Plastic bags – Ethanolic extract	<ul style="list-style-type: none"> Reduction of microbial growth (TABC, TPC, TEC, TSC and Total Mould and Yeast Count) Preservation of chemical (pH, TVBN, TBARS) and sensory attributes Good antioxidant effect and overall acceptability 	(Saleh et al., 2020)
Oregano (<i>Origanum vulgare</i>)	Glycerol, EO, N,O-carboxymethyl chitosan and EO/ N,O-carboxymethyl chitosan water solutions	Chicken breast fillets	14 days – 4°C	<ul style="list-style-type: none"> EO and N,O-carboxymethyl chitosan used individually, showed a significant antibacterial and preservative effect EO/ N,O-carboxymethyl chitosan combination resulted to a 6 day shelf-life extension of chicken fillets 	(Khanjari et al., 2013)
Oregano (<i>Origanum vulgare</i>)	5g EO /100g nanoemulsion	Chicken pâté	45 days – Nanoemulsion encapsulation – Pasteurisation in hot water bath and ambient temperature storage	<ul style="list-style-type: none"> Good antimicrobial growth: low values of MIC and MBC on <i>E. coli</i> and <i>S. aureus</i> No significant change in physicochemical properties of meat (moisture, protein, ash, fat, pH) 	(Moraes-Lovison et al., 2017)
Pepper seeds (<i>Piper annuum</i>)	1 % powder and 7% oil	Chicken sausages	14 days – 100°C for 30mn then 4°C ± 1°C – Cellulose casing and PVDC bags – Powder and EO	<ul style="list-style-type: none"> Retarded lipid oxidation (lower TBARS values) Sensory attributes and nutritional value favourably affected No textural properties change, except for hardness decrease 	(Kim, 2020)
Pomegranate (<i>Punica granatum</i>)	Pomegranate juice phenolics 8ml /100g meat Powder extract phenolics 1ml / 100g meat	Cooked chicken patties	15 days – 4°C – Rind powder and aqueous extract – Aerobic packaging in LDPE pouches	<ul style="list-style-type: none"> Better protection against oxidative rancidity (TBARS) than BHT used as positive control Total phenolic compounds increased in the final product No negative effect on the sensory attributes 	(Naveena et al., 2008)

Plant name	Concentrations	Chicken meat product	Experimental storage parameters	Research output	References
Sage (<i>Salvia officinalis</i>)	0.2% w/w	Cooked chicken thigh and breast	96h – 4°C – Polyester film – Marinade and heating	<ul style="list-style-type: none"> • Lower TBARS values → Protection from oxidation processes • Increasing in moisture content • Great consumer acceptability 	(Sampaio <i>et al.</i> , 2012)
Thyme (<i>Thymus vulgaris</i>)	0.05 wt/vol of EO blend	Fresh raw marinated chicken meat (Breast and wings)	12 days – +4°C Marinade with EO blend	<ul style="list-style-type: none"> • High lipid oxidation prevention potential (TBARS) • No pH, colour, shear force, moisture, cooking yield, purge loss or marinade uptake changes 	(Rimini <i>et al.</i> , 2014)
		Frozen raw marinated chicken meat (Breast and wings)	90 days – -18°C – Marinade with EO blend		
Turmeric (<i>Curcuma longa</i>)	0.5 and 1%	Cooked chicken breast meatballs	4h at 4°C then 18mn cooking at 150, 200 and 250°C – Turmeric powder	<ul style="list-style-type: none"> • Dose-dependent inhibition of the heterocyclic aromatic amines (HAA) formation • Reduction of the cooking loss and the lipid oxidation • Preservation of colour properties 	(Kilic <i>et al.</i> , 2021)

BA: Biogenic Amine – BHT : Butylated Hydroxytoluene – DPPH: 2,2-Diphenyl 1-picrylhydrazyle – EO: Essential Oil – EVOH: Ethylene Vinyl Alcohol – FICA: Ferrous Ion Chelating Activity – HAA: Heterocyclic Aromatic Amines – LAB: Lactic Acid Bacteria – LDPE: Low Density Polyethylene – MBC: Minimum Bactericidal Concentration – MIC: Minimum Inhibitory Concentration – PET: Polyethylene Terephthalate – PLA: Polylactic Acid – PVDC: Poly Vinylidene Chloride – TBA: Thiobarbituric Acid – TBARS: Thiobarbituric Acid Reactive Substances – TEC: Total Enterobacteriaceae Count – TPC: Total Psychrophilic Count – TSC: Total Staphylococcal Count – TVBN: Total Volatile Basic Nitrogen – TVC: Total Viable Count.

Table 1 offers a comprehensive overview of the plant extracts tested and added in different forms to improve and preserve the quality of chicken meat products and details their impacts on the products. The studies reported significant antimicrobial and antioxidant potential of the plants used. Furthermore, most of the studies evidenced positive impacts on the physicochemical, sensorial and nutritional properties of chicken meat products. It is noteworthy that the recovery of the extracts depends on the targeted bioactive compounds and the type or part of the plant. Furthermore, the aerial plant parts, encompassing fruits, leaves, flowers, and bark, serve as primary sources (Kicel *et al.*, 2019; Polka & Podszdek, 2019). In some bulbs and rhizomes like turmeric and ginger, the emphasis lies in their underground parts (Elmowalid *et al.*, 2019; Kilic *et al.*, 2021). Seeds and roots can be also used (Melloul *et al.*, 2022; Sharma *et al.*, 2023). A relatively new way to extract plant phytochemicals, significant due to reduced costs and less waste generation, is the valorisation of industry by-products rather than non-by-product plant materials. By-products include pomaces from the processing of tomato (seeds and peels), grape (seeds, skins and stems) and olive (skin, pulp, ker-

nels and oil residue), which showed interesting biological activities and promising preservation abilities for meat products (Gutiérrez-Del-río *et al.*, 2021). Overall, it has been observed that the inclusion of plant extracts in the formulation and preparation of chicken meat products do not compromise the sensory properties or overall acceptability as assessed by sensory panellists (Mohd Subakir *et al.*, 2022; Zhu *et al.*, 2022). The following sections delve into these details and discuss some examples of the different plant extracts that have been incorporated as natural chicken meat preservatives.

3. Plant extracts and incorporation strategies

Several techniques for incorporating plant-based components into chicken meat and its derived products have been evaluated, which taken all together aimed to extend product shelf-life while improving or preserving product quality. These approaches encompass the utilisation of raw plant material and various forms of extracts as natural food additives in meat preparations during processing, as well as in the form of dietary supplements in animal feed during breeding.

3.1. Direct incorporation

Direct incorporation is a simple application, low cost, and does not require specific equipment or reagents. The plant material can be spread fresh or powdered onto chicken meat products. For instance, *Sallam et al.* (2004) added fresh or dried garlic cloves to raw chicken sausages, *Kilic et al.* (2021) incorporated powdered turmeric into chicken meatballs, *Najeeb et al.* (2015) tested powders of drumstick leaves, curry, and mint on restructured chicken slices, and *Kim* (2020) formulated chicken sausages enriched with pepper seed powder.

To strengthen the efficacy of phytochemicals, marination encompasses immersing chicken meat in a solution infused with aromatic plants, spices and other ingredients (*Incili et al.*, 2020). This approach solubilises the plant compounds, thereby increasing their availability to preserve meat, enhances the organoleptic properties, likely tenderness and juiciness, and reduces the cooking loss (*Sampaio et al.*, 2012; *Rimini et al.*, 2014; *Lytou et al.*, 2018; *Wu et al.*, 2019). Aqueous extracts can be further used. For example, the application of aqueous extracts of coriander and pomegranate rind powder has been reported by *Ahmad et al.* (2023) and *Naveena et al.* (2008). Aqueous extraction consists of soaking different parts of the plant in hot or cold water for a specified time, filtrating to discard the solid retentate and eventually reduce the liquid through evaporation and/or lyophilisation. Water has the ability to dissolve a wide range of compounds, and different biocomponents can be recovered depending on the adopted heating method: decoction, infusion or maceration (*Rahim et al.*, 2022).

3.2. Alcoholic and hydroethanolic extracts

Ethanol is less harmful than most other organic solvents and is the most recommended for food applications. The combination of water and alcohol allows the extraction of a larger group of compounds compared to using the solvents individually (*Alzeer & Abou Hadeed*, 2016; *Tobiszewski & Namieśnik*, 2017). Rosemary and clove hydroethanolic extracts, along with olive leaf ethanolic extract have been used as additives and revealed better preservative properties (increased shelf-life) of raw poultry meat stored at 4°C for 15 days (*Zhang et al.*, 2016; *Saleh et al.*, 2020). Laurel bay leaf ethanolic extract allowed 16 days of preservation for the same product and under the same conditions (*Youssef et al.*, 2021).

It is noteworthy that the extraction yield and composition of the plant extracts depend on the chosen method and the variations in the time-temperature regime used. Conventional extraction methods such as maceration, digestion, percolation and Soxhlet, are effective in extracting most secondary metabolites of plants and are simple to replicate. However, these extraction methods are only adapted to small-scale batch production and involve several time and solvent-consuming steps (*Bitwell et al.*, 2023). Thus, developing environmentally friendly innovative methods that are adapted to large-scale production and that are economically viable are keystones in modern phytochemistry research. Newer methods have emerged, like accelerated solvent extraction, microwave assisted extraction, ultrasound assisted extraction (sonication) (*Nayak et al.*, 2015), supercritical fluid extraction (*Caredda et al.*, 2002), enzyme assisted extraction (*Rafińska et al.*, 2022), pressurised hot water extraction and deep eutectic solvents (*Loarce et al.*, 2021; *Liao et al.*, 2022).

3.3. Essential oils

Essential oils are obtained by hydro-distillation and are added directly as ingredients in chicken meat preparations; for this purpose, essential oils of fennel seeds, pepper seeds, garlic, basil, and rosemary are used (*Sallam et al.*, 2004; *Stojanović-Radić et al.*, 2018; *Kačániová et al.*, 2019; *Kim*, 2020). The oils can also be encapsulated to preserve their odours and flavours, protect them from degradation and likely improve their stability. In fact, encapsulation seemed to increase the bioavailability of essential oils by preserving them from degradation, especially by gastric acids (*Zhang et al.*, 2022; *Zhang & Piao*, 2023). Innovative techniques, such as nanoemulsions of essential oils and synergistic incorporation into packaging and edible coatings, is another way of improving their preservative properties (*Sirocchi et al.*, 2013; *Moraes-Lovison et al.*, 2017; *Noori et al.*, 2018; *Gagaoua et al.*, 2021; *Qiu et al.*, 2022).

3.4. Indirect incorporation

Innovative techniques such as nano-emulsions of essential oils and synergistic incorporation of plant extracts into packaging and edible coatings represent green approaches to improve chicken meat quality preservation while reducing or eliminating the strong odours and flavours of some aromatic plants (*Sirocchi et al.*, 2013; *Moraes-Lovison et al.*, 2017; *Noori et al.*, 2018; *Gagaoua et al.*, 2021; *Qiu et al.*, 2022). In

this context, several approaches have been explored. For example, a coating made of a synergistic blend of propolis extract and chitosan, enriched with *Zataria multiflora* essential oil revealed substantial antimicrobial and antioxidant effect, while enhancing chemical characteristics and sensory acceptability of chicken breast meat (Mehdizadeh & Mojaddar Langroodi, 2019). Phenolic extracts of petioles from betel leaf have been also used to develop a sustainable, biodegradable, functional antioxidant film, successfully maintaining raw chicken meat quality for up to 12 days at refrigeration temperature (Nandi & Guha, 2024). In another study, lower values of pH, thiobarbituric acid reactive substances (TBARS) and total microbe counts after five days of storage were observed in chicken samples packed in carrageenan-based films fortified with medicinal plant extracts (Seol et al., 2013). Jacob Rani & Venkatachalam (2023) conducted a study on poultry meat packaging with a chitosan-based active coating, synergised with nanoparticles synthesised from cellulose, hemicellulose and lignin from leaves of the abundant invasive plant, cattail (*Typha latifolia*). The coating exhibited good antioxidant and antimicrobial activities due to the phenolic properties of the plant extracts, and so subsequently extended the shelf-life of the product. These few studies exemplified the potential for incorporating plant extracts with the aim of reducing wastage and improving the freshness and sensory qualities of chicken products.

3.5. *In vivo* feed supplementation

An alternative strategy regarding the use of plants to enhance the quality of chicken meat and increase its nutritional value is the inclusion of specific medicinal and aromatic plants in the animal diet as feed supplements (Giannenas et al., 2020; Jin et al., 2020; Mohebodini et al., 2021). Phenolic compounds can be adopted to combat infectious agents as alternatives to antibiotics that can lead to resistance phenomena in animals with possible transmission to humans (Mahfuz et al., 2021). The growth performance of battery and ground-raised broilers, evaluated by the measurement of the body weight gain and the consumption index, was significantly ameliorated after broilers were fed with green oak acorns (Berkane et al., 2021). Dietary addition of oregano and germanander for instance, decreased lipid oxidation, monitored by TBARS assay and total carbonyl values, leading to a storage duration of seven days (Al-Hijazeen et al., 2022). Feed supplementation with thyme oil

decreased the saturated fatty acid content of poultry meat and increased the unsaturated fatty acids, with unchanged TBARS values for 42 days at refrigeration temperature (Canan Bölükbaşı & Erhan, 2006).

4. Effects and mechanisms of action of plant extracts in chicken meat and processed products

4.1. Antimicrobial potential

Plant extracts have been proven to be valuable in reducing microbial growth in chicken meat. For instance, pomegranate juice marinades were able to delay the microbial growth of *Pseudomonas* spp., *Enterobacteriaceae*, *Brochothrix thermosphacta* and lactic acid bacteria (LAB) for 6 to 9 days at 4°C and 10°C on chicken breast fillets (Lyttou et al., 2018). The synergistic action of oregano essential oil and chitosan coating diminished *Pseudomonas deceptionensis* CM2 and bacteria total viable count (TVC) in chicken breast fillets stored in refrigerated conditions for 12 days (Zheng et al., 2023). Citrox®, a commercial citrus extract also showed a positive effect on the reduction of the TVC, *Pseudomonas*, *Enterobacteriaceae*, LAB, and *Clostridium* spp., and prolonged the shelf-life of fresh ground chicken refrigerated at 4°C (Mexis et al., 2012).

The mechanisms of action of plant extracts and essential oils against bacteria are intricate and multifaceted. They vary depending on the diverse plant constituents, type of microorganisms, and strains. These mechanisms are not completely elucidated yet, but the commonly known ones that can be enumerated as follows:

- *Cell membrane disruption*: Cell wall thickening is a significant pathway to antibiotic resistance in bacteria. Polyphenols, flavonoids and other bioactive compounds counteract it by compromising the membrane fluidity, rendering it permeable, and cell death occurs by leakage of the cytoplasmic content (Weng et al., 2023). Flavonoids for instance, can interfere with lipid bilayers by inducing bacterial membrane disruption, which inhibits processes such as biofilm formation, cell envelope synthesis, and nucleic acid synthesis (Górniak et al., 2019).
- *Efflux pumps inhibitors (EPIs)*: Efflux pumps are membrane proteins maintaining cell homeostasis through active efflux. In bacteria, they are involved in (multi)drug resistance

mechanisms (Kumawat et al., 2023). Numerous plant species have demonstrated their potential to inhibit these pumps and disturb the inner metabolism of Gram-positive and Gram-negative strains (Seukep et al., 2020; Brown et al., 2021; Mehta et al., 2022).

- *Quorum sensing interference*: Quorum sensing is a paracrine cellular signalling system by which bacteria interact with each other and with their environment (Thompson et al., 2023). Perturbing this process alters the genetic expression of virulence determinants and reduces the formation of biofilms (Ivanov et al., 2022; Kumawat et al., 2023).

These control modes not only reduce bacterial count and inhibit multiplication, but also reinstate antibiotic efficacy (Ivanov et al., 2022). Other mechanisms such as oxygen quenching, the inhibition of enzyme activity, damage to DNA, ribosomes or mitochondria, protein denaturation, and induction of oxidative stress by reactive oxygen species (ROS) are other pathways that have been described in the literature (Rout et al., 2022).

4.2. Antioxidant potential

Oxidation is the second most important degradation form after microbial spoilage of chicken meat, and of meat products in general (Domínguez et al., 2019). In fact, oxidation leads to changes in several meat quality traits, like colour, taste and flavour. In fact, development of lipid rancidity leads to undesirable taste and flavour. The colour change is more noticeable on chicken thigh meat cuts, due to the physiological specifications of poultry, as pH and myoglobin content are higher in this cut and different from in the breast (Wideman et al., 2016). Oxidative deterioration also alters the nutritional value by the loss of proteins and vitamins, along with the generation of toxic compounds (Domínguez et al., 2019; Dursun & Güler, 2023). In this context, several plant extracts, which exhibited a strong antioxidant activity, were tested on chicken meat with the aim to increase its shelf-life and improve its nutritional quality. Rosemary, oregano, pomegranate, olive leaf and clove showed effectiveness in drastically reducing TBARS values, interpreted as a superior protection against oxidative rancidity of chicken meat lipids, even better than some synthetic preservatives like BHT (Al-Hijazeen, 2022; Naveena et al., 2008; Saleh et al., 2020; Zhang et al., 2016).

Aromatic plants are rich in polyphenols and flavonoids that prevent oxidative damage in meat by forming multiple coordinate bonds with pro-oxidative compounds (Gutiérrez-Del-río et al., 2021; Pateiro et al., 2021). These bioactive compounds act as hydrogen atom donors, metallic ions chelators, ferrous reducing agents or radical scavengers by decomposing ROS species like hydrogen peroxide H_2O_2 and superoxide anion $O_2^{\cdot-}$. These various mechanisms of action impede the oxidation reactions, neutralise free radicals and reduce lipid oxidation by lowering the production of peroxide molecules (Köksal et al., 2017; Yan et al., 2020).

4.3. Enzyme regulatory potential

When the animal is slaughtered oxygen and glucose delivery to cells are no longer active, therefore leading to dysregulated muscle homeostasis (Ouali et al., 2013). The complex processes of post-mortem transformation of muscle into meat are initiated, and sophisticated biochemical reactions in the carcass are triggered (Terlouw et al., 2021; Lamri et al., 2023). Such pathways lead to the production of ROS. In this matter, polyphenols would act on the regulation of certain pathways and enzymes, such as NADH oxidase, by inhibiting ROS formation, thereby breaking the oxidation chain reaction (Yan et al., 2020). They can also upregulate endogenous antioxidant enzymes like superoxide dismutase, catalase and glutathione peroxidase.

4.4. Preservation of physicochemical and sensory properties of meat

The correlation between the underlying mechanisms of action of plant extracts and the preservation of the physicochemical properties of chicken meat has been established from the foregoing discussed research results:

- The regulation of enzymes in the tenderisation process and scavenging ROS formation seemed to have a direct impact on the meat texture. For instance, meat from chicken fed with oregano essential oil has lower Warner-Bratzler (WB) shear force values (Mahfuz et al., 2021). Improvements in the water holding capacity of the meat increases the cooking yield and decreases the purge loss, leading to a better meat tenderness and juiciness (Zheng et al., 2023).

- Inhibiting lipid oxidation prevents the development of a rancid taste in meat. Furthermore, essential oils and aromatic compounds in the extracts allow the development of new aromas and flavours in chicken meat products, resulting generally in good overall acceptability by consumers (Munekata *et al.*, 2015; Hadidi *et al.*, 2022).
- Colour is influenced, among other factors, by exposure to oxygen, storage temperatures, and anatomical location of the meat cuts that affects the pH balance and the concentration of myoglobin (Wideman *et al.*, 2016). Packed chicken meat in edible coatings enriched with essential oils or sprayed on the surface with phenolic extracts promoted the oxygenation of myoglobin to form oxymyoglobin, which gives the bright, vivid, light pink hue to chicken meat, and inhibits myoglobin's oxidation to metmyoglobin, thus preserving the visual appeal of the meat (Figure 1) (Gagaoua *et al.*, 2021; Zhou *et al.*, 2021; Wu *et al.*, 2022).

4.5. Nutritional value enhancement

Even though the primary objective for which plant extracts and essential oils are used in food as natural preservatives is for their antioxidant and antimicrobial effects, they still contribute indirectly to

the preservation and enhancement of the nutritional content of the food. The antioxidant effects of polyphenols and terpenoids, along with iron sequestration by flavonoids preserve for instance, polyunsaturated fatty acids (PUFA), like omega-3 fatty acids (Tang *et al.*, 2002; Gutiérrez-Del-rio *et al.*, 2021). Consuming food products enriched with aromatic plants increases the daily intake of polyphenols, known for their beneficial effects on health (Fraga *et al.*, 2010; Vauzour *et al.*, 2010; Tresserra-Rimbau *et al.*, 2018). Figure 1 depicts a few of the preservation effects of plant extracts on chicken meat.

5. Plant compounds involved in chicken meat quality preservation and/or improvement

Secondary metabolites, which originate mainly from defence reactions against environmental threats, exhibit unique and specific activities through distinct mechanisms, contributing to their importance in a variety of applications (Gutiérrez-Del-rio *et al.*, 2021). The secondary metabolites that derive from primary metabolites during plant development have been the subject of much attention in the literature due to their structural diversity and properties, highlighting their importance in medicinal and culinary applications (Twaij & Hasan, 2022). Owing to the wide range of compounds that exist in the vegetal realm, all their differences, and in the absence of a universal classification, each author

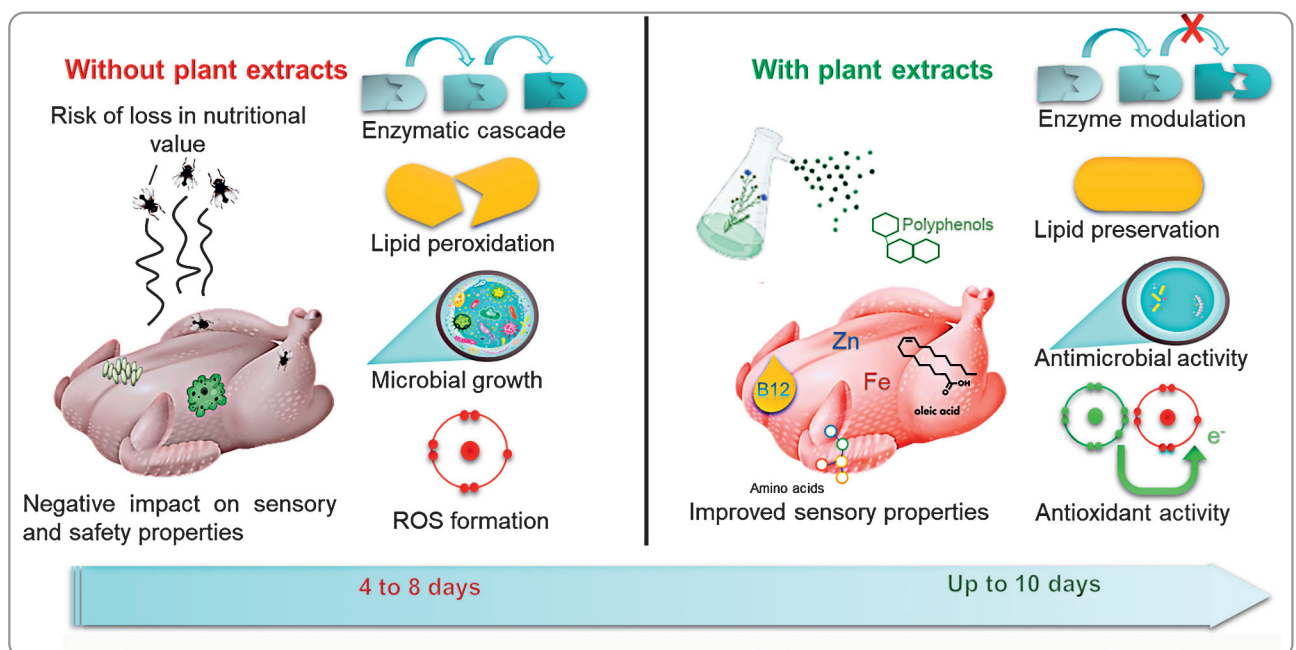


Figure 1. Visual illustration highlighting the positive impacts of chicken meat preservation that can be achieved with plant extracts.

sorts them according to their own study aims. For instance, *Arvind* (2016) used a classification based on the chemical composition: alkaloids, glycosides, polyphenols (flavonoids, phenolics and tannins), saponins, terpenes (carotenoids and steroids) and anthraquinones. *Ahmed et al.* (2017) referred to the British Nutrition Foundation that divides them into four categories: terpenoids, phenolics, nitrogen containing compounds and sulphur containing compounds, while *Kabera et al.* (2014) used a more generic classification system of three major groups: terpenoids, alkaloids and phenolics. Some of these various plant metabolites are particularly appreciated in the preservation of muscle foods according to *Biswas et al.* (2023) and are described in-depth in the following sections.

5.1. Polyphenols

Polyphenols are abundant in fruits, vegetables and herbs. They act as powerful antioxidants and antimicrobials when incorporated into meat products (*Wu & Zhou, 2021; Biswas et al., 2023*). The ability of phenolic compounds to act as antioxidants relies on the quantity and location of hydroxylic groups within their structure, as these factors determine their effectiveness in neutralising reactive radicals. Consequently, polymers with an elevated concentration of hydroxylic groups exhibit a greater antioxidant capacity (*Oliveira et al., 2018*). For example, pepper fruits (*Capsicum* spp.), one of the most widely used and appreciated spices in the world for their spiciness and unique flavours, are rich in phenolic compounds such as capsaicinoids, luteolin and quercetin (*Batiha et al., 2020a*). An earlier study has shown that capsiate, dihydrocapsiate and their analogues possess very high antioxidant activity (*Rosa et al., 2002*). Clove (*Syzygium aromaticum*) is another traditional spice used for food preservation, particularly in meat processing where it can replace chemical preservatives due to its antioxidant and antibacterial properties (*Cortés-Rojas et al., 2014; Batiha et al., 2020b*). Clove has been documented as a significant source of phenolic compounds, as it contains hydroxybenzoic, ferulic, caffeic, ellagic and salicylic acids (*Cortés-Rojas et al., 2014*). Garlic (*Allium sativum* L.) is a well-known bulb in traditional medicine and culinary preparations, including traditional meat products (*Gagaoua & Boudechicha, 2018*). It is rich in phenols and various sulphur phytoconstituents such as alliin, alliin, ajoenes, vinyldithiols. It has been successfully eval-

uated for its various biological activities, including antibacterial, antiviral, antifungal, antiprotozoal and antioxidant (*Batiha et al., 2020b*).

5.2. Flavonoids

Flavonoids are another class of plant compounds known for their antioxidant and antibacterial activities (*Dias et al., 2021*). In fact, more than 6000 different flavonoids have been identified in plants so far (*Hichri et al., 2011*). They are abundant in green plants, and are present mainly as glycosides in leaves, flowers, stems and roots (*Chen et al., 2023*). Flavonoids' antioxidant capacities are modulated by the location of the catechol B-ring on the pyran C-ring, along with the quantity and arrangement of hydroxylic groups present on the catechol group within the B-ring (*Dias et al., 2021*). Cloves for instance, contain quercetin and kaempferol (*Thomas et al., 2022*). Moreover, multiple studies indicate that garlic, rich in flavonoids, phenols and various sulphur compounds, exhibits strong radical-scavenging activity (*Jang et al., 2017*), and the antibacterial activity of these phytochemicals is linked to different pathways (*Górniak et al., 2019*).

5.3. Terpenes

Terpenes are the main compounds of essential oils and are biologically generated by the mevalonate pathway (*Dhifi et al., 2016*). From the molecular level viewpoint, they are constituted from 2-methylbuta-1,3-diene carbon structures, also known as isoprene units. These units are capable of being reordered into cyclic structures, thus explaining the important structural diversity of this group (*Hyldgaard et al., 2012; Masyita et al., 2022*). Terpenes are easily identified and classified by the number of isoprene units in their carbon skeleton (*Twaij & Hasan, 2022*). Terpenes play an important role in food safety without affecting food quality (*Falleh et al., 2020*). Terpenes such as thymol, carvacrol and eugenol are found in essential oil of thyme, oregano, rosemary, and clove. They have been proven to possess antimicrobial properties (*Mendonca et al., 2018; Bellés et al., 2019*). Clove flower buds contain up to 18% essential oil composed of eugenol, eugenol acetate and β -cariofilene (*Jirovetz et al., 2006*). An earlier study demonstrated the antimicrobial efficacy of essential oils from several spices: cinnamon, thyme, rosemary, garlic, sage, oregano, basil, marjoram, savory and clove (*Mendonca et*

al., 2018). Other studies further tested successfully the antibacterial efficacy of thyme and rosemary essential oils at very low concentrations against a mix of three strains of *Listeria monocytogenes* (Garratana et al., 2016). Moreover, others have shown that thyme, bay leaf, oregano and clove essential oils exhibit varying degrees of inhibition against *Escherichia coli* (Thielmann et al., 2019).

6. Practical considerations for implementing plant extracts as meat preservatives

Natural bioactive compounds have clearly proven their effectiveness in reducing microbial growth, preventing oxidation, and enhancing the organoleptic properties of meat, including poultry. Nevertheless, some factors hinder their successful utilisation and pose challenges to their widespread industrial application for reducing chicken meat deterioration and for prolonging the shelf-life. In the following, we discuss some of the practical considerations that are worthy of consideration in order to avoid drawbacks associated with their use.

6.1. Determination of the composition and concentration of plant extracts

The composition and concentration of the bioactive compounds of plant extracts are not consistent across all sources and batches, and vary even for the same plant species according to growing conditions, harvest time and season, extraction settings, storage conditions and packaging methods (Oluyemisi Folashade et al., 2012; Tajik et al., 2014; Pferschy-Wenzig & Bauer, 2015). These result in unpredictable synergistic and antagonistic interactions between the extract compounds themselves, or between the extract compounds and the chicken meat matrix. These interactions can affect the stability of the extracts and their antioxidant and antimicrobial activity (Lu et al., 2017; Woron & Siwek, 2018; Nguyen & Karboune, 2023). Therefore, the standardisation and determination of the effective concentration are even more challenging: under-dosage reduces the potency of the extract while too high concentrations may lead to unpleasant sensory changes and formulation issues, introducing unfamiliar textures or flavours, thus affecting the consumer acceptability of the final product. In the meat matrix, the presence of fatty acids, proteins and other components can favour these changes when reacting with the compounds of the plant extracts. Find-

ing the right balance between preservation efficacy and sensory acceptability is crucial and a key challenge (Lu et al., 2017; Skochko et al., 2018; Barbieri et al., 2019; Sajad et al., 2020). Moreover, during the preparation of these additives, other interfering molecules or compounds can be extracted from the plant, making a purification step necessary. Purification techniques have made significant advancements in recent years and appear to address these issues effectively on an experimental level. However, the feasibility for industrial-scale implementation remains limited due to the associated high costs and the substantial equipment it necessitates (Weil & Veraitch, 2014; Folim, 2015).

6.2. Regulatory and safety aspects

Due to the complex composition of plant extracts, their use as food preservatives is conditioned by strict national and/or international standards and is under regulatory compliance. This is even more important when it comes to the determination of the concentration to be used in meat products, due to the nature of meat constituents and how they react with phytochemicals (Alirezalu et al., 2020; Biswas et al., 2023). As depicted in Figure 2, plant extracts are susceptible to diverse environmental contaminants, including pesticides, waterborne chemicals, synthetic drugs and heavy metals (Han et al., 2016; Kostic et al., 2019). Moreover, the native bacterial microbiota of plants can pose risks to human health, like mycotoxins from fungi or thermoresistant toxins from sporulating bacteria (Omotayo et al., 2019; Alirezalu et al., 2020). Genetic cross contamination within plant species is an inevitable occurrence, whether it involves organic or heirloom plants intermingling, or crossing paths with genetically modified crops. Such interactions can yield unexpected outcomes or the introduction of undisclosed compounds, such as allergens, toxins and even opioids, thereby complicating the contamination landscape (Geller et al., 2015; Cau et al., 2021). This intricate web of cross-contamination highlights the need for meticulous monitoring and regulation within the agricultural industry to ensure the safety and integrity of food supply (Steier, 2016).

Even though legal frameworks and directives can vary between countries, the safety and efficacy of the natural preservatives must be demonstrated in order to obtain regulatory acceptance. For instance, in the United States, the Food and Drug Administration (FDA) maintains a list of generally recognised as

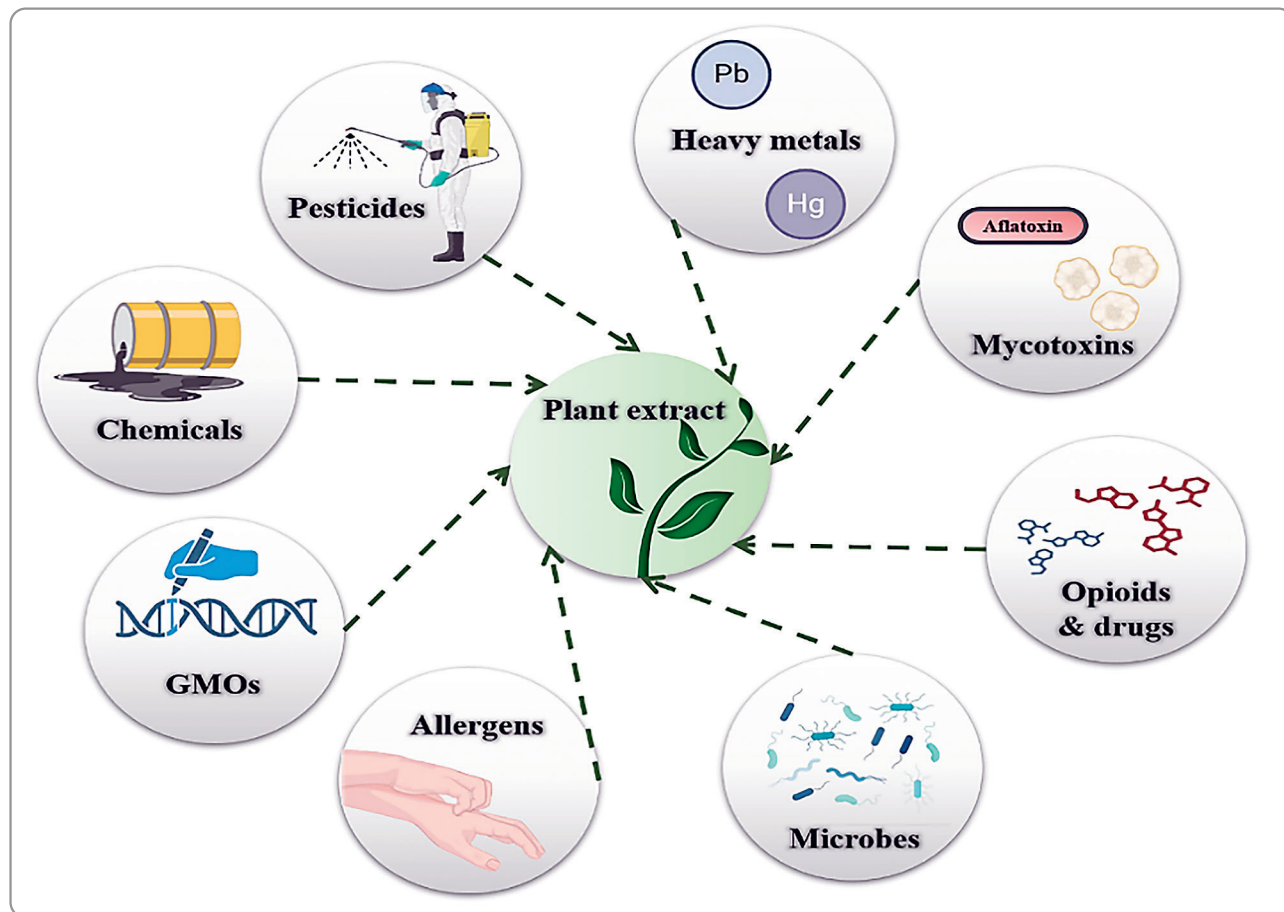


Figure 2. Safety hazards that can be associated with plant extract usage.

safe (GRAS) essential oils that can be used in meat products (Khaneghah et al., 2017). In the European Union, the Regulation 1129/2011 prescribes permissible compounds and their limited doses in various food products, considering the composition of the product, and whether or not it will undergo thermal treatment (Alirezalu et al., 2020). Regulation EU 1169/2011 also sets out the legal obligation to declare known allergens, like celery, sesame or soy (Cau et al., 2021).

6.3. Bioavailability and intestinal absorption

When added to chicken meat, extracts from medicinal and aromatic plants have roles in the preservation of the product before consumption and the improvement of the product’s sensory attributes (Muhialdin et al., 2020; Hassan et al., 2022). Polyphenols, the main secondary metabolites of plants, have seen greater consumption popularity in recent decades, causing a significant increase in the demand for polyphenol-enriched products. Selling arguments advocating the beneficial effects on the human body after ingestion, and even describing the products enriched with polyphenols as “superfood” con-

tributed greatly to the development of this new dietary trend (Fernández-Ríos et al., 2022). While plant components have shown their antioxidant, antimicrobial and enzyme regulatory efficacy as well as their contribution to reduce several diseases, scientists describe it as a marketing gimmick and are more sceptical about the real impact of polyphenols on the human body when ingested in food. This scepticism comes from the fact that the bioavailability and efficacy of consuming polyphenols in food are hardly predictable, and are influenced by a wide range of variables (Tresserra-Rimbau et al., 2018). We believe that much work in this area is needed in the future.

6.4. Cost considerations

The cost of plant extract production and commercialisation is higher than for synthetic preservatives. The latter are cheaper due to their longer shelf-life, stability and mass-production adaptability. Therefore, scaling up the production of plant extracts to meet the demands of the food industry can present logistical challenges (Surekha & Reddy, 2014; Vara et al., 2019). As a matter of fact, sourc-

ing ingredients for natural preservative production is conditioned by the seasonality of plants and their geographical availability, causing supply chain complexations. Furthermore, import/export taxes, certification and labelling costs inflate the bill (Balasubramaniam *et al.*, 2022). The production plans have to be studied in depth and adapted to the current regulations and recommendations (Lee & Paik, 2016). For instance, the EU REACH Regulation (EU, 2006) on registration, evaluation, authorisation and restriction of chemicals strongly encourages the adoption of eco-friendly “green” solvents as alternatives to conventional organic ones. The selection of one solvent over another is a strategic decision, since it affects the extraction method, compound selectivity, production yield, costs and safety (Pateiro *et al.*, 2021). While multiple environmentally friendly extraction techniques have emerged at experimental level in scientific literature, the acquisition of avant-garde technologies has a cost. Moreover, the type of extract can present another drawback. A typical case in point would be the use of essential oils in food preservation. Otherwise indisputably effective as antioxidants and antimicrobials, essential oils are hydrophobic, rendering their solubilisation very technical; they are highly concentrated in volatile compounds, resulting in strong off-odours and aromas; and have a considerably low extractability and extraction yield (Al-Refaie *et al.*, 2023). Given these conditions, the production cost of using essential oils in chicken meat production is thus elevated (Bouarab Chibane *et al.*, 2019).

7. Conclusion

From this review, we can conclude that investigations of the utilisation of plant extracts to preserve chicken meat and its processed meat products have yielded a promising avenue for prolonging the shelf-life duration. This review highlighted the plant extracts that have rich composition in diverse groups of bioactive compounds, which confer strong microbial growth mitigation and enzyme inhibition, and prevent lipid and protein oxidation. They also can enhance the organoleptic and sensory properties of chicken meat products. However, the use of plant-based preservatives at an industrial scale faces some challenges, including standardisation, regulatory approval, sensory acceptability, and cost-effective-

ness. Moreover, in the scientific literature, we have noticed a gap regarding chicken meat quality preservation in comparison to other meat species (mainly red meat products), and most existing studies only pulverise the surface, focusing on the antioxidant and antimicrobial effects using manual, conventional methods, without delving deeper into a better understanding of the underlying mechanisms or identifying the specific compounds involved in the preservation process. To overcome these challenges, it is necessary to initiate further interdisciplinary research efforts that combine principles from food science, biochemistry and biotechnology. For instance, omic approaches unravel complex molecular factors influencing chicken meat quality and could offer a holistic view to understand and predict quality changes during storage (Wang *et al.*, 2023). Furthermore, high-throughput screening through appropriate design of experiments can efficiently identify the potential extract/compound candidates, while microbiome analysis can clarify interactions of the compounds with chicken meat-associated microorganisms. Additionally, nanotechnology is another promising discipline that contributes to the optimisation of encapsulation and emulsion, with prominent uses in meat research (Lamri *et al.*, 2021). Nano-techniques protect the extracts from degradation during storage and guarantee suitable meat quality preservation without introducing the strong aromas of certain plant extracts into the meat products. In addition, nanotechnology can enable controlled release of the extracts, which in turn, increases the bioavailability and intestinal absorption of high value compounds like polyphenols and flavonoids from chicken meat-enriched products. Cutting-edge green processes for recovering natural compounds from plants are also highly regarded in the scientific community. For example, approaches such as supercritical fluid extraction, ultrasound extraction or microwave assisted extraction, coupled with the use of eco-friendly solvents like deep eutectic and ionic solvents demonstrate environmental responsibility and offer promising alternatives to the traditional extraction methods that use organic solvents, known to be toxic and polluting. Overall, the adoption of plant-based natural preservatives not only aligns with the clean label and health-conscious preferences of consumers, but also contributes to the sustainability of the meat industry by reducing its environmental impacts.

Očuvanje kvaliteta mesa živine biljnim ekstraktima: pregledni rad

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INFORMACIJE O RADU

Ključne reči:

Bezbednost pilećeg mesa
Biljni ekstrakti
Rok upotrebe
Prirodni konzervansi
Bioaktivna jedinjenja
Konzervisanje mesa

APSTRAKT

Potrošači cene meso živine zbog njegove nutritivne vrednosti, niskog sadržaja masti, raznovrsnosti upotrebe u raznim kuhinjama i pristupačnih cena. Međutim, njegova podložnost kvarenju kao posledice više faktora pre klanja i prerade predstavlja izazov za industriju mesa, posebno u zemljama u razvoju. Da bi se poboljšala bezbednost živinskih proizvoda, koriste se sintetički konzervansi kao što su nitriti, butilovani hidroksitoluen i sulfiti. Trenutno, ovi aditivi/konzervansi, međutim, izazvaju zabrinutost zbog njihovog uticaja na zdravlje ljudi, što je dovelo do pomeranja kod potrošača na prirodne alternative, kao što su lekovite i aromatične biljke. Stoga se ovaj rad bavi potencijalom biljnih ekstrakata kao prirodnih konzervansa za poboljšanje kvaliteta i roka trajanja pilećeg mesa i prerade. Ovaj rad pruža pregled različitih biljnih ekstrakata i eteričnih ulja koja su pokazala antimikrobna, antioksidativna i inhibitorna svojstva enzima, bez ugrožavanja senzornih atributa proizvoda. Razmatraju se različite metode inkorporacije, uključujući direktnu inkorporaciju ili mariniranje u vodene i/ili alkoholne ekstrakte, i upotrebu eteričnih ulja, uključujući in vivo suplementaciju stočnom hranom. Sve u svemu, svaka metoda različito utiče na kvalitet finalnog proizvoda. Dalje smo sumirali sadašnja saznanja o mehanizmima delovanja testiranih biljnih ekstrakata, iako nisu u potpunosti razjašnjeni. Uprkos prednostima ovih jedinjenja, potrebno je rešiti neke izazove, uključujući standardizaciju sastava ekstrakata, usklađivanje osetljivosti bioaktivnih jedinjenja sa uslovima obrade, obezbeđivanje isplativosti i dobijanje regulatornih odobrenja za njihovu upotrebu. Povećanje proizvodnje u cilju zadovoljavanja potreba industrije takođe predstavlja neke tehničke izazove. Sve u svemu, primena prirodnih biljnih konzervansa ne samo da poboljšava kvalitet pilećeg mesa, već bi takođe mogla da podrži mesnu industriju u smislu uskladjivanja sa očekivanjima potrošača u razvoju za održive prehrambene proizvode.

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