Review Article

Journal of Advanced Veterinary Research
(2024) Volume 14, Issue 2, 326-329

Antimicrobial activities of coriander in chicken meat products: A review

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ARTICLE INFO

Recieved: 09 August 2023

Accepted: 18 October 2023

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Keywords:

Coriander
Chicken meat
Antibacterial activities

ABSTRACT

Chicken meat products contribute significantly as a fairly priced substitute for red meat, which is critically undersupplied in Egypt. This type of meat is high in animal protein, vital amino acids, and trace elements. Furthermore, as a result of rapid improvements in food processing and technology, a variety of chicken meat products, including as chicken burgers, chicken fillets, chicken sandwiches, chicken nuggets, and chicken panne, were manufactured and released into the chicken meat markets. Such key products are defined by their distinct flavor and aroma, which captivates buyers, particularly children. Microorganisms can contaminate chicken meat products at any stage of production, including raw material preparation, manufacture, distribution, and storage. As a result, chicken products are regarded to be a possible source of bacteria that cause food poisoning, such as *Staphylococcus aureus* (*S. aureus*) and *Salmonella* spp. Essential oils derived from the coriander plant (*Coriandrum sativum* L.), either from the seeds or the leaves, are among the most extensively utilized. Coriander and coriander essential oils are antibacterial, antioxidant, anti-diabetic, anxiolytic, anti-epileptic, depressive, anti-mutagenic, anti-inflammatory, antidyslipidemic, antihypertensive, neuroprotective, and diuretic. In this review, we threw the light on the microbial contamination of chicken meat and meat products in Egypt and worldwide. Besides, the antibacterial activities of coriander will be reviewed.

Introduction

Chicken meat and meat products such as liver, gizzards, chicken burgers, luncheon meat, and frankfurters are essential sources of protein, energy, vitamins, and minerals around the world because they are healthy, delicious, and affordable (Darwish *et al*., 2018; Morshdy *et al*., 2021a, b). Chicken products, however, may represent a concern due to cross-contamination of chicken meat from the environment or the food chain. Chicken meat contains a significant number of microelements that aid in human growth and health, including copper, iron, zinc, calcium, phosphorus, and cobalt. Furthermore, vitamins such as the vitamin B group can be obtained from chicken flesh (El Bayomi *et al*., 2018).

Bacteria, viruses, fungus, and parasites are examples of biological hazards. Such hazards may contaminate edible portions of the chicken and then make their way to the human body when such components are consumed, resulting in food poisoning. Bacterial food poisoning is classified into three categories: *E. coli*, *Salmonella* spp., *Campylobacter* spp., *Listeria monocytogenes*, *Shiegella* spp., and *Yersinia* spp. are examples of bacterial foodborne infection. Foodborne intoxication is induced by *Staphylococcus aureus* (*S. aureus*) and *Clostridium botulinum* already performed toxins. The third kind of bacterial food poisoning is foodborne toxicoinfection, which involves *Clostridium perfringens* and *Bacillus cereus* (*B. cereus*) (Alsayeqh *et al*., 2021).

Sources of microbial contamination of chicken meat involves extrinsic and intrinsic sources. The extrinsic sources of contamination for chicken meat include feathers, contaminated animal feed, contaminated equipment (knives, cutting boards, and processing machines), contaminated water used for washing poultry carcasses, operators' hands, and clothes, and dropping the bird carcass to the ground of the slaughterhouse or butcher shop. Intrinsic sources of contamination of poultry carcasses include cutting of the intestinal tract or proventriculus during evisceration, over scalding of poultry carcasses, and migration of microorganisms from the intestine to other organs of the bird during slaughtering. Because of raw materials, spices, and water used during the packing process, the processing procedure might potentially contribute to meat product contamination (Darwish *et al*., 2022).

Coriander (*Coriandrum sativum* L.) is a tall, glabrous annual plant planted primarily in the Indian subcontinent but also in Europe, Northern Africa, and Asia for culinary, aromatic, and medicinal purposes. Its herbage, commonly known as cilantro, is utilized in a variety of dishes. Coriander seeds are pulverized and used as a spice, for example, in curry powders. The essential oil extracted from coriander fruits (also known as seeds) is a key flavoring agent in a variety of foods, including gin, breads, soups, sauces, tinned products, and sweets. The species has a relatively broad distribution and a rigorous taxonomy that distinguishes three subspecies and ten botanical variations. Essential oils extracted from the coriander plant, either from the seeds or the leaves, are widely used. Coriander and its essential oils have antibacterial, antioxidant, anti-diabetic, anxiolytic, anti-epileptic, anti-depressant, anti-mutagenic, anti-inflammatory, antidyslipidemic, antihypertensive, neuroprotective, and diuretic properties (Lo Cantore *et al*., 2004).

In this review, we like to shed some insight on the microbiological contamination of chicken meat and meat products in Egypt and around the world. Coriander's antimicrobial properties will also be discussed.

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Bacterial contamination of chicken meat and meat products

In Japan, consumption of raw or undercooked poultry items contaminated with *Campylobacter* has been found as a risk factor for human *Campylobacter*iosis, according to Sasaki *et al*. (2013). They wanted to know if killing *Campylobacter*-positive chickens was linked to contamination of chicken products obtained from *Campylobacter*-negative flocks slaughtered at the same abattoir. *Campylobacter* was found in 22 broiler farms one week before slaughter and in one abattoir on nine different slaughter days. A total of 600 bulk packed chicken items were tested, with 198 (33.0%) testing positive for *Campylobacter*. 180 (51.1%) of the 350 chicken items derived from *Campylobacter*-positive flocks were contaminated with the bacterium. Only 18 (7.2%) of the 250 chicken products originating from *Campylobacter*-negative flocks were affected. The *Campylobacter* isolates in 14 of these 18 items were identical to isolates recovered from the flock slaughtered immediately before the *Campylobacter*-negative flock. Notably, on 4/6 slaughter days, *Campylobacter*-negative flocks were slaughtered before positive flocks, and *Campylobacter* was missing from all negative flock chicken products. These findings imply that implementing logistic slaughter (in which *Campylobacter*-negative flocks are slaughtered first) reduces the prevalence of *Campylobacter*-positive chicken products significantly.

Multidrug resistance bacteria (MDR bacteria), such as extended spectrum beta-lactamase (ESBL) *Enterobacteriaceae*, methicillin resistant *Staphylococcus aureus* (MRSA), and vancomycin-resistant Enterococci (VRE), offer a challenge to the human health care system, according to Zarfel *et al*. (2014). These MDR bacteria have been identified increasingly outside of the hospital environment in recent years. Food contamination with MDR bacteria, particularly meat and meat products, is also an issue. The study's goal was to assess the prevalence of MDR bacteria in chicken meat on the Austrian market. 50 chicken flesh samples were tested for this investigation. All samples came from chickens slaughtered in Austrian slaughterhouses and were labelled as Austrian. The presence of ESBL *Enterobacteriaceae*, methicillin resistant Staphylococci, and other pathogens was determined in the samples. Resistance genes in isolated bacteria were identified using PCR and sequencing. 26 ESBL generating *E. coli*, five *mec*A gene carrying Staphylococci (but no MRSA), and four VRE were found in Austrian chicken flesh samples. There were no ESBL *Enterobacteriaceae*, MRSA, methicillin resistant coagulase negative *Staphylococcus* (MRCNS), or VRE found in 24 (48%) of the samples. None of the samples had all three categories of multiresistant bacteria studied. According to prior research, the prominent ESBL genes were CTX-M-1 and SHV-12.

Foodborne infections pose a significant hazard to food safety, particularly in underdeveloped nations where hygiene and sanitation facilities are frequently inadequate. *Salmonella enterica*, *E. coli* O157:H7, and *Shigella* spp. are among the leading causes of foodborne illness outbreaks. In Egypt, Ahmed and Shimamoto (2014) studied the prevalence of these infections in meat (beef and chicken) and dairy products gathered from Egyptian street vendors, butchers, retail stores, and slaughterhouses. Using culture and PCR-based approaches, 1600 food samples (800 meat items and 800 dairy products) were analyzed. *Shigella* spp., *S. enterica*, and *E. coli* O157:H7 were found in 69 (4.3%), 54 (3.4%), and 27 (1.7%) samples, respectively. In 28 (1.8%), 22 (1.4%), 16 (1.0%), and 3 (0.1%) samples, *S. enterica* serovar Typhimurium, *S. enterica* serovar Enteritidis, *S. enterica* serovar Infantis, and non-typable serovars were discovered, respectively. All *E. coli* O157:H7 isolates tested positive for the virulence toxin genes *stx1* and/or *stx2*. *Shigella flexneri*, *Shigella sonnei*, and *Shigella dysenteriae* were found in 18 (1.2%), 7 (0.4%) and 2 (0.1%) samples, respectively. *S. enterica* and *Shigella* spp. were found in higher concentrations in meat products (53; 6.6% and 16; 2.0%, respectively) than in dairy products (16; 2.0% and 11; 1.4%, respectively), but *E. coli* O157:H7 was found in higher concentrations in dairy products (29; 3.6%) than in meat products (25; 3.1%). A large-scale survey throughout Africa was conducted to investigate the prevalence of foodborne pathogens in meat and dairy products. In addition, Abdallah *et al*. (2015) sought to identify and characterize extended-spectrum ß-lactamases and/or carbapenemase -producing *Enterobacteriaceae* isolated from retail chicken meat in Zagazig, Egypt. In 2013, 106 *Enterobacteriaceae* isolates were obtained from retail chicken meat samples purchased in Zagazig, Egypt. MALDI-TOF MS was used to identify the species. In order to screen for ESBL-E, isolates obtained from meat samples were inoculated onto EbSA (Cepheid Benelux, Apeldoorn, the Netherlands) selective screening agar. A combined disc diffusion test with clavulanic acid (Rosco, Taastrup, Denmark) confirmed ESBL formation. Double disc synergy testing validated the formation of carbapenemases. PCR was used to identify resistance genes for TEM, SHV, and CTX-M, as well as carbapenemases (KPC, NDM, OXA-48, IMP, and VIM). PCR products of CTX-M genes were purified and sequenced. A PCR-based approach was used to group *E. coli* into phylogenetic groups. The results showed that 69 (65.09%) of the 106 isolates were ESBL producers. Twelve (11.32%) of these isolates also produced class B carbapenemases phenotypically. TEM genes were found in 61 (57.55%) of the isolates. 49 (46.23%) of the isolates carried CTX-M genes, while 25 (23.58%) carried SHV family genes. The NDM group included all CPE. CTX-M-15 was the most common CTX-M sequence type (89.80%). The vast majority of the ESBL-EC (80%) belonged to the low virulence phylogroups A and B1. Besides, Hamza *et al*. (2017) studied *Clostridium perfringens* strains isolated from processed chicken flesh for toxinotyping and antimicrobial susceptibility. Two hundred processed chicken meat samples from luncheon meats, nuggets, burgers, and sausages were tested for the presence of *Clostridium perfringens* using a multiplex PCR assay for the presence of alpha (cpa), beta (cpb), epsilon (etx), iota (ia), and enterotoxin toxin (cpe). In vitro tests were performed on *C. perfringens* isolates against eight antibiotics (streptomycin, amoxicillin, ampicillin, ciprofloxacin, lincomycin, cefotaxime, rifampicin, and trimethoprim-sulfamethoxazole). The results showed that 32 *C. perfringens* strains (16%) were recovered from the 200 processed chicken meat samples analysed. *C. perfringens* prevalence was strongly dependent on the type of toxin genes found (P = 0.0), with sausages having the highest prevalence (32%), followed by luncheon meat (24%), burgers (6%), and nuggets (2%). *C. perfringens* type A was the most common (24/32; 75%), followed by type D (21.9%) and type E (3.1%). Only 9 (28%) of the 32 *C. perfringens* strains evaluated were enterotoxin gene carriers, with type A (n = 6) accounting for the majority (n = 6). The resistance/susceptibility of *C. perfringens* strains to routinely used antibiotics varied. The majority of the bacteria examined were responsive to ampicillin (97%) and amoxicillin (94%), but resistant to streptomycin and lincomycin. It is worth noting that the resistance of the nine isolates with enterotoxigenic potential was higher than that of the non-enterotoxigenic isolates. The scientists concluded that the very elevated *C. perfringens* isolation rates from processed chicken meat samples, as well as resistance to various routinely used antibiotics, indicate a possible public health danger. Tarabees *et al*. (2017) tested 100 raw chicken flesh samples for *Salmonella* spp., which were then identified using biochemical and serological assays, as well as a matrix-assisted laser desorption/ionization time-of-flight (MALDI-TOF) profile. Furthermore, the isolated serovars were tested for the presence of virulence genes thought to play a role in infection using multiplex polymerase chain reaction (PCR). S. Enteritidis was recovered from two samples (2%), whereas S. Typhimurium was isolated from three samples (3%) of chicken meat, according to the data. *S*. Enteritidis contained the *sitC, sopB, sifA, lpfC, spaN, sipB, invA, spiA*, and *msgA* genes, which were discovered using multiplex PCR. The *sitC, iroN, sopB, sifA, lpfC, spaN, sipB, invA*, and *tolC* genes were successfully amplified in *S*. Typhimurium. The scientists found that the presence of *S*. Enteritidis and *S*. Typhimurium in meat, even at low levels, had serious consequences. Furthermore, this is the first attempt to uncover a diverse set of virulence genes in Egyptian *Salmonella* isolates recovered from meat products. To reduce the human health risk associated with salmonellosis, a strict public health and food safety policy is urgently required. Darwish *et al*. (2018) found that chicken giblets and wastewater samples can transmit methicillin-resistant *S. aureus* (MRSA) and heat-resistant staphylococcal enterotoxins to humans. In addition, the isolated MRSA showed varied degrees of antibiotic resistance. As a result, extreme hygiene precautions should be taken while preparing chicken products for human consumption, including giblets. Furthermore, chicken meat and giblets must be completely cooked before serving to people. Raoultella ornithinolytica is one of the new gram-negative bacteria linked to foodborne disease, according to El-Shannat *et al*. (2020). Researchers confirmed that distinguishing *R. ornithinolytica* from Klebsiella oxytoca is difficult due to their evolutionary relationship. The emergence of multidrug resistance in Raoultella strains has increased concern for pathogen detection, which aids in disease control and minimizes its impact. The goal of this work was to establish a reliable tool for identifying Raoultella ornithinolytica, which was isolated from chicken product samples, and to characterize *R. ornithinolytica*'s resistance profile using antibiogram sensitivity assays. Between January and September 2019, forty samples of chicken items were collected from several marketplaces in Alexandria Governorate, Egypt. Nuggets, strips, burgers, luncheon meats, pane, frankfurters, and minced chicken meat were among the items that examined. The results showed that thirty-three bacterial isolates (82.50%) were isolated into pure cultures from the chicken samples. Three isolates (9.09%) tested positive for *R. ornithinolytica*, while 30 isolates (90.91%) tested positive for other pathogens (*Escherichia coli*, *Enterobacter aerogenes*, *Proteus vulgaris*, *R. ornithinolytica*, and *Klebsiella pneumoniae*). *R. ornithinolytica* isolates were resistant to five types of antibiotics and sensitive to two types of antibiotics. Furthermore, Habashy *et al*. (2021) revealed that *Salmonella* spp. isolation rates from chicken breast and thigh retailed in Egypt were 33.3% and 16.6%, respectively. *Salmonella* serotypes found include *S*. Typhimurium, *S*. Enteritidis, *S*. Kentucky, *S*. Anatum, and *S*. Typhimurium recovered at rates of 23.33% and 13.33% from breast and thigh muscles, respectively, followed by S. Enteritidis (3.33% each). *Salmonella* Typhimurium isolates also included the hilA and stn genes. According to Morshdy *et al*. (2023), *Salmonella* spp. could only be isolated from chicken burger and fillet at 10% and 23.33%, respectively.

Antibacterial activities of coriander

Aliphatic (2E)-alkenals and alkanals isolated from fresh coriander leaves (Umbelliferae) were reported to have bactericidal action against *Salmonella choleraesuis* sp. *choleraesuis* ATCC 35640. With a minimum bactericidal concentration (MBC) of 6.25 microg/mL (34 microM), (2E)-Dodecenal (C(12)) was the most efficient against this food-borne bacteria, followed by (2E)-undecenal (C(11)) with an MBC of 12.5 microg/mL (74 microM). The time-kill curve analysis revealed that these alpha,beta-unsaturated aldehydes are bactericidal against *S. choleraesuis* at any development stage, and that their bactericidal activity is attributed in part to their ability to behave as nonionic surfactants (Kubo *et al*., 2004). Coriander essential oil is used in cooking, but it also has a long history as a traditional medicinal. Steam distillation of dried completely mature fruits (seeds) of *Coriandrum sativum* L. yields it. The oil is a colorless or pale yellow liquid with a distinct odor and a mild, sweet, warm, and aromatic flavor; linalool is the most abundant ingredient (about 70%). A NOEL for coriander oil is around 160 mg/kg/day, according to the results of a 28-day oral gavage study in rats. Coriander oil has a maternal NOAEL of 250 mg/kg/day and a developmental NOAEL of 500 mg/kg/day in a developmental toxicity investigation. Coriander oil is not clastogenic, but the results of mutagenicity tests for the spice and various extracts are contradictory. Coriander oil possesses antibacterial action that is broad-spectrum. Coriander oil is irritating to rabbits but not to people; it is not a sensitizer, despite the fact that the entire spice may be. Based on the history of coriander oil intake without adverse effects, the lack of toxicity in limited studies, and the lack of toxicity of its principal constituent, linalool, the use of coriander oil as an added food ingredient is regarded safe at current levels of use (Burdock and Carabin, 2009).

Silva *et al*. (2011) investigated the antibacterial activity of essential oil of coriander (*Coriandrum sativum*) against Gram-positive and Gram-negative microorganisms. Antibacterial susceptibility was assessed using traditional microbiological techniques in tandem with flow cytometry for cellular physiology evaluation. Coriander oil exhibits antibacterial efficacy against all bacteria examined, according to our findings. Furthermore, except for *Bacillus cereus* and *Enterococcus faecalis*, coriander oil displayed bactericidal action against practically all microorganisms tested. The incorporation of propidium iodide and the simultaneous loss of all other cellular functions such as efflux activity, respiratory activity, and membrane potential appear to indicate that the principal mechanism of action of coriander oil is membrane damage, which leads to cell death. The findings provided support the use of coriander oil in antibacterial compositions. Moreover, coriander (*Coriandrum sativum* L.) essential oil was tested for a synergistic antibacterial action with six different antibacterial medications (cefoperazone, chloramphenicol, ciprofloxacin, gentamicin, tetracycline, and piperacillin). Coriander oil's antibacterial activity was evaluated using microdilution susceptibility tests and checkerboard assays for synergistic interaction. Coriander essential oil showed in vitro effectiveness against *Acinetobacter baumannii* when combined with chloramphenicol, ciprofloxacin, gentamicin, and tetracycline, indicating a possible synergistic interaction against two reference strains of A. baumannii (LMG 1025 and LMG 1041) (FIC index from 0.047 to 0.375). When the interaction between coriander essential oil and piperacillin or cefoperazone was investigated, the isobolograms and FIC index revealed an additive interaction. The in vitro interaction may boost the antibacterial efficiency of ciprofloxacin, gentamicin, and other antibiotics (Duarte *et al*., 2012).

Fujita *et al*. (2015) mentioned that using a broth dilution method, essential oil extracted from fresh leaves of Polygonum odoratum Lour was examined for its effects on a foodborne bacterium *Salmonella choleraesuis* subsp. *choleraesuis* ATCC 35640. At a dosage of 200 g/mL, this essential oil demonstrated substantial antibacterial activity against *S. choleraesuis*. GC-MS characterized twenty-five volatile compounds from this essential oil, and aldehyde compounds were plentiful and accounted for more than three-fourths of the essential oil. Dodecanal (C12) was the most prevalent of the chemicals studied (55.5%), followed by decanal (C10) (11.6%). Both alkanals had minimum growth inhibitory concentration (MIC) and minimum bactericidal concentration (MBC) values of 100 g/mL against *S. choleraesuis*. Dodecanol (lauryl alcohol) and 2E-dodecenal, both with MBCs of 6.25 g/mL, were shown to have the most powerful antibacterial action against this bacterium. Their principal antibacterial activity against *S. choleraesuis* is most likely due to their ability to operate as nonionic surface-active agents (surfactants), affecting the native function of integral membrane proteins nonspecifically. Thus, biophysical processes mediate antibacterial action. Depending on the length of the alkyl chain, a biological mechanism is also implicated in the case of 2E-alkenals.

Silva and Domingues (2017) demonstrated that foodborne illness is a large economic burden and a substantial public health hazard worldwide, affecting over 48 million people and resulting in 3,000 deaths each year in the United States alone. Development of effective preservation systems capable of removing microbial contamination of foods is one feasible strategy for reducing foodborne diseases. New issues for the food industry have emerged in recent years, such as the growth in antimicrobial resistance of foodborne bacteria to traditional preservatives and customer demand for naturally based goods. To address this, new ways utilizing natural or bio-based materials as food preservatives must be researched. Coriander (*Coriandrum sativum* L.) is a well-known herb that is widely used as a spice, in folk medicine, as well as in the pharmacy and food industry. Coriander seed oil is the second most important essential oil in the world, with antibacterial activity against Gram-positive and Gram-negative bacteria, yeasts, dermatophytes, and filamentous fungi. This review highlights coriander oil antimicrobial activity and potential mechanisms of action in microbial cells, as well as the ability of coriander oil usage as a food preservative, pointing out possible paths for the successful evolution of these strategies towards the successful development of a coriander oil food preservation strategy.

Aelenei *et al*. (2019) determined the antibacterial activity of coriander essential oil and its major constituent, linalool, when combined with antibiotics against Gram-positive (methicillin-susceptible and methicillin-resistant *Staphylococcus aureus*, *S. epidermidis*) and Gram-negative bacteria (*Pseudomonas aeruginosa*, *Escherichia coli*). Gas chromatography with flame ionization and mass spectrometry detection was used to determine the chemical makeup of coriander essential oil. The broth microdilution and checkerboard assays were used to evaluate the antibacterial activity of coriander essential oil, linalool, and their combinations with antibiotics. Coriander essential oil contained thirty-four components, the most abundant of which was linalool (70•11%). Coriander essential oil and linalool were found to have synergistic interactions with antibiotics (oxacillin, amoxicillin, gentamicin, ciprofloxacin, tetracycline) against Gram-positive and Gram-negative bacteria. Minimum inhibitory doses of antibiotics were significantly reduced in these synergistic combinations, and antibiotic resistance reversal activity was also observed. These discoveries hold great promise for the development of novel antibiotics for bacterial infections.

The study significance and impact

Methicillin-resistant *Staphylococcus aureus* (MRSA) and Gram-negative bacteria continue to be serious hazards to human health, necessitating the discovery of new antibacterial drugs or combinations with high efficacy. Coriander essential oil/linalool synergistically interacted with antibiotics against MRSA and other Gram-positive bacteria (methicillin-susceptible *S. aureus*, *S. epidermidis*), but also Gram-negative bacteria (*Pseudomonas aeruginosa*, *Escherichia coli*). Antibiotic susceptibility was also increased, and antibiotic resistance was reversed. Coriander essential oil/linalool combinations are thus particularly promising to produce novel antimicrobials.

Kačániová *et al*. (2020) evaluated the essential oil of *Coriandrum sativum*'s chemical composition, antioxidant, antibacterial, and antibiofilm properties. The biofilm profiles of *Stenotropomonas maltophilia* and *Bacillus subtilis* were examined on glass and hardwood surfaces using a MALDI-TOF MS Biotyper. The molecular variations between biofilms on different days were also found. In the current investigation, the predominant volatile components of coriander essential oil were -linalool (66.07%). Coriander essential oil inhibited radical scavenging activity by 51.05%. Coriander essential oil was the most effective against B. subtilis, followed by *S. maltophilia* and *Penicillium expansum*. Coriander essential oil exhibited the greatest antibiofilm action against *S. maltophilia*. In the case of planktonic cells, a clearly differentiated branch was obtained for early growth variants of *S. maltophilia*, and all experimental groups and time spans can be reported for the grouping pattern of B. subtilis preferentially when compared to the media matrix, but without clear differences among variants. Coriander was efficient against the tested *Penicillium expansum* in the vapour phase after 14 days with MID50 367.19 and MID90 445.92 L/L of air, according to the data.

Al-Khayri *et al*. (2023) reported that essential oils are hydrophobic liquids produced by specialised secretory tissues in the plant's leaves, seeds, flowers, bark, and wood as secondary metabolites, and they serve a vital ecological role in plants. Due to their medicinal capabilities, essential oils have been employed in different traditional treatment systems and are claimed to be a good replacement for chemical and synthetic medications that have negative side effects. As a result, numerous plant sources for essential oil production are currently being investigated. Coriander essential oil, derived from *Coriandrum sativum* leaf and seed oil, has been shown to have a variety of biological properties. Aside from its use in food preservation, the oil has a wide range of medicinal effects, including allelopathic qualities. Coriander essential oil has several effects such as antimicrobial, anthelmintic, insecticidal, allelopathic, antioxidant, antidiabetic, anticonvulsive, antidepressant, and hepatoprotective properties, as well as playing a major role in maintaining good digestive health. Coriander essential oil is one of the most promising alternatives in the food and pharmaceutical industries.

Conclusion

This review demonstrated the importance of the chicken meat products as essential sources of high quality protein, vitamins and minerals. However, several reports showed the potential contamination of chicken meat with foodborne pathogens. Interestingly, coriander and its essential oil act as promising candidates with antibacterial activities and food flavoring and preservative agents.

Conflict of interest

The authors have no conflict of interest to declare.

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