Zagazig J. Agric. Res., Vol. 48 No. (3) 2021 805-815

Biotechnology Research

Available online at http://zjar.journals.ekb.eg

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ANTIMICROBIAL POTENTIALS OF CINNAMON AND GARLIC EXTRACTS AGAINST SOME FOODBORNE PATHOGENES

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Received: 13/06/2021 ; Accepted: 22/06/2021

ABSTRACT: Cinnamon and Garlic had a traditional important nutritional and medical importance because they contain many important active compounds, the rediscover of its compositions and the extraction protocol will be led futural to improve their antimicrobial properties that increase the safety of food products and their shelf life through work against spoilage bacteria and foodborne pathogens. In current study, cinnamon and garlic plants were used to determine their chemical composition, phenolic compounds profile by (HPLC) and evaluate the antimicrobial effects against gramme negative and positive bacterial strains *Escherichia coli* O157, *Bacillus cereus*, *Salmonella typhi*, *Shigella* sp., *Staphylococcus aureus* and *Streptococcus pyogenes* and the food spoilage fungi *Aspergillus niger* and *Aspergillus flavus* were also chosen as models. The watery, acetonic and ethanolic extracts of cinnamon parks and garlic bulbs (with concentrations of zero, 100, 200 and 400 $mg.ml^{-1}$) were prepared, the antimicrobial activities were tested by disc diffusion method. The ethanolic extracts were more antimicrobial efficiency by comparing with the acetonic or watery extracts, the inhibition zones were dramatically increased by increasing the extracts concentrations with recorded the lowest levels of minimal inhibitory concentrations (MICs) by 45 $mg.ml^{-1}$, the maximum inhibition zones ranged from 23.6 to 27.4 mm as maximum, the garlic extracts showed stronger antifungal activities comparing with cinnamon extracts with (MIC) of 80 $mg.ml^{-1}$ as maximum.

Keywords: Cinnamon bark, Garlic bulbs, ethanolic extract, foodborne pathogens.

INTRODUCTION

Antimicrobial agents are fundamentally paramount in curtailment the global burden of foodborne pathogens and infectious diseases **(Bhatia and Narain, 2010).** Several natural plants have been recognized as abundant resources of various anti-microbial compounds as a preferred alternative that can be effective in the microbial disease's treatment **(Jaya-prakasha, 2011).** Approximately 30% or more of the contemporary pharmacological drugs are derived from natural or chemical plant extracts **(Murugesan *et al*., 2011).** Furthermore, there are 30.000 antimicrobial ingredients have been extracted from more than 1500 natural plants have antimicrobial activities **(Tajkarimi *et al*., 2010).** Moreover, plant extracts have antimicrobial and antioxidant properties at the same time and therefore considered that an ideal choice for food preservation than synthetic preservatives **(Khaldi and Seifuddin, 2010).** While most of the antimicrobial components of plant origin include the componds of saponins, glucosinolates, thiosulfinates, flavonoids and phenolics **(Negi *et al*., 2005).** However, the main compounds with antimicrobial activity are phenolics which include aliphatic and aromatic acids, aldehydes, alcohols, and iso-flavonoids which able to convert by nano techniques to more effective

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molecules **(Cicerale *et al*., 2012).** Emphatically, cinnamon like a lot of plants has a wide variety of phenolics compounds that exhibit antimicrobial activities **(Lange-veld *et al*., 2014).** While the most important phenolic compounds in cinnamon plants are cinnamaldehyde, cinnamate and cinnamic acid **(Vangalapati *et al*., 2012).** Except that, the presence and concentration of each compound vary depending on the plant part, trans-cinnamaldehyde in bark was shown to be responsible for antimicrobial activity in cinnamon extracts **(Rao and Gan, 2014).** However, several studies have described the antimicrobial effects of cinnamon extracts on both gram-negative (G^{-ve}), gram-positive (G^{+ve}) and many of yeasts and fungi species **(Utchariyakiat *et al*., 2016).** On other side, garlic is one of the oldest known nutritional and medicinal plants and has long be used in human pathogens treatment **(Younis *et al*., 2010).** The great scientist Louis Pasteur was the first discovered the antibacterial activity of garlic juices against both (G^{-ve}) and (G^{+ve}) bacteria **(Whitemore and Naidu, 2000).** Garlic bulbs extract is a strong antibacterial material against the bacterial species such *as Staphylococcus aureus, Streptococcus* spp., *Escherichia coli, Shigella senteriae, Salmonella spp., Klebsiella* spp., *Proteus mirabilis*, and *Helicobacter pylori* **(Indu *et al*., 2006).** Also, it is effective against most of enteric genera of Enterobacteriaceae family and even against even those strains that have become antibiotics resistant **(Ross *et al*., 2001).** Garlic bulbs extract is integrated antimicrobial material, not only having antibacterial activities but also possesses antiviral and antifungal properties **(Tsao and Yin, 2001).** Garlic has the same growth inhibition when tested against the fungal pathogen's genera of *Aspergillus* and *Cryptococcus* as equally as ketoconazole antibiotic **(Shams Ghahfarokhi *et al*., 2006).** On other side, *Escherichia coli O157:H7* is considered the most studied foodborne pathogenic bacteria due to its low dose infectiveness, the wide-spread prevalence and the severity of symptoms associated **(Atnafie *et al*., 2017)**. At the same concept, *Bacillus cereus* has been studied enough in food manufacturing processes and contamination of raw materials subsequent its spore thermal resistance **(Senesi and Ghelardi, 2010).** However, *Salmonella* infection remains a main public health apprehension around the world, on the economic burden of both developed and industrialized countries through the costs associated with infection surveillance and prevention **(Crump *et al*., 2004).** Unlike other popular foodborne pathogens, humans are the only natural hosts of *Shigella* that cause bacillary dysentery (shigellosis), they are a highly contagious microorganism with outbreaks of foodborne diseases frequently involving infected food handlers **(FDA, 2012).** In the same jeopardy, *Staphylococcal* foodborne disease (SFD) is one of the most popular food-borne diseases worldwide caused of the enterotoxin's food contaminated performed by *Staphylococcus aureus* **(Argudin *et al*., 2010).** Also, foodborne *Streptococcus pyogenes* one of the most outbreaks reported from developed and industrialized countries which are caused by contamination during the final steps of food preparation **(Levy *et al*., 2003).** As per the Food and Agriculture Organization (FAO), *Aspergillus niger* fungi is one of the most common species of the *Aspergillus* genera and is a common proportion of all the fungus found in food industry and responsible for post-harvest decay **(Ashiq, 2015).** While *Aspergillus flavus* has a significant impact on immunosuppressed people which are most susceptible to this fungal infection, *A. flavus* can be found in any climate but it is most common in warm temperatures zones and low moisture levels environments **(Klich, 2007).** Recently, plant extracts (PEs) and essential oils (EOs) have gained great importance because of their flavoring beside its greater antimicrobial potential **(Negi and Jaya-prakasha, 2006).** For the future, the nano-capsulation of plant extracts and the essential oils nano-emulsion has high entrapment efficiency, small particle size, stability, safety and by their extracted with ethanol can release its main effective chemical components and easiest trans-formed into nanoforms **(Rungsiri and Bungorn, 2014).**

MATERIALS AND METHODS

Plant Extracts Preparation

Fresh cinnamon bark (*Cinnamomum zeylanicium*) and garlic bulbs (*Allium sativum*) were purchased from the local market, air-dried plant samples re-dried at 50°C and grinded into fine powder and grounding by passing through

100 mm sieve and then kept in a sterile air-tight container. Three types of extracts were prepared, 200 grams of cinnamon and garlic powders dissolved in 1 liter of distillate water, acetone, and ethanol 95%, respectively. Solutions were stirred at 150 rpm for not less than 30 h and then filtered through multi layers of muslin, mixtures were centrifuged at 10000 rpm for 10 min and re-filtered through Whatman filter paper No.(1) to obtain a clear filtrate and then evaporated at 40°C by using rotatory vacuum evaporator, the extract was collected and tight stored at 4°C **(Gauthami *et al*., 2015).**

Microbial Strain and Culture Media

The identified foodborne microbial strains were brought from the culture collection of Agricultural Research Center (ARC), Egypt. Two common bacterial strains *Escherichia coli* O157 (G^{-ve} short rods) and *Bacillus cereus* (G^{+ve} sporulated long rods) were selected, two types of enteric poisoning pathogenic bacteria (G^{-ve} short rods) were *Salmonella typhi* and *Shigella* sp., addition to two types of food poisoning pathogenic bacteria (G^{+ve} cocci) were *Staph. aureus* and *Strept. pyogenes*, while the species of aspergilli ascomycetes food spoilage fungi were *Aspergillus niger* and *Aspergillus flavus* were also chosen as models. Bacterial strains were cultivated aerobically in Luria-Bertani [LB] medium, the pre-cultures were performed during 24 h of fermentation (log phase) at 37°C, also Potato Dextrose Agar [PDA] was used for fungi strains at 25°C, while Mueller-Hinton [MH] agar was used for the disc-diffusion method according to the protocol described by the clinical laboratory standards institute (CLSI) guidelines **(Cockerill, 2012)**.

Chemical Composition Determination

The major chemical composition was analyzed for the percentage of ash, moisture, crude fibers, crude fats, carbohydrates, and crude protein were determined according to the protocols of Association of Official Analytical Chemists **(AOAC, 2003).** On other side, the total flavonoids compounds were determined by using the method achieved by **Dewanto *et al.* (2002).** An aliquot of 250 µl of each extract or the standard solution were mixed with 1.25 ml of deionized water followed by 75 µl of a $NaNO_2$ (5%) solution. After 5 min, 150 µl of $AlCl_3.6H_2O$ (10%) solution was added to each mixture. After 5 min, 0.5 ml of 1M NaOH was added, and the total volume was completed to 3.0 ml with deionized water, the catechin flavonoid was used as a standard for the spectrophoto-metrically measuring at absorbance of 510_{nm} which was corrected by blank prepared, the results were expressed as mg of catechin equivalents (CE)/gram dry weight. Also, the total phenolics contents were determined with the Folin-Ciocalteu reagent, the gallic acid was used as a analytical standard and the total phenolics were apparent as mg gallic acid equivalents (GAE)/gram dry weigh. 1 g of samples were extracted in 10 ml methanol, then 0.5 ml of sample or standard transferred into test tubes and mixed with 2.5 ml of a 10 folds dilute Folin-Ciocalteu reagent and 2 ml of sodium carbonate (7.5%), tubes were covered tightly and standing for half hour at low temperature and then read at 760_{nm} Spectro-photometrically **(Kim *et al*., 2004)**. On the same concept, the quantitative analysis of phenolic components was determined by using high performance liquid chromate-graphy (HPLC) analysis at the Department of Food sciences, Faculty of Agriculture, Cairo University according to the protocol of **Goupy *et al*. (1999).** Hewlett-Packard HPLC (series 1050) equipped with auto-sampler injection, solvent degasser, Ultraviolet (UV) detector set at 280_{nm} and quaternary HP pump (series 1050), the separation column was Alltima C_{18}, 5mm (150 mm×4.6mm Alltech). The column temperature was maintained at 35°C and the gradient separation was carried out with methanol and acetonitrile as a mobile phase at flow rate of 1 $ml.min^{-1}$, standards were dissolved in a mobile phase and injected into HPLC, the retention time and peaks area were used to calculate phenolic compounds concentration by using the data of Hewlett-Packard software.

Determination of Antimicrobial Activity

Briefly, the antimicrobial activity test was determined by using disk diffusion Mueller-Hinton agar plates and carried out according to the protocol according to Baur and Kerby described by (CLSI) guidelines as follows: The overnight bacterial cultures grown on Mueller-Hinton broth were adjusted to the density of 0.5

McFarland turbidity standard unit. The inoculation of the tested bacterial strains was streaked on to Mueller-Hinton agar plates by using a sterile swab. Sterile filter discs (diameter 6 mm of Whatman Paper No. (1): 6 mm, England) were impregnated with (100 µl/disc) of each purified cinnamon and garlic extracts (water, acetone, and ethanol), the disks were placed on the appropriate agar medium, distilled water was used as negative control. After bacterial incubation at 37°C for 24 h and 27°C for 72 h for fungi, the diameter of the inhibition zone in millimeters was measured, the diameter of the zones of inhibition around each of the discs was taken as measure of the antimicrobial activity. Each experiment was carried out in triplicate and the mean diameter of the inhibition zone was recorded with its standard divisions; the minimal inhibitory concentrations (MICs) $mg.ml^{-1}$ were defined as the lowest concentrations of plant extracts that completely inhibited the growth of each microbial strain. Stock solutions of the plant extracts carried out by adding equivalents balances to 1 ml of dimethyl-sulph-oxide (DMSO) at each serial dilution, further progressive dilutions to obtain the final concentrations of zero, 50, 100, 200, and 400 $mg.ml^{-1}$ and then injected within the culture medium, the growth control consisting of clear media and growth culture (negative and positive control) **(Cockerill, 2012).**

Statistical Analysis

Each experiment was carried out in triplicate and the mean values were recorded with its standard divisions. However, the final data were subjected to statistical analysis using the SPSS (Software version no. 20). The differences between extracts were analyzed by one-way analysis of variance (ANOVA). The probability value for the statistical test was 0.5%. Also, the Duncan test were applied to compare the differences of the inhibition zones between plants extracts with control groups **(Turker *et al*., 2009).**

RESULTS AND DISCUSSIONS

Major Chemical Compositions

The primarily obtained results about the major chemical composition presented in Table 1 indicated that, Cinnamon bark chemical composite from 5.08% moisture, 2.84% crude protein, 4.36% crude fat, 26.4% crude fiber, 3.37% ash and 57.95% total carbohydrates, these results are quite like results reported by **Farhat *et al*. (2001)**. While, garlic bulbs contain 6.04% moisture, 11.23% crude protein, 0.83% crude fat, 2.2% crude fiber, 3.18% ash and 76.52% total carbohydrates, these results were in line with **Otunola *et al*. (2010).**

Minor Chemical Compositions

The phenolic compounds especially the flavonoids groups are the most important minor chemical composites in cinnamon bark and garlic bulbs which have strong antimicrobial properties, the ethanolic extraction showed the highest levels comparing by water or acetone extractions. The data presented in Table 2 recorded total cinnamon flavonoids by (88, 109, 133 $mg.g^{-1}$) while the extracted total phenolic were (122, 475, 544 $mg.g^{-1}$) in watery, acetonic and ethanolic extracts, respecti-vely. The results are in accordance with those reported by **Bozina *et al*. (2008)**. While the total garlic extracted flavonoids were (83, 116, 184 $mg.g^{-1}$) and (108, 486, 614 $mg.g^{-1}$) for total extracted phenolic in water, acetone and ethanolic extracts, respectively. It is clearly that, the efficiency of ethanolic extraction to extract most the phenolic components, the similar results were also obtained by **Assous *et al*. (2016).**

On other side, the HPLC profile analysis chart for the ethanolic extraction of cinnamon bark were illustrated in Fig. 1, seven different phenolic compounds were detected, which were varied in their amounts. It was observed that cinnamic acid, ellagic acid and 0-coumaric acid were found in high levels and their contents were 96.9, 32.4 and 21.8 $mg.kg^{-1}$ respectively, which represent about 27.8% of total extracted phenolic compounds and 76% of all detected phenolic compounds and these results are in accordance with those reported by **Shalaby *et al*. (2016).**

Fifteen different phenolic compounds were detected in garlic extract and illustrated in Fig. 2, which were varied in their amounts. It was observed that catechol, *0*-coumaric acid, benzoic acid and ellagic acid were found in high levels and their amounts were 35.3, 34.4, 31.4 and 19.9 $mg.kg^{-1}$ respectively represent about 19.8% of total extracted phenolic compounds and 75% of all detected phenolic compounds, these results are accordance with those obtained by **Shalaby *et al*. (2016)**.

Table 1. Major chemical compositions of cinnamon bark and garlic bulbs

Major contents	Concentrations (mg. g^{-1})	
	Cinnamon bark	Garlic bulbs
Ash	33.7	31.8
Moisture	50.8	60.4
Crude fat	43.6	8.3
Crude fiber	264	22.0
Crude protein	28.4	112.3
Carbohydrate	579.5	765.2

Table 2. Minor chemical compositions of cinnamon bark and garlic bulbs

Extract type	Total flavonoids content $mg.kg^{-1}$		Total phenolics content $mg.kg^{-1}$	
	(Catechin Equivalent)		(Gallic Acid Equivalent)	
	Cinnamon bark	Garlic bulbs	Cinnamon bark	Garlic bulbs
Watery	88_A	83_A	122_C	108_B
Acetonic	109_B	116_B	475_D	486_D
Ethanolic	133_C	184_D	544_E	614_E

The values in the same raw or column followed by different letters differ significantly, and when the means followed by the same letters do not differ significantly at ($p \geq 0.01$).

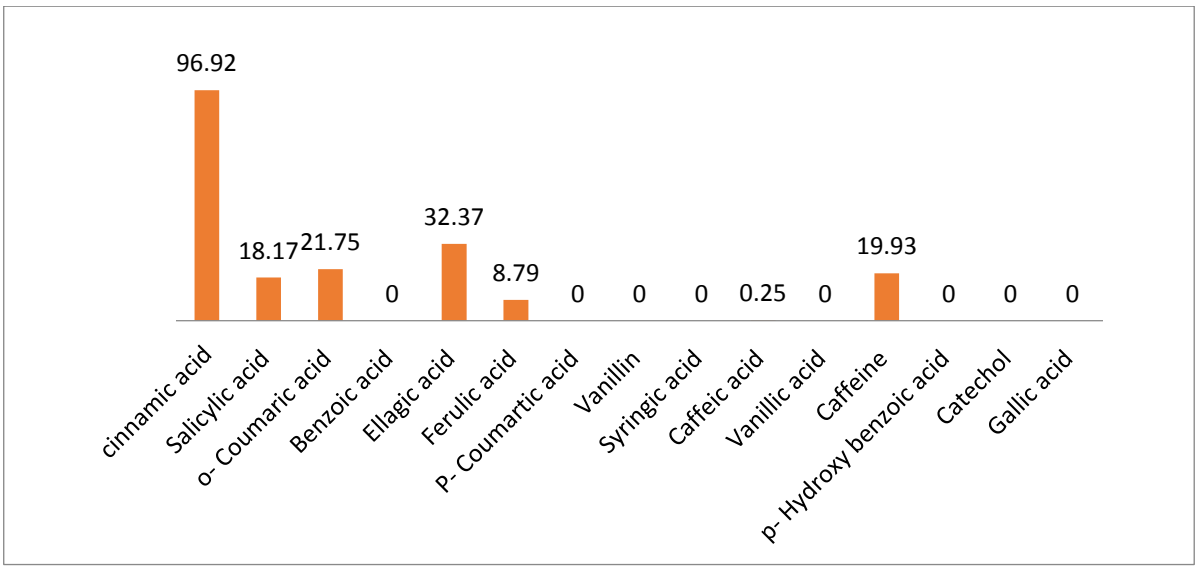

Fig. 1. Phenolic compounds in ethanolic extracts of cinnamon bark ($mg.kg^{-1}$)

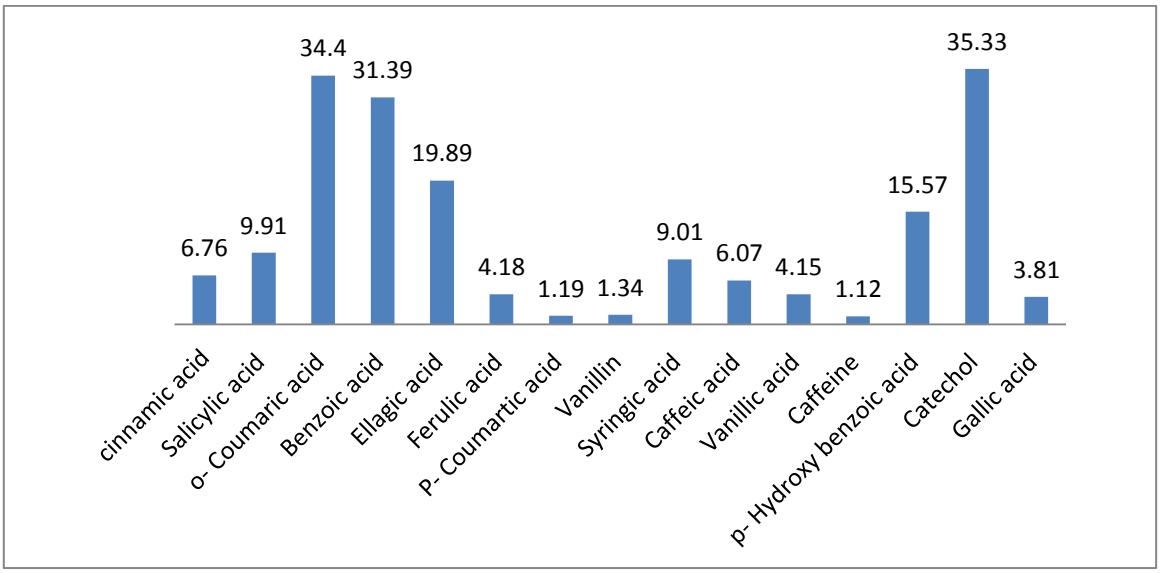

Fig. 2. Phenolic compounds in ethanolic extracts of garlic bulbs (mg.kg^{-1})

Effects of Cinnamon and Garlic Extracts on Antimicrobial Activities

The data represented in Table 3 indicated to the inhibitory effects of cinnamon and garlic extracts verse all studied microbial species groups with various concentrations. It is clear from data that the inhibitions activities of ethanolic extracts which were more antimicrobial efficiency by comparing with the acetonic or watery extracts, the inhibition zones were dramatically increased by increasing the extracts concentrations with recorded.

The lowest levels of minimal inhibitory concentrations (MICs) by 45 mg.ml^{-1}, the maximum inhibition zones ranged from 23.6 to 27.4 mm as maximum, these results are in accordance with those reported by **Khashan (2014) and Banik *et al*. (2018)** which confirmed the effects of phenolic compounds as antimicrobial agents due to the ability of phenolic compounds to bind with microbial cell walls and prevent cell division and growth **(Coppo and Marchese, 2014)**.

However, the cinnamon and garlic extract especially ethanolic ones showed maximum inhibition zones against the G^{+ve} bacterial strains from the genera of sporulated bacilli by (27.4, 21.83 mm) for cinnamon and garlic ethanolic extract respectively, and for G^{+ve} non-sporulated *Staphyllococci* and *Streptococci* were (23.6, 22.86 and 23.06, 19.3 mm) for cinnamon and garlic ethanolic extracts, respectively. The minimal inhibitory concentrations ranged from 45 to 60 mg.ml^{-1} as maximum, these results are in accordance with those with **Abdulrasheed *et al*. (2019)** and obtained by **Gulfraz *et al*. (2014)**. In addition, G^{-ve} bacterial strains from coliform group of the genus of *Escherichia* were (22.7, 20.23) and the enteric genera of *Salmonella* and *Shigella* were (19.66, 22.7 and 19.16, 20.3 mm) for cinnamon and garlic ethanolic extracts, respectively. The minimal inhibitory concentrations ranged from 60 to 65 mg.ml^{-1} as maximum, these results are also similar with those obtained by **Bharath *et al*. (2016)**. On other side, the garlic ethanolic extracts showed stronger antifungal activities comparing with cinnamon extracts due to the good amounts of phenolic complex. The inhibition zones ranged from 19.66 to 22.13 mm for the two types of fungal strains *A. niger* and *A. flavus*, respectively. While the minimal inhibitory concent-rations ranged from 75 to 80 mg.ml^{-1} as maximum, these results are also in accordance with those recorded by **Lakshmeesha *et al*. (2014) and Doudi *et al.* (2016)**.

Conclusion

Garlic and cinnamon had an important nutritional and medical importance because they contain many important chemical compounds for treating many common diseases, and due to of their antimicrobial properties that increase the

Table 3. The effect of cinnamon bark and garlic bulbs extracts on the antimicrobial activity

Group	Microbial strain	Cinnamon watery extract Concentrations (mg.ml^{-1})				Cinnamon acetonic extract Concentrations (mg.ml^{-1})				Cinnamon ethanolic extract Concentrations (mg.ml^{-1})			
		MICs	100	200	400	MICs	100	200	400	MICs	100	200	400
			Inhibition zone (mm ± SD)				Inhibition zone (mm ± SD)				Inhibition zone (mm ± SD)		
1	*E. coli*	95	6.93±0.31$_B$	10.9±0.26$_C$	14.93±0.31$_D$	70	9.86±0.47$_B$	15.87±0.28$_C$	19.98±0.75$_D$	55	12.13±0.21$_B$	16.06±0.21$_C$	22.7±0.30$_D$
	B. cereus	90	7.66±0.65$_B$	12.03±0.41$_C$	18.7±0.30$_D$	75	8.94±0.28$_B$	15.6±0.35$_C$	23.49±0.38$_D$	45	12.6±0.40$_B$	17.66±0.35$_C$	27.4±0.56$_D$
2	*S. typhi*	115	0.00±0.00$_A$	7.13±0.32$_B$	11.73±0.40$_C$	85	6.4±0.23$_B$	9.2±0.31$_C$	14.67±0.21$_D$	60	9.83±0.47$_B$	13.56±0.40$_C$	19.66±0.42$_D$
	Shigella sp.	110	0.00±0.00$_A$	10.63±0.40$_B$	15.4±0.44$_C$	85	6.54±0.31$_B$	11.33±0.40$_C$	16.83±0.40$_D$	65	7.43±0.45$_B$	10.6±0.46$_C$	19.16±0.38$_D$
3	*S. aureus*	95	6.03±0.25$_B$	10.4±0.56$_C$	15.8±0.46$_D$	70	9.35±0.86$_B$	13.72±0.45$_C$	22.44±0.52$_D$	60	11.7±0.26$_B$	16.03±0.42$_C$	23.6±0.49$_D$
	S. pyogenes	90	7.86±0.32$_B$	11.13±0.31$_C$	17.3±0.40$_D$	80	6.2±0.43$_B$	9.3±0.49$_C$	15.78±0.31$_D$	60	10.56±0.38$_B$	16.83±0.42$_C$	22.86±0.70$_D$
4	*A. niger*	165	0.00±0.00$_A$	7.64±0.31$_B$	11.03±0.45$_C$	115	0.00±0.00$_A$	7.92±0.21$_B$	13.53±0.50$_C$	95	6.63±0.51$_B$	10.23±0.35$_C$	16.5±0.44$_D$
	A. flavus	155	0.00±0.00$_A$	10.2±0.66$_B$	13.83±0.50$_C$	110	0.00±0.00$_A$	9.89±0.47$_B$	15.95±0.31$_C$	90	9.26±0.35$_B$	13.93±0.67$_C$	20.63±0.40$_D$

Group	Microbial strain	Garlic watery extract Concentrations (mg.ml^{-1})				Garlic acetonic extract Concentrations (mg.ml^{-1})				Garlic ethanolic extract Concentrations (mg.ml^{-1})			
		MICs	100	200	400	MICs	100	200	400	MICs	100	200	400
			Inhibition zone (mm ± SD)				Inhibition zone (mm ± SD)				Inhibition zone (mm ± SD)		
1	*E. coli*	95	6.7±0.61$_B$	8.3±0.65$_C$	11.53±0.72$_D$	75	10.96±0.47$_B$	16.06±0.21$_C$	20.73±0.83$_D$	65	8.73±0.30$_B$	15.03±0.25$_C$	20.23±0.75$_D$
	B. cereus	90	0.00±0.00$_A$	0.00±0.00$_A$	9.38 ±0.54$_B$	60	9.23±0.21$_B$	14.76±0.35$_C$	22.46±0.55$_D$	60	9.03±0.65$_B$	14.03±0.38$_C$	21.83±0.68$_D$
2	*S. typhi*	115	7.18±0.20$_B$	9.6±0.36$_C$	18.06±0.83$_D$	80	6.08±0.15$_B$	9.56±0.40$_C$	14.33±0.58$_D$	60	10.06±0.31$_B$	15.66±0.61$_C$	22.7±0.36$_D$
	Shigella sp.	110	0.00±0.00$_A$	10.0±0.20$_B$	15.36±0.57$_C$	75	7.26±0.31$_B$	10.63±0.40$_C$	16.83±0.35$_D$	60	9.0±0.30$_B$	14.6±0.40$_C$	20.3±0.61$_D$
3	*S. aureus*	95	0.00±0.00$_A$	0.00±0.00$_A$	18.46±0.50$_B$	65	9.7±0.36$_B$	15.56±0.45$_C$	22.26±0.64$_D$	55	11.16±0.32$_B$	18.03±0.15$_C$	23.06±0.60$_D$
	S. pyogenes	90	0.00±0.00$_A$	0.00±0.00$_A$	13.5 ± 0.36$_C$	75	6.3±0.40$_B$	9.7±0.44$_C$	14.83±0.21$_D$	60	6.36 ±0.06$_B$	10.2±0.30$_C$	19.03±0.25$_D$
4	*A. niger*	95	6.2±0.36$_B$	8.86±0.31$_C$	11.23±0.42$_D$	90	9.46±0.47$_B$	11.76±0.45$_C$	15.86±0.42$_D$	80	8.53±0.41$_B$	11.63±0.45$_C$	19.66±0.35$_D$
	A. flavus	90	6.54±0.29$_B$	9.5±0.46$_C$	14.73±0.25$_D$	85	6.53±0.42$_B$	8.78±0.40$_C$	12.26±0.40$_D$	75	8.86±0.42$_B$	14.63±0.40$_C$	22.13±0.32$_D$

Values represent means ± Standard division (SD) obtained from three treatments.

The means in the same raw or column followed by different letters differ significantly, and when the means followed by the same letters do not differ significantly at ($p \geq 0.01$).

safety of food products and their shelf life through this work against spoilage and foodborne pathogens. The results of the current study showed that the ethanolic extracts of cinnamon parks and garlic bulbs contain a good amount of total phenolics and flavonoids components. The phenolic compounds were estimated by (HPLC) device, which showed the following results: cinnamon bark contains 7 phenolic compounds, the most important of which were cinnamic acid, ellagic acid and 0-coumaric acid by 96.9, 32.4 and 21.8 mg.kg^{-1}, respectively. While garlic bulbs contain 15 phenolic compounds, the most important of which were catechol, 0-coumaric acid, benzoic acid and ellagic acid by 35.3, 34.4, 31.4 and 19.9 mg.kg^{-1}, respectively. The plant extracts showed a significant effect against various microbial genera which used in the experiments, both extracts have a good activity against gramme negative and gramme positive bacteria, the garlic ethanolic extracts showed stronger antifungal activities comparing with cinnamon extracts with (MIC) of 80 mg.ml^{-1} as maximum, the alcoholic extract by ethanol would be available the active components such as cinnamic acid, 0-coumaric acid catechol, benzoic acid and ellagic acid which responsible for the antimicrobial properties of cinnamon or garlic extract. By featuring, the ethanolic extracts will led to prepare a nano emulsion from these plants extracts or its active molecules which indicates the possibility of using these

extracts as supernatural antimicrobial agents in the face of the increasing trend of against microbial strains that cause food spoilage as well as foodborne pathogens and illuminated the risk of bacteria to resist antibiotics.

Conflicts of Interest

The authors declare no conflict of interest.

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إمكانيـــات التضـاد الميكروبي لمستخلصات القرفة والثوم ضـــد بعض الممرضات المنقولة بالغذاء

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تتمتع نباتات القرفة والثوم بأهمية غذائية وطبية تقليدية لاحتوائهما على العديد من المركبات النشطة المهمة، وسيؤدي إعادة اكتشاف مكوناتهما وبروتوكول الاستخلاص إلى تحسين خصائصهما المضادة للميكروبات والتي سوف تزيد من سلامة المنتجات الغذائية وفترة صلاحيتها من خلال العمل ضد البكتيريا المسببة للفساد الغذائي ومسببات الأمراض المنقولة بالغذاء. ففي الدراسة الحالية، تم استخدام نباتات القرفة والثوم لتحديد التركيب الكيميائي، وتقديرالتركيبة الفينولية بواسطة جهاز الفصل الكروموتوجرافى وكذلك تقييم التأثيرات المضادة للميكروبات ضد السلالات البكتيرية السالبة والموجبة لجرام من اجناس الأشيريشيا كولاي والباسيليس سيريس والسالمونيلا تيفى والشاجيلا والأستافيللوكوكس أوريس مع الأستربتوكوكيكس بايوجينز بالأضافة لفطريات فساد الطعام من نوعى الأسبرجليس نيجر وأسبراجيلس فليفيزوالتى تم اختيارها أيضًا كنماذج ميكروبية. حيث تم تحضير المستخلصات المائية والأسيتونية والإيثانولية لقرون القرفة وفصوص الثوم (بتركيزات 100، 200 و 400 ملجرام لكل مليميتر من المستخلص)، وتم اختبار الأنشطة المضادة للميكروبات بطريقة الانتشار فى الأجار، وكانت المستخلصات الإيثانولية أكثر كفاءة في مقاومة الميكروبات عن طريق المقارنة بالمستخلصات الأسيتونية أو المائية، تمت ملاحظة أزدياد مناطق التثبيط بشكل كبيربزيادة التركيزات المستخدمة المستخلصات مع تسجيل أدنى مستوي لأقل تركيز مثبط بمقدار 45 مليجرام لكل مليميتر من المستخلص، وتراوحت مساحة مناطق التثبيط القصوى من 23.6 إلى 27.4 مليميتر كحد أقصى. كما أظهرت المستخلصات الإيثانولية للثوم نشاطًا مضادًا للفطريات أقوى مقارنة بمستخلصات القرفة مع تسجيل أدنى مستوي لأقل تركيز مثبط بمقدار 80 مليجرام لكل مليميترمن المستخلص كحد أقصى.

الكلمات الإسترشادية: عيدان القرفة، فصوص الثوم، الأستخلاص الأيثانولى، الممرضات المنقولة بالغذاء.

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