Effect of some Essential Oils of *Zingiberaceae* Family on Pathogenic Bacteria Content in Minced Meat

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Abstract: Meat and its products such as minced meat are highly perishable and can spoil very easily if they are not store properly. Pathogens bacteria such as *Sylococcus aureus* and *Escherichia coli* were the most bacteria caused meat spoilage. Essential oils and their extracts can be used to extend the shelf life of meat and their products and control/inhibit the microbial growth. In the current study, the essential oils of three species of Zingiberaceae family, (ginger, galangal and turmeric) were extracted to investigate and compare their chemical compositions and study their effect on control/inhibit the growth of pathogenic bacteria in minced meat. Samples of fresh rhizomes of ginger, galangal and turmeric were purchased from Qena governorate local market during spring 2018. Proximate chemical analysis and total antioxidant content of samples were determined. Effect of different concentrations of 1, 1.5 and 2% of ginger, galangal and turmeric essential oils on pathogenic bacteria content in minced meat during cold storage at 2°C for 10 days was investigated. The obtained results showed that ginger had the highest content of moisture, protein and ash. Galangal scored the highest content of total fiber, while turmeric recorded the highest level of fat and carbohydrates. Total phenolic & flavonoid content of ginger, galangal and turmeric were 39.6 and 18.61; 34.96 and 19.37; and 41.40 and 18.97 mg/g, respectively. Also, decreased both of aerobic plate count, *Sylococcus aureus* count and *E. coli* count in treated minced meat with herbs extracts than control samples all over the period of experiment were observed. Whereas there were significant differences between control minced meat and all treated minced meat with herbs extracts at $p<0.05$ level. The pH values of control samples were higher than samples treated with ginger, galangal and turmeric all over the experiment. Additionally, the mean of pH values of treated samples decreased as concentrations of essential oil increased. Essential oil extracted from ginger was the most efficient on *Sylococcus aureus* count than that of essential oil extracted from galangal and turmeric, while essential oil extracted from turmeric was the most efficient on *E. coli* count than that of essential oils extracted from ginger and galangal. It could be concluded that essential oil from *Zingiberaceae* family such as ginger, galangal and turmeric were considered as efficient antimicrobial agents for preserving meat and its products and extending their shelf life.

Key words: Essential oils, extracts, ginger, galangal, turmeric, total phenolics, microbial content, minced meat.

Introduction

Meat has a short shelf life of one day or less at ambient temperature (15-30°C) and a few days at refrigerated temperature (0-10°C) due to their microbial spoilage of both pathogenic and non-pathogenic microorganisms and/or lipid oxidation **(Salem *et al.*, 2017)**. Studies on the microbiological quality of food shows that minced meat is a medium rich in nutrients required for the growth of pathogenic microorganisms **(Elmalı and Yaman, 2005; Norman and Gravani, 2006).** It has been known as a vehicle for transmission of organisms such as *E. coli* and *S. aureus* **(Bell, 1997)**.

Escherichia coli is a gram negative bacterium. It is subtype and may vary widely contaminated in ecosystem. Contaminated both water and then to contaminate the food. In human it is a common inhabitant of the gastrointestinal tract. It can also

cause various intestinal which can develop to extra-intestinal diseases **(Nelson *et al.*, 2008)**.

Sylococcus aureus is nonspore forming Gram-positive cocci, which in some strains, are able to produce an enterotoxin **(Oonmetta-aree *et al.*, 2006; Vanderzant and Splittstoesser, 1992)**. Although, several synthetic food additives have been widely used in the meat industry to extend food shelf life, inhibit lipid oxidation and delay or inhibit the growth of pathogenic microorganisms, the trend is to decrease their use because of the growing concern among consumers about such chemical additives.

Phenolic compounds were the main contributor of antioxidant activity in plants **(Maizura *et al.*, 2011)**. They were considered as an important class of antioxidant due to their radical scavenging activity via hydrogen atom donation. Plants of the family *Zingiberaceae* comprises about 1400 species. The main zingiberaceous genera are Alpinia, Amomum, Curcuma, Elettaria, Hedychium, Kaempferia and Zingiber **(Tripathi *et al.*, 2013)**. Spices and herbs are an excellent source of phenolic compounds (flavonoids, phenolic acid and alcohols, stilbenes, tocopherols, tocotrienols), ascorbic acid and carotenoids which have been reported to show good antioxidant activity **(Zheng and Wang, 2001)**. *Zingiberaceae* plants contain many essential oils, including terpenes, alcohols, ketones, tannins, flavonoids, carotenoids and phytoestrogens **(Habsah *et al.*, 2000; Matsuda *et al.*, 2002; Suhaj, 2006)**. They have been reported for their biological activities in antifungal, antioxidant, insecticidal, and anti-inflammatory activities, Ginger (*Zingiber officinale*) has been used as a spice and as natural additives for more than 2000 years **(Bartley and Jacobs, 2000)**. Galangal (*Alpinia galanga*) is used to flavor foods. Its rhizome has a wide range of applications in traditional medicine, as the essential oil shows an antimicrobial activity **(Yang and Eilerman, 1999).** Turmeric (*Curcuma longa* L.) belongs to the *Zingiberacea* family reported to possess numerous medicinal properties including antioxidant activity **(Pulla and Lokesh, 1992)**. So, the current study was conducted to evaluate the effect of essential oils of the three species from *Zingiberaceae* family (ginger, galangal and turmeric) on control/inhibit the growth of pathogenic bacteria in minced meat.

Materials and Methods

Materials

Samples of fresh rhizomes of ginger (*Zingiber officinale*), galangal (*Alpinia galangal)* and turmeric (*Curcuma longa*) each of weighed (3.5-5 kg) were obtained from Qena governorate local market during spring 2018.

Minced meat was purchased from Qena Governorate local markets. Meats were divided into 13 groups, one group was left as untreated groups (control), and the treated groups were treated with (1, 1.5 and 2%) concentrations of each essential oil (ginger, turmeric and galangal). All samples were kept in polyethylene film and stored at cold storage 2°C for 10 days. All samples were analyzed in triplicate for proximate composition, total phenolic, total flavonoids, tannins and saponins. Samples were investigated bacteriologically for aerobic plate count, (*Sylococcus aureus* and *E. coli* count) during storage at cold storage 2°C for 10 days.

Methods

Proximate chemical analysis

All samples of fresh rhizomes of ginger, galangal and turmeric were analyzed in triplicate for moisture, protein (TN× 6.25, micro - kjeldahl method using semiautomatic apparatus, Velp company, Italy) , fat (soxhelt semiautomatic apparatus Velp company, Italy , petroleum ether solvent), ash and fiber contents were determined using the methods described in the **AOAC. (2010)**. Carbohydrates calculated by differences:

Carbohydrates (%) = 100 - (% moisture + % protein + % fat + % Ash + % fiber)

Determination of pH value

The pH value was determined by blending 10 g of the homogenized sample with 90 ml distilled water **(Kirk and Sawyer, 1991)** and measuring using a pH meter (Model No. pH-8414).

Preparation of extracts

Fresh rhizomes of ginger, galangal and turmeric were cleaned, sliced and dried by the oven drying methods at 60º C for 24 hours. After drying, samples were blended to turn into powder. The powder of sample was kept in polyethylene film and stored till used.

Hydro-alcoholic extractions

The extraction procedure for the hydro-alcoholic extract was carried out according to **Charles *et al.*, (1993)** method.

Determination of total phenolic compound

Total phenolic content was measured by using Folin's reagent according to method of **AOAC (2000).**

Determination of total flavonoids

The flavonoids content was determined by method described by **Zhishen *et al.*, (1999)**.

Determination of tannins

Total tannins were determined according to method of **Rajeev *et al.*, (2012)**.

Determination of saponins

Total saponins were determined as described by **Edeoga *et al.*, (2005).**

Microbiological examination

Preparation of samples

Ten grams of each sample were weighted and placed in a 250 ml sterilized conical flask containing 90 ml of 0.1% peptone water to make a dilution of 10^{-1}. The flasks were then shaken well for 10 minutes. One ml of the diluted sample was added to 9 ml of sterilized peptone water in tube using sterilized pipettes. This was shaken vigorously 25 times. Further dilutions were made using the same procedure to prepare dilutions of 10^{-1} to 10^{-7}. The pervious dilutions were used for the following determination:

Determination of total aerobic plate count (APC)

One ml of each diluted samples were using sterilized basal media (in an autoclave at 121º C for 15 minutes) following the procedure proposed by International Commission on Microbiological Specifications for foods **(ICMSF, 1996).**

Determination of *E. coli* count

The total *E. coli* count was determined according to the method of the International Commission on Microbiological Specifications for Foods **(ICMSF, 1996).**

Determination of *Sylococcus aureus* count

The total *S. aureus* count was determined according to the method of the International Commission on Microbiological Specifications for Foods **(ICMSF, 1996)**.

Statistical analysis

The methods of statistical analysis were done using SPSS: analysis without anguish version 12.0 for windows **(Coakes, 2005)**. One Way ANOVA to detect the significant differences between the three treated groups (ginger, galangal and turmeric) **(Dowdy *et al.*, 2004)**. Duncan Multiple Comparison to recognize the significant differences between averages of counts of bacteria in different samples **(El-Sherbeeny, 1995).** The results were expressed as mean±standard deviation.

Results and Discussion

Chemical composition of ginger, galangal and turmeric dried rhizomes powder

Data in Table (1) showed that mean moisture content of ginger, galangal and turmeric was 10.35±0.062, 9.55±0.045 and 9.23±0.026%; respectively. The highest protein content was scored by ginger 8.5±0.045%, followed by galangal which contained 7.64±0.13%, while, the percentage of protein in turmeric was 7.07±0.02%. There was a significant difference between ginger and other plants in protein content at ($p<0.05$). Turmeric had the highest level of fat 4.74±0.66%, whilst, the lowest fat level was in ginger 1.74±0.09%, there was significant decrease in ginger fat content compared with galangal and turmeric. As observed from Table (4) galangal had the highest level of crude fiber 7.88±0.62%. The means of ash content in ginger, galangal and turmeric were 4.7±0.001, 2.89±0.020 and 4.43±0.007%; respectively. At last, the means of carbohydrate content in ginger, galangal and turmeric was 68.91±0.146, 67.85±0.159 and 70.82±0.23%; respectively. Such results were similar with those obtained by **(El-Ghorab *et al.*, 2010; Mohd *et al.*, 2003; Turker and Usta, 2006)**, but these results were disagreed with those obtained by **(Adel and Prakash, 2010; Fattepurkar *et al.*, 2009; Hussain *et al.*, 2009; Noheer, 2018)**.

Table (1): Mean of chemical composition of ginger, galangal and turmeric dried rhizomes powder

Sample	Moisture%	Protein%	Fats%	Crude Fibers%	Ash%	Carbohydrates %
Ginger	10.35±0.062^{a}	8.5±0.045^{a}	1.74±0.09^{b}	5.8±0.26^{b}	4.7±0.001^{a}	68.91±0.146^{b}
Galangal	9.55±0.045^{b}	7.64±0.13^{b}	4.19±0.38^{a}	7.88±0.62^{a}	2.89±0.020^{b}	67.85±0.159^{b}
Turmeric	9.23±0.026^{b}	7.07±0.02^{b}	4.74±0.66^{a}	3.69±0.13^{c}	4.43±0.007^{a}	70.82±0.23^{a}

Data followed by different letters in the same column are significantly different at $p\leq0.05$

Total antioxidant content of ginger, galangal and turmeric extractions

Antioxidants in such studied plants included phenolic, flavonoids, carotenoids, tannins and saponins. Results of total phenolic content were presented as milligrams of gallic acid equivalent (GAE) per one gram of dry extract. Data in Table (2) showed that the mean of total phenolic compounds in ginger, galangal and turmeric extracts were 39.6±2.02, 34.9±1.26 and 41.4±2.46 mg GAE/g; respectively. Such result was closed with that obtained by **Rababah *et al.*, (2004)** who showed that total phenolic content in ginger was 39.9 mg/g. There was a significant difference between total phenolic content of galangal extract and both these of ginger and turmeric at ($P<0.05$). Total flavonoids compound in ginger, galangal and turmeric extracts were 18.61±0.98, 19.37±1.11 and 18.97±0.28 mg/g; respectively. Tannins were considered antimicrobial substances. Ginger had the lowest level of tannins (10.37±0.05 mg/g). **Ekop *et al.*, (2010)** reported that the trace level of tannins in ginger rhizome is therefore considered to be below toxic level in animals. The levels of tannins in galangal and turmeric were 14.27±1.13 and 13.06±1.01 mg/g; respectively. Such results were similar with that were obtained by **Noheer, (2018).** Saponins have been reported to have antimicrobial properties and they may act as important precursor for steroidal substances. These steroidal substances have wide range of pharmacological activities **(Hashemi *et al.*, 2008).** Results showed that the mean of saponins in ginger, galangal and turmeric extracts were 11.82±0.32, 11.12±1.09 and 10.42±0.62 mg/g; respectively. **Johnson *et al.*, (1986)** stated that plants with high concentrations of saponins improve the growth of beneficial gastro-intestinal micro flora and the permeability of the mucosal cells of the small intestine, thereby facilitating the uptake of nutrients.

Table (2): Mean values of total antioxidant content of ginger, galangal and turmeric extractions

Sample	Total phenolic mg GAE/g	Total flavonoid mg/g	Tanins mg /g	Saponins mg /g
Ginger	39.6±2.02^{a}	18.61±0.98^{b}	10.37±0.05^{b}	11.82±0.32^{a}
Galangal	34.9±1.26^{b}	19.37±1.11^{a}	14.27±1.13^{a}	11.12±1.09^{a}
Turmeric	41.4±2.46^{a}	18.97±0.28^{ab}	13.06±1.01^{a}	10.42±0.62^{b}

Data followed by different letters in the same column are significantly different at $p\leq0.05$

Effect of different concentrations of (ginger, galangal and turmeric) essential oils on pH values of untreated and treated samples

Meat pH changes with the increasing bacterial population, **Shelef and Jay**, **(1970)** reported that the pH of beef rose with increasing bacterial growth. **Kesavan *et al.*, (2014)** reported that increasing meat pH reflects the degree of meat spoilage through protein breakdown for the production of free amino acids, leading to the formation of NH_3 and amines, compounds of alkaline reactions. Data in Table (3) showed that pH values of all samples of minced meat at the beginning of the experiment were 5.5±0.01. The mean of pH values of control samples in 3rd, 5th, 7th and 10th day were 5.97±0.002, 6.31±0.02, 6.65±0.007 and 6.82±0.19; respectively. The mean of pH values of samples treated with 1, 1.5 and 2% ginger oil in 10th day were 6.43±0.02, 6.22±0.11 and 5.98±0.018; respectively. While, the mean of pH values of samples treated with 1, 1.5 and 2% galangal oil in 10th day were 6.67±0.31,

6.4±0.05 and 6.17±0.04; respectively. Finally, the mean of pH values of samples treated with 1, 1.5 and 2% turmeric oil in 10th day were 6.38±0.62, 6.29±0.31 and 6.05±0.002; respectively. There were significant differences in the mean of pH value in different treatment samples during storage period at ($p<0.05$). As cleared from results listed in Table (3) pH values of all treated samples were lower than pH value of control samples in the same times of examination, that might be due to the antimicrobial effect antioxidant compounds such phenolic and flavonoids in essential oils of plants. **Aureli *et al.*, (1992)** suggested that the increased pH value of meat might be due to the effect of microbial growth which may cause protein hydrolysis and release of nitrogenous compounds that increase the pH value of meat. As observed from the same table the more essential oil was concentrated, the less pH value would be. For example the treated minced meat by essential oil 2% concentration had lower pH value than that was treated by 1 or 1.5%, similar finding was obtained by **ALsaiqali *et al.*, (2016)** whom indicated that the high concentration of essential oils reduced the values of pH. Also, the obtained results in Table (3) showed that essential oil of ginger was the more effective for lowing pH values, followed by turmeric essential oils and finally galangal essential oils. Such results were in agreed with those were obtained by **Kassem *et al.*, (2011); Shaltout *et al.*, (2017)**.

Table (3): Effect of different concentrations of (ginger, galangal and turmeric) essential oils on pH values of untreated and treated samples

Sample		Mean of pH values of samples in different times of examination				
		1st day	3rd day	5th day	7th day	10th day
Control		5.5±0.01	5.97±0.002^{a}	6.31±0.02^{a}	6.65±0.007^{a}	6.82±0.19^{a}
Ginger	1%	5.5±0.01	5.83±0.03^{bc}	6.01±0.11^{cd}	6.21±0.05^{c}	6.38±0.02^{bc}
	1.5%	5.5±0.01	5.77±0.01^{cd}	5.91±0.02^{d}	6.12±0.01^{cd}	6.22±0.11^{c}
	2%	5.5±0.01	5.54±0.06^{e}	5.69±0.03^{a}	5.88±0.02^{e}	5.98±0.018^{d}
Galangal	1%	5.5±0.01	5.90±0.11^{ab}	6.27±0.03^{a}	6.59±0.07^{a}	6.67±0.31^{a}
	1.5%	5.5±0.01	5.82±0.02^{a}	6.11±0.002^{bc}	6.34±0.21^{b}	6.40±0.05^{b}
	2%	5.5±0.01	5.77±0.24^{cd}	6.06±0.07^{b}	6.15±0.04^{cd}	6.17±0.04^{cd}
Turmeric	1%	5.5±0.01	5.85±0.51^{b}	6.18±0.21^{ab}	6.30±0.01^{bc}	6.43±0.62^{b}
	1.5%	5.5±0.01	5.81±0.07^{bc}	6.03±0.003^{cd}	6.17±0.12^{cd}	6.29±0.31^{bc}
	2%	5.5±0.01	5.68±0.21^{d}	5.73±0.04^{e}	6.06±0.11^{d}	6.05±0.002^{cd}

Data followed by different letters in the same column are significantly different at $p\leq0.05$

Effect of different concentrations of (ginger, galangal and turmeric) essential oils on total aerobic plate count of untreated and treated minced meat samples

The standard aerobic plate count (APC) of mesophilic bacteria was a rough measure of the bacteria content and the sanitary conditions during processing or temperature abuses of food **(Daoud *et al.*, 1995)**. From the data listed in Table (4) it could be observed that the examined samples had a moderated microbial value in primary samples. The mean value of APC of purchased minced meat before treated was $2.3\times10^{5}\pm4.24$ cfu/g. As showed in Table (4) the mean values of APC of control sample increased from $2.3\times10^{5}\pm4.24$ to $3.1\times10^{9}\pm4.6$ cfu/g throughout the storage period. All concentrations of the three plants extractions possessed antimicrobial activity

aerobic bacteria. Essential oil of ginger extraction had the highest efficiency against bacteria. Such results were closed with that obtained by **Ukaegbu-Obir *et al.*, (2016)**. Results clearly showed that the mean values of APC of treated samples with 1, 1.5 and 2% ginger extracts in 10th day were $5.4\times10^{7}\pm3.8$, $2.1\times10^{7}\pm5.17$ and $3.3\times10^{6}\pm6.86$ cfu/g; respectively. The current results were agreed with those obtained by **Kullanitpitch *et al.*, (2015).** Essential oil of turmeric extraction had higher efficiency against bacteria than that of galangal. The mean values of APC of treated samples with 1, 1.5 and 2% turmeric extracts in 10th day were $6.8\times10^{7}\pm3.63$, $3.2\times10^{7}\pm4.55$ and $5.7\times10^{6}\pm6.24$ cfu/g; respectively. While, The mean values of APC of treated samples with 1, 1.5 and 2% galangal extracts in 10th day were $1.7\times10^{8}\pm2.11$, $3.8\times10^{7}\pm4.09$ and $1.2\times10^{7}\pm5.15$ cfu/g; respectively. The varying degrees of sensitivity of the bacterial test organisms may be due to both the intrinsic tolerance of microorganisms and the nature and combinations of phyto-compounds present in the essential oil as recorded by **Natta *et al.*, (2008)**.

Table (4): Effect of different concentrations of (ginger, galangal and turmeric) essential oils on total aerobic plate count (APC) of untreated and treated samples

Sample		Total aerobic count (log cfu. g^{-1}) in different times of examination				
		1st day	3rd day	5th day	7th day	10th day
Control		$2.3\times10^{5}\pm4.24$	$7.3\times10^{6}\pm3.33^{a}$	$7.8\times10^{7}\pm4.02^{a}$	$2.8\times10^{8}\pm3.80^{a}$	$3.1\times10^{9}\pm4.6^{a}$
Ginger	1%	$2.3\times10^{5}\pm4.24$	$3.4\times10^{5}\pm2.32^{d}$	$5.2\times10^{6}\pm3.78^{b}$	$7.1\times10^{6}\pm2.32^{c}$	$5.4\times10^{7}\pm3.8$c
	1.5%	$2.3\times10^{5}\pm4.24$	$3.1\times10^{5}\pm2.88^{d}$	$4.4\times10^{6}\pm4.30^{c}$	$5.2\times10^{6}\pm4.74^{d}$	$2.1\times10^{7}\pm5.17^{d}$
	2%	$2.3\times10^{5}\pm4.24$	$2.6\times10^{5}\pm1.26^{e}$	$7.6\times10^{5}\pm2.91^{d}$	$1.2\times10^{6}\pm2.49^{e}$	$3.3\times10^{6}\pm6.86^{e}$
Galangal	1%	$2.3\times10^{5}\pm4.24$	$6.4\times10^{5}\pm6.01^{b}$	$6.6\times10^{6}\pm3.63^{b}$	$2.7\times10^{7}\pm2.43^{b}$	$1.7\times10^{8}\pm2.11^{b}$
	1.5%	$2.3\times10^{5}\pm4.24$	$4.8\times10^{5}\pm4.5^{c}$	$4.7\times10^{6}\pm4.06^{c}$	$7.3\times10^{6}\pm2.92^{c}$	$3.8\times10^{7}\pm4.09^{d}$
	2%	$2.3\times10^{5}\pm4.24$	$2.8\times10^{5}\pm3.03^{e}$	$3.4\times10^{6}\pm2.28^{c}$	$5.4\times10^{6}\pm4.34^{d}$	$1.2\times10^{7}\pm5.15^{d}$
Turmeric	1%	$2.3\times10^{5}\pm4.24$	$4.4\times10^{5}\pm2.81^{c}$	$6.2\times10^{6}\pm3.36^{b}$	$1.4\times10^{7}\pm5.31^{b}$	$6.8\times10^{7}\pm3.63^{c}$
	1.5%	$2.3\times10^{5}\pm4.24$	$3.4\times10^{5}\pm2.62^{d}$	$4.1\times10^{6}\pm2.25^{c}$	$6.8\times10^{6}\pm1.94^{c}$	$3.2\times10^{7}\pm4.55^{d}$
	2%	$2.3\times10^{5}\pm4.24$	$2.9\times10^{5}\pm2.32^{e}$	$6.3\times10^{5}\pm3.42^{d}$	$2.4\times10^{6}\pm3.43^{e}$	$5.7\times10^{6}\pm6.24^{e}$

Data followed by different letters in the same column are significantly different at $p\leq0.05$

Effect of different concentrations of (ginger, galangal and turmeric) essential oils on total *Sylococcus aureus* count of untreated and treated minced meat samples

Sylococcus aureus is the type species of the genus Sylococcus, which occurs as gram positive and catalase positive cocci **(ICMSF, 1996)**. Table (5) illustrated that the mean value of total *S. aureus* of all investigated samples in beginning was $1.1\times10^{2}\pm3.83$ cfu/g. All concentrations of the 3 plants extractions possessed antimicrobial activity against *S. aureus*. The mean values of total *S. aureus* count of control sample throughout the storage period were $4.6\times10^{3}\pm3.14$, $5.3\times10^{4}\pm3.33$, $4.2\times10^{5}\pm1.91$ and $3.9\times10^{6}\pm4.07$ cfu/g in 3rd, 5th, 7th and 10th day of the storage period; respectively. Data in Table (5) showed that essential oil of ginger had the highest efficiency against of *S. aureus*. Whereas, the essential oil of ginger successfully decreased the growth of *S. aureus* in treated minced meat with their essential oils. Such results were in agreement with that obtained by **Krittika *et al.*, (2007); Natta *et al.*, (2008)**. Also, results indicated that the high concentration of ginger essential oils (2%) reduced the growth of *S. aureus*

highly. The mean values of total *S. aureus* count of treated samples with 1, 1.5 and 2% ginger extracts in 10th day were $4.3\times10^4\pm2.82$, $1.5\times10^4\pm2.66$ and $2.2\times10^3\pm3.13$ cfu/g; respectively. Essential oil of galangal had the lowest efficiency against of *S. aureus* compared to those extracted from ginger and turmeric. The mean values of total *S. aureus* count of treated samples with 1, 1.5 and 2% galangal extracts in 10th day were $1.5\times10^5\pm4.24$, $6.2\times10^4\pm1.08$ and $4.8\times10^4\pm4.21$ cfu/g; respectively. These results compatible with those were obtained by **Oonmetta-aree et al. (2006)**. Essential oil of turmeric possessed good efficiency against of *S. aureus*. The mean values of total *S. aureus* count of treated samples with 1, 1.5 and 2% turmeric extracts in 10th day were $5.2\times10^4\pm3.08$, $3.7\times10^4\pm2.17$ and $4.2\times10^3\pm3.01$ cfu/g; respectively. In agreement with such results that reported by **Mohd *et al.*, (2015).**

Table (5): Effect of different concentrations of (ginger, galangal and turmeric) essential oils on total *Sylococcus aureus* count of untreated and treated samples

Sample		Total *Sylococcus aureus* count (log cfu. g^{-1}) in different times of examination				
		1st day	3rd day	5th day	7th day	10th day
Control		$1.1\times10^2\pm3.83$	$4.6\times10^3\pm3.14^a$	$5.3\times10^4\pm3.33^a$	$4.2\times10^5\pm1.91^a$	$3.9\times10^6\pm4.07^a$
Ginger	1%	$1.1\times10^2\pm3.83$	$4.1\times10^2\pm2.26^b$	$3.7\times10^3\pm1.04^b$	$3.2\times10^4\pm1.03^b$	$4.3\times10^4\pm2.82^c$
	1.5 %	$1.1\times10^2\pm3.83$	$3.7\times10^2\pm7.17^b$	$2.1\times10^3\pm4.11^c$	$2.4\times10^3\pm3.36^c$	$1.5\times10^4\pm2.66^d$
	2%	$1.1\times10^2\pm3.83$	$1.9\times10^2\pm3.20^c$	$5.2\times10^2\pm0.19^e$	$1.9\times10^3\pm2.44^d$	$2.2\times10^3\pm3.13^e$
Galangal	1%	$1.1\times10^2\pm3.83$	$5.8\times10^2\pm3.04^b$	$5.4\times10^3\pm3.73^b$	$3.5\times10^4\pm2.21^b$	$1.5\times10^5\pm4.24^b$
	1.5 %	$1.1\times10^2\pm3.83$	$4.4\times10^2\pm1.73^b$	$3.2\times10^3\pm2.44^c$	$1.4\times10^4\pm4.21^b$	$6.2\times10^4\pm1.08^c$
	2%	$1.1\times10^2\pm3.83$	$2.7\times10^2\pm5.4^c$	$1.7\times10^3\pm3.31^c$	$3.6\times10^3\pm2.02^c$	$4.8\times10^4\pm4.21^c$
Turmeric	1%	$1.1\times10^2\pm3.83$	$4.9\times10^2\pm1.16^b$	$4.4\times10^3\pm2.06^b$	$2.4\times10^4\pm3.32^b$	$5.2\times10^4\pm3.08^c$
	1.5 %	$1.1\times10^2\pm3.83$	$3.9\times10^2\pm1.12^b$	$2.3.\times10^3\pm3.43^c$	$4.2\times10^3\pm1.19^c$	$3.7\times10^4\pm2.17^d$
	2%	$1.1\times10^2\pm3.83$	$2.2\times10^2\pm1.25^c$	$1.3\times10^3\pm2.21^d$	$3.1\times10^3\pm1.99^c$	$4.2\times10^3\pm3.01^e$

Data followed by different letters in the same column are significantly different at $p\leq0.05$

Effect of different concentrations of (ginger, galangal and turmeric) essential oils on total *E. coli* count of untreated and treated minced meat samples

Data in Table (6) pointed that the total *E. coil* count of control sample was more compared with samples with 1, 1.5 or 2 % ginger, galangal or turmeric extracts. The mean value of total *E. coli* of all investigated samples in beginning was $2.5\times10^2\pm4.19$ cfu/g. **Debbarma *et al.*, (2012)** reported that ginger essential oils have antibacterial activity on *E. coli*. The serogroups and the zingiberaceous extracts seemed to have an impact on the antimicrobial activity **(Habsah *et al.*, 2000; Indu *et al.*, 2006).** After 10 days storage period, the total *E. coil* count of treated samples with 1, 1.5 and 2% ginger extracts were $3.3\times10^5\pm3.63$, $5.6\times10^4\pm3.78$ and $3.9\times10^4\pm4.02$ cfu/g. **Nader *et al.*, (2010)** indicated that the ginger extracts were more effective on gram positive bacteria (*S. aureus*) than on gram negative bacteria (*E. coli*), that probably due to the differences in cell wall structure of gram-positive bacteria and gram negative bacteria. The galangal essential oil showed antimicrobial activity against *E. coli*. The total *E. coil* count of treated samples with 1, 1.5 and 2% galangal extracts after 10 days storage period were $4.8\times10^5\pm3.22$, $6.9\times10^4\pm2.81$ and $2.9\times10^4\pm3.06$ cfu/g. similar finding

was obtained by **Watcharaporn and Nakanyapatthara, (2014).** Data in Table (6) showed that essential oil of turmeric had the highest efficiency against of *E. coli*. The total *E. coil* count of treated samples with 1, 1.5 and 2% turmeric extracts after 10 days storage period were $2.5\times10^5\pm5.27$, $4.5\times10^4\pm3.04$ and $2.3\times10^4\pm3.31$ cfu/g. Such results were agreed with those of **Zeayd, (2014);** who recorded that high concentrations of turmeric had a greater antiseptic property for *E. coli*. Also results were closed with those were obtained by **Parveen and Jehan, (2015)** who revealed that different extracts of turmeric had antimicrobial activity against *Escherichia coli* produced different zones of inhibition.

Table (6): Effect of different concentrations of (ginger, galangal and turmeric) essential oils on total *E. coli* count of untreated and treated samples

Sample		Total *E. coli* count (log cfu. g^{-1}) in different times of examination				
		1st day	3rd day	5th day	7th day	10th day
Control		$2.5\times10^2\pm4.19$	$7.4\times10^3\pm5.33^a$	$6.5\times10^4\pm4.01^a$	$3.2\times10^5\pm3.87^a$	$5.1\times10^6\pm4.20^a$
Ginger	1%	$2.5\times10^2\pm4.19$	$6.8\times10^2\pm3.93^b$	$4.5\times10^3\pm3.36^b$	$5.8\times10^4\pm2.23^b$	$3.3\times10^5\pm3.63^b$
	1.5%	$2.5\times10^2\pm4.19$	$4.9\times10^2\pm5.25^c$	$2.9\times10^3\pm2.92^c$	$5.9\times10^3\pm5.01^c$	$5.6\times10^4\pm3.78^c$
	2%	$2.5\times10^2\pm4.19$	$4.1\times10^2\pm4.14^c$	$2.2\times10^3\pm4.03^c$	$6.3\times10^3\pm2.62^c$	$3.9\times10^4\pm4.02^c$
Galangal	1%	$2.5\times10^2\pm4.19$	$8.1\times10^2\pm5.23^b$	$5.2\times10^3\pm4.11^b$	$6.3\times10^4\pm1.61^b$	$4.8\times10^5\pm3.22^b$
	1.5%	$2.5\times10^2\pm4.19$	$5.3\times10^2\pm3.78^b$	$4.1\times10^3\pm3.07^b$	$1.1\times10^4\pm2.96^b$	$6.9\times10^4\pm2.81^b$
	2%	$2.5\times10^2\pm4.19$	$4.9\times10^2\pm2.62^c$	$2.8\times10^3\pm4.91^c$	$4.3\times10^3\pm4.08^c$	$2.9\times10^4\pm3.06^c$
Turmeric	1%	$2.5\times10^2\pm4.19$	$6.5\times10^2\pm3.53^c$	$3.7\times10^3\pm3.63^c$	$4.1\times10^4\pm4.34^b$	$2.5\times10^5\pm5.27^b$
	1.5%	$2.5\times10^2\pm4.19$	$4.6\times10^2\pm5.21^c$	$2.4\times10^3\pm4.01^c$	$5.1\times10^3\pm2.17^c$	$4.5\times10^4\pm3.04^c$
	2%	$2.5\times10^2\pm4.19$	$3.8\times10^2\pm2.42^d$	$1.7\times10^3\pm3.46^d$	$4.7\times10^3\pm3.53^c$	$2.3\times10^4\pm3.31^c$

Data followed by different letters in the same column are significantly different at $p\leq0.05$

Conclusion

Generally, according to this study it could be concluded that essential oils of ginger, galangal and turmeric and their extracts had good antimicrobial potential in addition to the antioxidants and anticancer effects. Such substances can be used as effective natural additives instead of synthetic substances. These substances are had beneficial effects to extend the shelf life of meat and their products by controlling/inhibition the microbial growth.

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تأثير بعض الزيوت العطرية للعائلة الزنجبيلية على محتوى البكتريا المسببة للأمراض في اللحم المفروم

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تعتبر اللحوم ومنتجاتها مثل اللحم المفروم من الأغذية الأكثر عرضة للتلف ويمكن أن تفسد بسهولة إذا لم يتم تخزينها بشكل صحيح. ومن أكثر أنواع البكتريا المسببة لفساد اللحوم البكتريا العنقودية وبكتريا القولون. يمكن استخدام الزيوت العطرية ومستخلصاتها لزيادة مدة صلاحية اللحوم ومنتجاتها ، وتثبيط/وقف نمو الميكروبات. في الدراسة الحالية ، تم استخلاص الزيوت العطرية من ٣ أنواع من العائلة الزنجبيلية (الزنجبيل ، الخولنجان والكركم) ودراسة تركيبها الكيميائي وتأثيرها في تثبيط/وقف نمو البكتيريا المسببة لفساد اللحم المفروم. تم شراء عينات من جذور الزنجبيل والخولنجان والكركم الطازجة من السوق المحلي لمحافظة قنا خلال فصل الربيع لعام ٢٠١٨. تم تحليلها كيميائيا وتقدير محتواها من المواد المضادة للأكسدة. كما تم دراسة تأثير تركيزات مختلفة من الزنجبيل والخولنجان والكركم بنسب (١ ، ١,٥ ، ٢٪) على المحتوى البكتيري في اللحم المفروم خلال التخزين بالتبريد على درجة حرارة ٢°م لمدة ١٠ أيام. أظهرت النتائج التي تم الحصول عليها أن الزنجبيل يحتوي على أعلى نسبة من الرطوبة والبروتين والرماد ، وسجل الخولنجان أعلى نسبة من الألياف الكلية ، بينما سجل الكركم أعلى مستوى من الدهون والكربوهيدرات. كان إجمالي محتوى الفينولات والفلافونويدات الكلية من الزنجبيل ، الخولنجان والكركم ٣٩,٦ و ١٨,٦١ ، ٣٤,٩٦ و١٩,٣٧ ، ٤١,٤ و١٨,٩٧ ملجم / جرام على التوالي. وأظهرت النتائج انخفاض العدد الكلي للميكروبات الهوائية وبكتريا القولون والبكتريا العنقودية في اللحم المفروم المعالج بمستخلصات النباتات محل الدراسة عن عينة اللحم غير المعاملة بأي اضافات (الضابطة) طوال فترة التجربة ، في حين كانت هناك فروق ذات دلالة معنوية بين اللحم المفروم غير المعالجة (العينة الضابطة) وجميع عينات اللحم المفروم المعالجة بمستخلصات النباتات المدروسة عند مستوى دلالة ٠,٠٥. كانت قيمة الأس الهيدروجيني للعينات الضابطة أعلى من العينات المعالجة بكلا من الزنجبيل ، والخولنجان ، والكركم طوال فترة التجربة. بالإضافة إلى ذلك ، انخفض متوسط قيم الأس الهيدروجيني للعينات المعالجة بزيادة تركيزات الزيت العطري. كان الزيت العطري المستخلص من الزنجبيل هو الأكثر كفاءة في خفض العد الكلي للبكتريا العنقودية من الزيت العطري المستخلص من الخولنجان والكركم ، بينما كان الزيت العطري المستخلص من الكركم هو الأكثر كفاءة في خفض العد الكلي لبكتيريا القولون من الزيت العطري المستخلص من الزنجبيل والخولنجان. يمكن استنتاج أن الزيوت العطرية المستخلصة من العائلة الزنجبيلية مثل الزنجبيل ، والخولنجان ، والكركم لها تأثير فعال ومضاد للميكروبات بما يساعد على حفظ اللحوم ومنتجاتها من الفساد وإطالة فترة حفظها.

الكلمات المفتاحية: الزيوت العطرية، المستخلصات، الزنجبيل، الخولنجان، الكركم، الفينولات الكلية، المحتوى الميكروبي، اللحوم المفرومة.