Research Article

Antioxidant and Antimicrobial Activities of Galangal and Sumac to Improve Quality Attributes of Beef Burger

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Abstract | Meat products are an excellent source of protein but unfortunately it vulnerable to lipid oxidation and many pathogens, which carry the risk for human health. The aim of this work is to determine the antioxidant and antimicrobial activities as well as total phenolic and flavonoids contents in both water and ethanolic extracts of galangal and sumac extracts. Also, the effect of previous extracts on quality attributes of beef burger was evaluated. The ethanolic extracts of both galangal and sumac were shown to have significantly higher total phenolic and flavonoid contents than the aqueous extract, in particular 90% Ethanol Extract, where the 90% Ethanol Extract of sumac had 58.03 mg gallic acid/g dry sample for total phenolic and 28.45mg quercetin /g dry sample for total flavonoid whereas the 90% Ethanol Extract of galangal had 46.12 mg gallic acid/g dry sample for total phenolic and 20.08 mg quercetin /g dry sample for total flavonoid. Two types of burger were manufactured, the first was prepared from Brazilian meat while the other one from Sudanese meat. Six burger treatments were prepared from each type of meat. The results of inhibitory effect against the selected organisms indicated that; 90% ethanolic extract of sumac and galangal was found to be effective against all Gram negative bacteria, Gram positive bacteria, yeast and molds, with note that the gram positive bacteria were more sensitive than gram negative. Antibacterial activity of different galangal and sumac extracts against total bacterial count was more effective in burger prepared with Sudanese meat than burger prepared with Brazilian meat, where the highest synergistic antibacterial activity were recorded with the combination of Galangal and sumac extracts (250ppm Galangal +250ppm Sumac), which ranged from 1.75×10^4 and 5.75×10^4 at zero time of storage to 3.75×10^4 and 7.65×10^4 at the fourth month of storage. Antibacterial activity of different galangal and sumac extracts against staphylococcus, coliform group, psychrophilic bacteria, mold and yeast were demonstrated where the 90% ethanol extract of sumac and galangal had the highest antimicrobial activity. With concern to scavenge activity, the 90% Ethanol Extract of Galangal and sumac has the highest value; 96.15% and 97.12% respectively. Finally, it could conclude that the galangal and sumac extracts exhibited considerable antioxidant and antimicrobial activities against food spoilage bacteria, yeast, and mold which can be very useful for controlling of microbial spoilage in processed meat.

Keywords | Antimicrobial, Burger, Ethanol extract, Galangal, Sumac

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INTRODUCTION

Processed meats have great role in human health as source of essential amino acids and other important nutrients. In particular, beef-burger has a remarkable significance for many consumers in their daily life (Mahmoud et al., 2017). But unfortunately many fundamental problems like microbial and chemical reactions including moisture changes and oxidation may have devolved in meat and processed meats (Ragab et al., 2020). These lead to the need for using many preservatives like, nitrates and nitrites, which carry risk of carcinogenic effect on the human body, which threatening his health and his life in addition to economic and environmental impact (Alahakoon et al., 2015). It becomes clear to meat industry, the importance of using the natural additives to processed meats to play a role synthetic preservatives. Oilseeds, cereal crop, vegetables, fruits, leaves, roots, spices, herbs; all are considering as natural antioxidants (Palamutoğlu and Kasnak, 2019).

Many pathogenic bacteria, molds and yeasts can be contaminating the meat that act as very good media for their growth, these bacteria include coliform group, *Salmonella typhimurium*, *Escherichia coli O157:H7, Shigella dysenteria, Bacillus cereus* and *Staphylococcus aureus* (Naseri and Rahati, 2018). The use of antimicrobials addition is limited in foods, therefore, many researchers were directed toward the use of alternatives from nature as extracts from herbs and spices (Ahmadi et al., 2017). The demand for the use of herbs and spices as natural preservatives has been recently increased for extending shelf-life of meat and meat products by reducing or inhibiting lipid oxidation and microbial spoilage (Gramatiņa et al., 2017). Phenolic and flavonoids are compounds from herbs and spices that have antioxidant and anti-inflammatory activities, as they can interact with free radicals which initiate oxidation reactions (Dawidowicz et al., 2006).

Galangal is an Asian plant of the ginger family, the aromatic rhizome of which is widely used in cooking and herbal medicine, their family Zingiberaceae also contain turmeric, ginger, krachai, cardamom, and grains of paradise (Voravuthikunchai, 2007). It cultivates in many Asian Countries in addition to Egypt and Sri Lanka (Al-Snafi, 2014). Other very popular spice used for its antimicrobial activity is Sumac (*R. coriaria*) (Mahdavi, 2018), grows wildly in Mediterranean and Arabic countries (Kossah et al., 2010), in which many important ingredient as phenolic compounds, oleic and linoleic acids, vitamins, minerals as well as organic acids are found (Kossah et al., 2013). The aim of present study is to determine the antioxidant and antimicrobial activities as well as total phenolic and flavonoids contents in both water and ethanolic extracts of galangal and sumac extracts. Also, the effect of previous extracts on quality attributes of beef burger was evaluated.

MATERIALS AND METHODS

Meat types

Two types of imported meat were used in this study. The chilled sudanese beef was purchased from the market, while frozen Brazilian beef meat was obtained from the Nile Company for consumer complexes in Giza, Egypt.

Herbs and other ingredients

Galangal (*Alpinia galanga*.) and Sumac (*Rhus coriarail*) were obtained from the local market at Giza, Egypt. Texturized soy was purchased from Food Technology Research Institute, Agricultural Research Center, Giza, Egypt. It was rehydrated by water (at a ratio of 1:1 w / v) and minced through 3 mm plate twice. Fresh onion, spices, bread crust, whole eggs and salt were obtained from the local market at Giza, Egypt.

Microbial cultures

Four bacterial strains representing, two grams negative (*Escherichia coli* and *Salmonella typhimurium*), two gram positive bacteria (*Staphylococcus aureus* and *Bacillus cereus*), beside two yeast strains (*Candida albicans*, and *Saccharomyces cerevisiae*), in addition to two mold strains (*Aspergillus niger* and *Aspergillus flavus*) were obtained from Cairo Microbiological Research Center (Cairo MIRCEN), Faculty of Agriculture, Ain Shams University, Egypt.

Preparation of galangal and sumac extracts

The Galangal and Sumac extracts were prepared according to (Zia-ur-Rehman, 2006). Ten gm of galangal and sumac samples were separately extracted with 100 ml distilled water for aqueous extract and 100 ml of ethanol at different concentrations (50, 70 and 90%) for ethanolic extracts then left at room temperature overnight in a shaker. Filtration of the galangal and sumac extracts were done by filter paper (Whatman No. 1), under the same conditions re-extraction of the residues were done. The combined filtrate was evaporated in a rotary evaporation (BÜCHI Rotavapor R-124, Germany) at 40°C. All galangal and sumac extracts obtained after evaporation of ethanol were dried in vacuum oven at 40°C then converted to powder form.

Preparation of burger samples

Burger samples were prepared according to the method described by (Mikkelsen, 1993) and (Heinz et al., 2007) with some modifications. Two types of burger were manufactured, the first was prepared from Brazilian meat while the other one from Sudanese meat. Six burger treatments were prepared from each type of meat as presented in Table 1. Beef meat and fat were cut into approximately 5 cm cubes and minced by using mincer.

The other ingredients were added and mixed by using a laboratory blender. After blending, the mixture was shaped using a patty maker (stainless steel model "Form") to obtain round discs of 10 cm diameter and 0.5 cm thickness. All treatments were packaged in a foam plates, wrapped with polyethylene film and stored at -18°C for 3 months. The samples were taken for analysis every month periodically.

Table 1: Ingredients (%) used in the preparation of different burger treatments.

Ingredients	Control	Powders (ppm)		90% Ethanol extract (ppm)		
		1000	1000	500	500	250
Type of meat*	60.0	60.0	60.0	60.0	60.0	60.0
Fat tissue	7.5	7.5	7.5	7.5	7.5	7.5
Rehydrated soy	10.0	10.0	10.0	10.0	10.0	10.0
Egg	5.0	5.0	5.0	5.0	5.0	5.0
Onion	5.0	5.0	5.0	5.0	5.0	5.0
Ice water**	6.0	5.05	5.05	6.0	6.0	6.0
Bread crust	3.15	3.15	3.15	3.15	3.15	3.15
Spices mix.	1.65	1.65	1.65	1.65	1.65	1.65
Salt	1.65	1.65	1.65	1.65	1.65	1.65
Ascorbic acid	0.025	-	-	-	-	-
Na- benzoate	0.025	-	-	-	-	-
Galangal powder	-	1.0	-	-	-	-
Sumac powder	-	-	1.0	-	-	-
Galangal extract	-	-	-	0.05	-	0.025
Sumac extract	-	-	-	-	0.05	0.025

*Type of meat = Frozen Brazilian meat or Chilled Sudanese meat.

Analytical methods

Determination of total phenolic content (TPC)

The method reported by (Julkunen-Tiitto, 2002) was used to determine the total phenolic content in all extracts. From each diluted extract 50 µL Aliquots and 1950 µL water were mixed in a 10 ml test tube. After that 1 ml of Folin-Ciocalteu reagent was added to the mixture then undergo vigorously shaken. Immediately, we add 5 ml of 20% sodium carbonate solution, the volume of the mixture was brought up to 10 ml and shaken thoroughly again. After 20 min, at 735 nm by spectrophotometer the absorbance of the mixture was read (model: CT2200-s/n: RE1310004 – Germany). Calculation of Phenolic contents of the extracts were done on the basis of gallic acid standard curve. The total phenolic content was expressed as mg gallic acid equivalents per g of the dry weight of the galangal and sumac material.

Determination of total flavonoids

Flavonoids content was measured according to the AlCl3 method (Huang et al., 2006). Where 0.5 ml of extract was mixed with 1.0 ml of 2 % methanolic AlCl3.6H2O, after 10 min at 430 nm the absorbance of the mixture was measured. The total content of flavonoids was calculated on the basis of the calibration curve of quercetin and expressed as mg quercetin per g dry matter.

DPPH radical-scavenging activity

Antioxidant activity was determined using the 2, 2-dipheny-l-1picrylhydrazyl (DPPH) radical scavenging method according to the procedure described by (Sreejayan and Rao, 1996).

Thiobarbituric acid value (T.B.A) (Antioxidant activity)

The TBA as an indication for lipid oxidation was determined according to the method described by (Kirk and Sawyer, 1991).

Microbiological examinations

Antimicrobial activity of different galangal and sumac extracts

Agar wells-diffusion method was used according to the method of (Wan, 1998). Briefly, 0.5 ml of fresh overnight cultures of the tested bacteria (containing 10^6–10^7cfu/ml) was spread on nutrient agar in sterile Petri dishes (9cm). Wells were created using a 6 mm. Each well was filled with 30µl of sumac and galangal extracts and incubated at 37 °C for 24h. The inhibition zones were observed as no growth of bacteria and the inhibition activity was recorded in millimeter (mm). All experiments were conducted in duplicate and the results are expressed as average values of inhibition.

Microbial load of burgers during frozen storage

Sample preparation

Ten grams of burger samples were mixed with 90 ml of sterile peptone solution (10 g peptone / 1 L distilled water) in a blender, under aseptic conditions, to give 1/10 dilution. Serial dilutions were prepared to be used for counting total bacteria count, coliform group, psychrophilic bacteria, *Staphylococcus aureus*, and yeast and mold counts.

Microbiological methods

Total bacteria count, coliform group, psychrophilic bacteria, *Staphylococcus aureus*, and yeast and mold counts of burger samples were determined by using Nutrient agar, MacConkey agar, Nutrient agar, Baird-parker agar and Potato Dextrose agar media, respectively according to the procedures described by (Tortorello, and Lou, 2015) and (Difco-Manual, 1984). The Colonies were counted after incubations at 37°C/48 h for TBC; 37°C /24h for Coliform group and *Staphylococcus aureus*; 5°C/8 day for Psychrophilic and 25°C/5 day for yeasts and molds count.

RESULTS AND DISCUSSION

The societal concerns about food safety especially meat and meat products, which faced by a numbers of challenges that related to microbial load and biological issues, has been devolved widely (Lianou et al., 2017), subsequently the demand for the use of herbs and spices as natural preservatives has been increased recently.

Selection of the best concentration of galangal and sumac powder based on Sensory properties

The best sensory properties were obtained in Burger with 1% Galangal powder and Burger with 1% Sumac powder as showed in Table 2.

Table 2: Selection of the best concentration of spices based on the Sensory properties

Treatments							Sensory properties
7	6	5	4	3	2	1	
8.2	8.44	8.4	7.4	7.5	8.9	8.5	Taste
8.1	8.3	8.8	8.1	7.9	8.6	7.3	Odor
8.1	8.3	8.6	8.5	8.6	7.5	8.6	Color
7.7	7.9	8.4	8.25	8	8.5	8.2	Texture
8	8.2	8.56	8.06	8	8.4	8.2	Overall acceptability

1, Control; 2, Burger with 1% Alpinia Galange powder; 3, Burger with 1.5 % Alpinia Galange powder; 4, Burger with 2% Alpinia Galange powder; 5, Burger with 1% Rhus Coriarail powder; 6, Burger with 1.5% Rhus Coriarail powder; 7, Burger with 2% Rhus Coriarail powder.

Two extract samples of galangal and Sumac were used in this study; aqueous extract and ethanolic extract. The amounts of total phenolic and flavonoids content in both water extract and ethanolic extract of galangal and Sumac were recorded in Table 3. The ethanolic extract of both galangal and sumac had significantly higher total phenolic and flavonoid contents than the aqueous extract, in particular 90% Ethanol extract, where the 90% ethanol extract of sumac had 58.03 mg gallic acid/g dry sample for total phenolic and 28.45mg quercetin/g dry sample for total flavonoid whereas the 90% ethanol extract of galangal had 46.12 mg gallic acid/g dry sample for total phenolic and 20.08 quercetin /g dry sample for total flavonoid. Similar result was obtained by (Mahae and Chaiseri, 2009), who found that the ethanolic extract of galangal had the highest concentration of phenolic and flavonoid in compare with aqueous and oil extract, also (Mayachiew and Devahastin, 2008) demonstrated that the flavonoids and phenolic acids were the most phenolic compounds in galangal.

The inhibitory effect of different galangal and sumac extracts against some selected microorganisms strains in all the samples were showed in Table 4. The present work denoted that the ethanolic extract had more effective inhibitory effect than the aqueous extract (Dobre et al., 2013). The 90% ethanolic extract of sumac and galangal was found to be effective against all Gram negative bacteria, Gram positive bacteria, yeast and molds. But the gram positive bacteria were more sensitive than gram negative (Youssef et al., 2015), this finding may be attributed to the variation in structure of bacterial cell wall among Gram-positive and Gram-negative bacteria that interfere with the antibacterial activity of many natural and synthetic substance (Burt, 2004). The sumac and galangal extract have a different degree of antimicrobial activity on different microorganism, where the widest inhibition zones diameters were recorded with *Saccharomyces cerevisiae* (yeast) 39.0 mm and 35.0 mm in the 90% ethanolic extract of sumac and galangal respectively. On the other hand, the narrowest inhibition zone was recorded with gram negative bacteria in particular *Escherichia coli*; 20.0 mm and 16.0 mm in the 90% ethanolic extract of sumac and galangal, respectively. The inhibitory effect that displayed by sumac extract against the microorganisms present in this work were also recorded by (Nasar-Abbas and Halkman, 2004), add to that (Sharma et al., 2015), found that the galanga contain an important bioactive fractions acting as therapeutic agents against different foodborne pathogen.

Table 3: The quantitative phytochemical analysis and DPPH radical-scavenging activity of the ethanolic and aqueous extract of Galangal and Sumac.

Type of extract			Total phenolic mg/g	Total flavonoid mg/g	DPPH %
Galangal	Aqueous extract		31.68	3.49	91.95
	Ethanol extract	50%	33.96	11.77	93.27
		70%	39.18	15.42	94.47
		90%	46.12	20.08	96.15
Sumac	Aqueous extract		36.98	4.14	93.83
	Ethanol extract	50%	40.48	15.80	95.67
		70%	53.71	21.44	96.43
		90%	58.03	28.45	97.12

The results of antibacterial activity of different galangal and sumac extracts against different foodborne pathogens in burger prepared with brazilin meat and Sudanese meat during storage period were recorded. Antibacterial activity of different galangal and sumac extracts against the total bacterial count in burger during storage period extended to four months was present in Table 5. Antibacterial activity of different galangal and sumac extracts was more effective in burger prepared with Sudanese meat than burger prepared with brazilin meat, where the highest synergistic antibacterial activity were recorded with the combination of Galangal and sumac extracts (250 ppm Galangal + 250 ppm Sumac), which ranged from 1.75×10^4 and 5.75×10^4 in day zero of storage to 3.75×10^4 and 7.65×10^4 in fourth

Table 4: Inhibition zones diameters (mm) of different galangal and sumac extracts against some selected microorganisms strains.

Microorganisms	Galangal				Sumac			
	Aqueous extract	Ethanol extract			Aqueous extract	Ethanol extract		
		50%	70%	90%		50%	70%	90%
Gram negative bacteria								
Escherichia coli	5.0	8.0	12.0	16.0	8.0	12.0	15.0	20.0
Salmonella typhimurium	6.0	10.0	13.0	18.0	9.0	14.0	16.0	22.0
Gram positive bacteria								
Staphylococcus aureus	11.0	15.0	16.0	22.0	12.0	17.0	23.0	26.0
Bacillus cereus	9.0	12.0	15.0	20.0	11.0	16.0	21.0	25.0
Yeasts								
Saccharomyces cerevisiae	18.0	28.0	33.0	35.0	18.0	31.0	36.0	39.0
Candida albicans	16.0	25.0	27.0	30.0	16.0	28.0	34.0	37.0
Molds								
Aspergillus niger	12.0	18.0	22.0	25.0	15.0	21.0	28.0	31.0
Aspergillus flavus	8.0	10.0	17.0	22.0	13.0	18.0	22.0	35.0

Table 5: Antimicrobial activities of galangal and sumac against total bacterial count in beef burger.

Treat storage period	Burger prepared with brazilin meat						Burger prepared with Sudanese meat					
	Control	Powder additives		Ethanol extract 90%			Control	Powder additives		Ethanol extract 90%		
		1% galangal	1% sumac	500 ppm Galangal	500 ppm sumac	250 ppm galangal + 250ppm sumac		1% galangal	1% sumac	500 ppm galangal	500 ppm sumac	250 ppm galangal + 250 ppm sumac
Zero	9.15×10^4	8.26×10^4	7.35×10^4	7.42×10^4	6.15×10^4	5.75×10^4	5.60×10^4	5.11×10^4	4.21×10^4	3.58×10^4	2.45×10^4	1.75×10^4
1M	8.65×10^4	7.33×10^4	6.87×10^4	6.25×10^4	5.85×10^4	4.92×10^4	4.25×10^4	4.15×10^4	3.50×10^4	3.13×10^4	2.00×10^4	1.23×10^4
2M	9.60×10^4	8.95×10^4	7.60×10^4	6.32×10^4	5.95×10^4	5.67×10^4	5.55×10^4	4.25×10^4	4.15×10^4	3.05×10^3	2.75×10^3	2.00×10^4
3M	10.72×10^4	9.58×10^4	8.35×10^4	7.25×10^4	6.58×10^4	6.23×10^4	6.75×10^4	5.50×10^4	5.12×10^4	3.35×10^4	3.00×10^4	2.85×10^4
4M	6.35×10^5	3.72×10^5	9.16×10^4	8.77×10^4	8.22×10^4	7.65×10^4	2.81×10^5	1.21×10^5	5.21×10^4	5.55×10^4	4.65×10^4	3.75×10^4

Table 6: Antimicrobial activities of Galangal and sumac against *Staphylococcus aureus* in beef burger.

Treat storage period	Burger prepared with Brazilin meat						Burger prepared with Sudanese meat					
	Control	Powder additives		Ethanol extract 90%			Control	Powder additives		Ethanol extract 90%		
		1% galangal	1% sumac	500 ppm galangal	500 ppm sumac	250 ppm galangal +250 ppm sumac		1% galangal	1% sumac	500 ppm galangal	500 ppm sumac	250 ppm galangal +250 ppm sumac
Zero	2.0×10^2	ND	ND	ND	ND	ND	1.75×10^2	ND	ND	ND	ND	ND
1M	1.5×10^2	ND	ND	ND	ND	ND	1.0×10^2	ND	ND	ND	ND	ND
2M	3.0×10^2	ND	ND	ND	ND	ND	2.0×10^2	ND	ND	ND	ND	ND
3M	4.1×10^2	ND	ND	ND	ND	ND	2.5×10^2	ND	ND	ND	ND	ND
4M	8.7×10^2	ND	ND	ND	ND	ND	6.0×10^2	ND	ND	ND	ND	ND

month of storage in Sudanese and brazilin meat burger respectively as a result of synergistic actions of specific compounds inthe combination of Galangal and sumac extracts. From the public health of view Food Poisoning with *S. aureus* is one of most global widespread foodborne intoxication (Scallan et al., 2011), that consider as a serious risk to human health (Ahmed et al., 2020) and one of the main challenges to the meat processing industry (Fetsch and Johler, 2018). Antimicrobial activities of Galangal and sumac against Staphylococcus were showed in Table 6, where *S. aureus* is detected only in the control treatment of Sudanese and brazilin meat burger during the whole storage period, indicating the antibacterial effectiveness of both powder additives and extracts (ethanolic and aqaueus) of galangal and sumac against *S. aureus*.

Fungi and yeast contamination consider as one of serious problem in meat processing industry as a result of toxins production in particular the mycotoxins, that carry risk to humans health acting as predisposinf factor in immunosuppression and cancer (Dobre et al., 2013). In addition to the inhibitory effect of different galangal and sumac extracts against fungal grouth in Table 3, the antifungal activity of different galangal and sumac extracts in burger prepared with brazilin meat and Sudanese meat during storage period were recorded in Table 7, the result obtained denoted that the fungal growth was detected only in control treatment and 1% powder additives of galangal in both brazilin and Sudanese meat burger, while no any fungal growth was detected with all others treatments either powder additives of sumac or 90% ethanolic extract of galangal and sumac. antifungal activity of galangal and simac extracts is due to their componant of phenolic and flavonoids which have been domenstrated to their inhibition of cytoplasmic membrane function and DNA gyrase and β-hydroxyacylacyl carrier protein dehydratase activities (Zhang et al., 2010).

Coliform bacteria are considered as indicator organisms that indicate fecal contamination and subsequently insufficient sanitary conditions,they not likely cause illness but their presence indicates presence of pathogenic enteric bacteria (Hachich et al., 2012). Antimicrobial activities of Galangal and sumac against Coliform Group were showed in Table 8, the Coliform Group were detected in control treatment and Powder additives of 1% galangal in burger prepared with brazilin meat and Sudanese meat during storage period, while the ethanolic extract of both galangal and sumac was very effective as antimicrobial against coliform group.

Table 7: Antifungal activities of galangal and sumac against mold and yeast in beef burger

Treat storage period	Burger prepared with brazilin meat						Burger prepared with Sudanese meat					
	Control	Powder additives		Ethanol extract 90%			Control	Powder additives		Ethanol extract 90%		
		1% galangal	1% sumac	500 ppm galangal	500 ppm sumac	250 ppm galangal +250 ppm sumac		1% galangal	1% sumac	500 ppm galangal	500 ppm sumac	250ppm galangal +250 ppm sumac
Zero	6.5×10	4.0×10	ND	ND	ND	ND	4.0 ×10	2.5×10	ND	ND	ND	ND
1M	4.5×10	3.0×10	ND	ND	ND	ND	3.5 ×10	2.0 ×10	ND	ND	ND	ND
2M	4.0×10	3.5×10	ND	ND	ND	ND	3.0 ×10	1.5 ×10	ND	ND	ND	ND
3M	9.0 ×10	7.5×10	ND	ND	ND	ND	6.5 ×10	4.0 ×10	ND	ND	ND	ND
4M	1.5 ×10^2	10.0×10	ND	ND	ND	ND	9.5 ×10	7.0 ×10	ND	ND	ND	ND

Table 8: Antimicrobial activities of galangal and sumac against coliform bacteria in beef burger.

Treat storage period	Burger prepared with brazilin meat						Burger prepared with sudanese meat					
	Control	Powder additives		Ethanol extract 90%			Control	Powder additives		Ethanol extract 90%		
		1% galangal	1% sumac	500 ppm galangal	500 ppm sumac	250 ppm galangal +250 ppm sumac		1% galangal	1% sumac	500 ppm galangal	500 ppm sumac	250 ppm galangal +250 ppm sumac
Zero	4.5×10	3.5×10	ND	ND	ND	ND	3.0 ×10	2.5 ×10	ND	ND	ND	ND
1M	3.5×10	2.5×10	ND	ND	ND	ND	2.5 ×10	1.5 ×10	ND	ND	ND	ND
2M	5.0×10	3.5×10	ND	ND	ND	ND	3.5 ×10	3.0 ×10	ND	ND	ND	ND
3M	7.5×10	6.5×10	ND	ND	ND	ND	6.5 ×10	6.0 ×10	ND	ND	ND	ND
4M	5.0×10^2	9.0×10	ND	ND	ND	ND	8.0 ×10	7.5 ×10	ND	ND	ND	ND

Table 9: Antimicrobial activities of Galangal and sumac against Psychrophilic bacteria in beef burger.

Treat storage period	Burger prepared with Brazilin meat						Burger prepared with Sudanese meat					
	Control	Powder additives		Ethanol extract 90%			Control	Powder additives		Ethanol extract 90%		
		1% galangal	1% sumac	500 ppm galangal	500 ppm sumac	250 ppm galangal +250 ppm sumac		1% galangal	1% sumac	500 ppm galangal	500 ppm sumac	250 ppm galangal +250 ppm sumac
Zero	8.10×10^2	6.0 ×10	ND	ND	ND	ND	3.50×10^2	ND	ND	ND	ND	ND
1M	5.50×10^2	5.00 ×10	ND	ND	ND	ND	4.50×10^2	ND	ND	ND	ND	ND
2M	7.00×10^2	1.40×10^2	ND	ND	ND	ND	6.00×10^2	ND	ND	ND	ND	ND

3M	1.1×10^3	3.50×10^2	ND	ND	ND	ND	9.40×10^2	ND	ND	ND	ND	ND
4M	1.35×10^3	4.50×10^2	ND	ND	ND	ND	1.05×10^3	ND	ND	ND	ND	ND

Table 10: TBA values of beef burger formulated with imported meat with the ethanolic and aqueous extract of Galangal and Sumac.

Treat storage period	Burger prepared with brazilin meat						Burger prepared with Sudanese meat					
	Control	Powder additives		Ethanol extract 90%			Control	Powder additives		Ethanol extract 90%		
		1% galangal	1% sumac	500 ppm galangal	500 ppm sumac	250 ppm galangal +250 ppm sumac		1% galangal	1% sumac	500 ppm galangal	500 ppm sumac	250 ppm galangal +250 ppm gumac
Zero	0.391	0.383	0.365	0.377	0.355	0.342	0.263	0.257	0.245	0.239	0.230	0.228
1M	0.576	0.454	0.435	0.423	0.403	0.399	0. 419	0.345	0.322	0.320	0.311	0.300
2M	0.695	0.539	0.506	0.485	0.454	0.444	0.585	0.493	0.449	0.435	0.423	0.415
3M	0.922	0.731	0.699	0.655	0.623	0.603	0.765	0.621	0.584	0.543	0.522	0.500
4M	1.033	0.828	0.868	0.843	0.785	0.754	0.998	0.811	0.800	0.785	0.745	0.723

Psychrotrophic bacteria are the bacteria that can grow at low temperatures and causing spoilage of meat and meat product by the effect of their extracellular enzymes (Hassan et al., 2020). Psychrotrophic bacteria were detected in control treatment and Powder additives of 1% galangal in burger prepared with brazilin meat and only detected in control treatment in Sudanese meat during the whole storage period, while Powder additives of 1% of sumac and the ethanolic extract of both galangal and sumac was very effective as antimicrobial against Psychrotrophic bacteria as showed in Table 9. Antioxidant activity evaluation of galangal and sumac extracts: Galangal and sumac extracts exhibited antioxidant activity due to thier content of total phenolic and flavonoids compound, where the antioxidant activity was measured on the base of scavenging stable free radical, the DPPH (2, 2-diphenyl-1-picrylhydrazyl) radical as they make the molecules do not dimerize a result of their delocalization of electrons available on the entire molecule (Sánchez et al., 2010). The DPPH radical-scavenging activity of both Galangal and sumac extracts was higher in ethanolic extract than aqueous one, where the antioxidant activity increase with extract concentration. In particular, 90% Ethanol Extract of Galangal and sumac has the highest value; 96.15% and 97.12% respectively as showed in Table 3. Polyphenols presence may be the main cause of this antioxidant activity (Kossah et al., 2010). Kossah et al. (2011), detect that scavenging activity of Chinese sumac fruit extract was 95.42% in concentration of 0.4mg/ml.

The other term used for evaluation of Antioxidant activity of galangal and sumac extracts was the thiobarbituric acid (TBA) test, which assessed the secondary lipid oxidation products (Palamutoğlu and Kasnak, 2019). The obtained result in present work indicate that the TBA values decrease by increase of galangal and sumac extracts concentration in Burger, clearing the significance effectiveness of galangal and sumac extract as an antioxidant in processed meat during the storage period (Cheah and Abu Hasim, 2000). The lowest value of TBA was exhibited by the combination of Galangal and sumac extracts with concentration of 250ppm Galangal +250ppm Sumac in ethanolic extract in Burger prepared with Sudanese meat 0.228, 0.300, 0.415, 0.500, and 0.723 from zero time till the fourth month of storage respectively as showed in Table 10. On the basis of the results from TPC and DPPH assay we can conclude that the galangal and sumac extracts have very effective antioxidant activity in in the processed meat industry.

CONCLUSIONS AND RECOMMENDATION

The present work demonstrate that Galangal and sumac extracts exhibited considrable antioxidant and antimicrobial activities against food spoilage bacteria, yest, and mold where the ethanol extract (90%) gave the best results as antioxidant and antimicrobial activities for both Galangal and sumac extracts. The strongest preservative effect was exhibited by the combination of Galangal and sumac extracts, which could be a result of synergistic actions of specific compounds in the mixed herb as the burger made with added ethanol extract (90%) of Rhus Coriarail (250 ppm) and ethanol extract (90%) of Alpinia Galange (250 ppm) was gave the best results on quality characteristics. Two types of imported meat were used in Egypt to manufacture meat burgers, and they are in the same price range, Sudanese meat in the chilled form, and Brazilian meat in the frozen form. The results showed that the best of them on the quality characteristics is the chilled Sudanese meat burger made from chilled Sudanes meat geve the best result than the burger made from frozen Brazilian meat in terms quality characteristics. Thus, Galangal and sumac extracts have a great potential for used as a natural preservative substitute for chemical

preservatives in the processed meat industry besides the several health benefits for consumers.

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NOVELTY STATEMENT

The present work clarify that natural additives have many advantage over the synthetic substances to avoid their adverse effect in human health. In our work the Galangal and sumac extracts exhibited significant antimicrobial activities against food spoilage bacteria, yest, and mold. The strongest preservative effect was exhibited by the combination of Galangal and sumac extracts, which could be a result of synergistic actions of specific compounds in the mixed herb. Thus, Galangal and sumac extracts have a great potential for used as a natural preservative substitute for chemical preservatives in the processed meat industry besides the several health benefits for consumers.

AUTHOR'S CONTRIBUTION

Equally sharing.

Conflict of interest

The authors have declared no conflict of interest.

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