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Utilization of Rhizome (*Alpinia galanga* L.) in Improvement of Some Quality Attributes of Some Processed Meat

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Abstract

Rhizome Galangal (*Alpinia galanga* L.) is considered a natural source of fiber, minerals and natural antioxidant compounds. This research was performed to study. The effect of adding galangal powder in different proportions (1.5, 2.5, and 3.5 gm.). Also, the effect of adding galangal extract (5%, 10% and 15%) in proportions from the total formula of beef burger patties on chemical, physiochemical, microbiological and sensory characteristics of beef burger patties during the frozen storage period at −18˚C ± 2˚C up to 6 months. The obtained results showed that galangal contained crude fibers (14.00%), Moisture (5.43%), K (1108.13 ppm), Mg (970 ppm), P (729.21 ppm) and Ca (370.81 ppm), while Fe (58.53 ppm) and Na (33.74 ppm) as macro and micro elements. The percent of antioxidants was about (92.60%), phenols (123.81 mg/g) and flavonoids were about (109.77 mg/g) was higher in galangal extract than galangal powder, which was recorded in its antioxidants (72.95%), phenolic (47.66 mg/g) and flavonoids (34.02 mg/g), as well as the improvement of physiochemical quality criteria (pH, protein and TBA values) throughout frozen storage in comparison with the control sample. In addition, galangal inhibited the growth and activity of microbial oxidation in tested prepared product. Also, beef burger patties containing the galangal exhibited a good sensory property and palatable, especially those containing (2.5 and 3.5 g) galangal powder and (10% and 15%) galangal extract, even after storage for 6 months under frozen conditions. The present results are useful for using galangal in the fortification of some meat products to improve nutritionally and healthy safe.

Keywords

Antioxidant, *Alpinia galanga* L., TBA, Beef Burger, Microbiology, Sensory Evaluation

1. Introduction

Plants have been used throughout the world as drugs and remedies for various diseases since time immemorial. It's used because of its antimicrobial constituents, which are due to compounds synthesized in the secondary metabolism of the plant [1]. Medicinal plants of rhizomatous herb (*Alpinia galanga* L.) are distributed broadly throughout the tropics, especially in Southeast Asia and various parts of India. [2] Galangal has the phytochemicals such as galangal beta-Sitosterol, Quercetin, and Emodin. They are also the source of iron, vitamins A and C, sodium [3]. Terpinen-4-ol is one of the most active compounds of galangal and this plant also contains saponin, terpenoids, phenolic, flavonoids, carbohydrates, alkaloids, glycosides, phytosterols and volatile oils [4]. It's used in many regions for relieving toothache, muscular swelling, rheumatism, and abdominal pain [5], and also (*Alpinia galanga* L.) is one of the most important families (*Zingiberaceae*) members which comprise rhizomes. These rhizomes are used in folklore medicine for treating catarrh, rheumatism, bad breath, bronchial ulcers, cough, throat infections and digestive system problems; reported the presence of complex chemical profiles in Alpinia species [6], which has been used as food spices in both Chinese medicines since ancient times [1] evaluates the active components responsible for antimicrobial activity with different solvent systems like methanol, acetone and diethyl ether in different parts (root, rhizome and leaf) and also, compare their activity towards the human pathogens. [7] Reported that methanolic and aqueous extracts of galanga showed significant free radical scavenging activity against DPPH radical, had strong superoxide anion scavenging activity and also had metal chelating activity. Meat products are rich sources of nutrients, providing good quality animal proteins, essential amino acids, fatty acids, minerals and vitamins particularly B-complex [8]. The breakdown of proteins, fats and carbohydrates in meat results in the development of off-odors, off-flavors and slim formation which make the meat objectionable for human consumption [9]. Meat is one of the most sensitive foods against microbiological spoilage due to its physical and chemical properties microbe. Meat has an important place in daily nutrition because of its rich proteins, essential minerals and trace elements. It is also important because it also meets the need for vitamin B [10]. Moreover, oxidative processes apart from ail spoilage in meat and meat products are the main cause of their quality loss in term of texture, color, flavor, nutritive value and safety [11]. Lipid oxidation which causes quality loss of meat and meat products, changes in the odor, color, texture and nutritional value of the product, while toxic components appear [12]. In addition to the undesired taste and odor of meat products, the product quality decreases with the reaction of oxidized lipid products with carbohydrates, proteins and vitamins in meat. *A. galangal* has been used as a food additive in Thailand and other countries in Asia for a long time [6]. Galanga extract may be a possible additive for meat and meat products. The potent antioxidant activity of curcuminoids isolated from *A. galanga* was reported by [13] [14]. The antioxidative effect of

galangal in raw and cooked minced beef during storage at 4˚C was reported by [13]. It was found to delay the induction period of lipid oxidation and affect microbial growth in cooked beef. The application of dried galangal powder and its ethanolic extracts have been demonstrated to enhance the oxidative stability of meat. Shelf life is one of the most important factors affecting the quality and acceptability of meat and meat products. Meat has a limited shelf life due to its unique physical and chemical structure. Oxidation is one of the most important reasons for the limited shelf life of the meat [15]. The shelf life of meat products is shortened due to lipid oxidation and microbial spoilage, as these will reduce the quality and nutritional value of meat products [16] [17] and become unpalatable in terms of sensory properties or harmful to the consumer. Thus, food preservatives have been used for centuries to extend shelf life via their antioxidant or antimicrobial activities [18]. Thus, the aim of this investigation is to improve quality attributes, and extend the shelf life and nutritional value of minced meat fortified with *A. galanga*.

2. Materials and Methods

2.1. Materials

Plant Materials

Dried rhizomes of galangal (*Alpinia galanga* L.) were prepared from a local market near Food Technology Research Institute, Giza, Government.

2.2. Methods

2.2.1. Preparation of Extract

The rhizomes of galangal were cleaned and cut into small slices with (Type: Moulinex double force FP 822 - 220 V—60 Hz—1000 W—250 ml France), then the slices were ground. Using an electric grinder (Type: Moulinex MFP 626 - 220 V—50 - 60 Hz—1000 W—250 ml France) to a powder (40 µm particle size), Ground rhizomes were dipping hot water (60˚C) (1:100 w/v) in a dark bottle for 48 hr. at ambient temperature (25 ± ˚C) to obtain extracts, then extract was filtered by filter paper (Whatman 1). The water solution was removed under reduced pressure using rotary evaporator at temperature not exceeding 50˚C and the residue evaporates at 55˚C in oven under vacuumed. The obtained extracts were stored in the refrigerator (4˚C) till chemical analyses [19].

2.2.2. Meat Source and Preparation of Beef Burger

About 8 kg. of beef chuck were obtained 24 h postmortem butcher shop at Giza, Egypt. Conditions; beef samples were then frozen at −20˚C until processing into a patty on the day of purchase. After thawing, they were cut into small cubes and minced twice using (Moulinex double force FP 722 - 220 V—60 Hz—1000 W—250 ml France) first minced through a 6 mm "coarse grinding". Beef patties were prepared without seasonings using a simple traditional formulation: 75% minced beef included fat, 10% onion, garlic 1%, 2% salt, 11.5% starch in control [20] while, the proportions of adding starch vary according to the difference in

adding galangal, whether powder or extract. These ingredients were mixed together by hand for 5 min; using gloved fingers to avoid cross contamination of minced beef. Afterward, iced water (10%; v/w) was added and, re-minced through a 3-mm hole "fine grinding" to ensure uniform distribution of the ingredients. The homogenized meat mixture obtained was divided into four batches (3.0 kg each) to prepare the experimental treatments, packed in low density polyethylene bags and put in a freezer for 30 min before treatments [21].

2.2.3. Beef Burger Treatments

Each of the previous batches was mixed separately for 8 mins with the appropriate antioxidants and antimicrobials, was added to the raw minced beef and mixed thoroughly; all other meat batches were formulated to contain the same amount of water for uniformity. The first batch was designated as control (C; meat without any extract), while the other three treatments contained galangal with different concentrations of 1.2, 2.5, 3.5 g powder and 5%, 10%, 15% extract [13] [22] the concentrations of extracts; which are sensorial acceptable and also effective against bacterial load, were based on our primary studies, and also showed the best antioxidative and antimicrobial effect in the studies of [23] [24] on minced meat patties.

The formula of beef burger:

Burger patty 60 gm—meat 75%—onion 10%—garlic 1%—salt 1%—starch 11.5%.

2.2.4. Methods of Analysis

1) Proximate composition in terms of moisture, ash, crude lipid and total nitrogen (by applying the Micro-Kjeldahl method) and total carbohydrate (by difference) of galangal *A. galanga* were determined according to the [25].

2) Mineral content, iron (Fe), zinc (Zn), calcium (Ca), potassium (K) and phosphorus (P) were determined using by Agilent Technologies (model 4210 MPAES), atomic absorption spectrophotometer according to in [25].

3) Determination of radical scavenging activity in galangal:

The free radical scavenging effect of each extract was assessed by the discoloration of a methanolic solution of 2, 2-diphenyl-1-picrylhydrazyl (DPPH) radical (violet color) according to the method described [26]

4) Determination of total phenolic compounds in galangal:

The concentrations of total phenolic compounds in the methanolic extract (1:10) were determined by using folin-ciocalteu's reagent according to [27]

5) Determination of total flavonoid in galangal:

The calorimetrically method was performed as described by [28] was used to determine total flavonoids contents.

6) Determination of (TBARS) of in galangal:

A thiobarbituric acid reactive substance (TBARS) was determined according to the method proposed by [29]. TBARS content was expressed as mg of malondialdehyde (MDA)/kg meat. For pH determination 10 g of ground beef patty

samples were homogenized in 100 mL distilled water for 1 min in a warring blender, and the pH values: of the slurry were measured at room temperature (25 ± ˚C) using pH meter (JENWAY, 3510; UK) standardized at pH 4 and 7, as described by [30].

7) Microbiological analysis:

Microbiological status of prepared beef burger patties samples (immediately after formulation) were assessed including total bacterial count using Plate Count Agar, incubation at 35˚C - 37˚C for 24 - 48 hour mold and yeast count using Potato Dextrose Agar, incubation at 20˚C - 25˚C for 2 - 5 days and psychrophilic bacteria count using Plate Count Agar and incubation at 5˚C - 7˚C for 5 - 7 days [31] [32] while Coliform bacteria contamination was detected using presumptive test using Mac-Conkey broth and incubation at 35˚C - 37˚C for 24 - 48 h [33] Yeasts and molds: the procedures of [34] were followed for the determination of yeast and mold counts using potato-dextrose agar medium. The plates were incubated at 20˚C - 25˚C for 5 days. Colonies were counted after 3 and 5 days, and reported as yeasts and molds count per gram.

2.2.5. Sensory Evaluation of Burger

Sensory attributes of the burger, such as color, odor, texture, taste, tenderness, appearance, and overall palatability, were determined and the evaluation was carried out by 10 Food Tech judges. Rec. Using a 10-point pleasure scale. Samples receiving an overall quality score of 7 or above were considered palatable, according to the method of [35] [36].

2.2.6. Statistical Analysis

Statistical analyses: All analyses were performed in triplicate and average values were calculated. The results were expressed: Fisher's least significant difference (LSD) was carried out using SPSS according to [37].

3. Results and Discussion

3.1. Chemical Composition of Galangal

The chemical composition of galangal rhizomes is presented in this **Table 1**. Showed that the percentages of carbohydrates and fibers are the highest in its chemical composition, where it was recorded carbohydrates (79.02 %) and fiber (14.00%), respectively. as recorded moisture and ash (5.43%), (3.16%), respectively While protein (2.43%) and fat (1.38%) were recorded. Where fat is considered the lowest percentage in the chemical composition of galangal these results are in harmony with [19].

3.2. Mineral Contents of Galangal Powder on Dry Weight Basis

The Minerals contents (Ca, K, Cu, Mg, Zn, P, Na, Fe and P) of galangal powder were determined and listed in **Table 2**. From the obtained data it could be observed that, the galangal contained a high amount of K, Mg, P and Ca (1108.13, 970.00, 729.21 and 370.81 ppm), respectively, galangal also contains an appropriate

Table 1. The proximate analysis of galangal powder (% based on dry weight).

Chemical composition (%)	G. powder
Moisture	5.43 ± 0.31[c]
Ash	3.16 ± 0.98[d]
Fat	1.38 ± 0.44[f]
Fiber	14.00 ± 1.80[b]
Protein	2.43 ± 0.31[e]
Carbohydrates	79.02 ± 2.61[a]

Mean ± SD; with different superscripts in a row differ significantly ($p < 0.05$). Values ± SE; in the same line with different letters are significantly different at ($p < 0.05$). G.; galangal; Carbohydrates were calculated by difference {100—(Protein + Fats + Ash and Crude fiber)}.

Table 2. Minerals content of galangal powder on dry weight bases.

Content (ppm)	G. (powder)
Ca	370.81 ± 3.2[d]
K	1108.13 ± 4.3[a]
Cu	3.01 ± 1.3[h]
Mg	970.00 ± 0.11[b]
Zn	30.61 ± 6.5[g]
Na	33.74 ± 4.5[f]
Fe	58.53 ± 14.80[e]
P	729.21 ± 360[c]

Mean ± SD; with different superscripts in a row differ significantly ($p < 0.05$). Values ± SE; in the same line with different letters are significantly different at ($p < 0.05$). G.; galangal.

proportion of Fe, Na and Zn (58.53, 33.74 and 30.61 ppm), respectively, while the lowest percentage of Cu (3.01 ppm) the galangal powder could be considered as a good source for minerals and therefore it could be utilized galangal powder in food fortification these results are in symmetry with [38].

3.3. Determination of Total Antioxidant Contents, Total Phenolic and Total Flavonoids

Antioxidants are the most frequent and broadly disseminated group of which are ever present in fruits, vegetables, Spices, medicinal and aromatic plants [39] in Table 3. Antioxidant activities of the samples were studied using the DPPH where galangal extract recorded a higher percentage of antioxidants (92.60%) compared to powdered galangal, (72.95%). Also, where it scored the percentage of phenols (123.81 mg/g) and flavonoids (109.77 mg/g) in galangal extract was higher than that of powder galangal (47.66 mg/g) and (34.02 mg/g) respectively, the results are in agreement with those recorded by [40].

Table 3. Phytochemical properties of galangal (powder) and (extract).

Phytochemical properties	Antioxidant activity	
	G. (powder)	G. (extract)
Total phenolic as Gallic acid (mg/g)	47.66 ± 1.61[b]	123.81 ± 1.52[a]
Total flavonoids quercetin acid (mg/g)	34.02 ± 1.58[b]	109.77 ± 1.50[a]
antioxidant activity %	72.95 ± 4.42[b]	92.60 ± 1.69[a]

Mean ± SD; with different superscripts in a row differ significantly ($p < 0.05$). Values ± SE; in the same line with different letters are significantly different at ($p < 0.05$). G.; galangal.

3.4. Physiochemical Properties of Beef Burgers as Affected by Substitution Levels of Galangal (Powder) and Frozen Storage Periods at −18˚C ± 2˚C for 6 Months

The fresh beef burger used in this study was analyzed immediately upon receipt at the laboratory for physical analyses, as well as immediately after manufacturing (zero-time analyses), and then after 1, 3 and 6 months of frozen storage at −18 ± 2˚C. The TBA value has been widely used to measure lipid oxidation in meat products. There were significant differences between the TBA values of patty samples ($P < 0.05$) Table 4. Treatment with galangal (powder) resulted in lower TBA values at each evaluation period. Similar to [41] showed the antioxidant activity of freeze-dried extracts from galangal (powder) in ground beef patties. All treatment groups showed a significant ($p < 0.05$) decrease in TBA values during the storage period. Natural antioxidants are believed to break free radical chains of oxidation by donation of hydrogen from the phenolic groups, thereby forming a stable end product. The resultant beef burger as a control sample and their formulae showed that the protein decreased by increasing the storage period but, the decrease was not large. The decrease of total protein in the beef burger and their formulae may be due to the activation effect of microbial load which may cause protein hydrolyzing their formulae may be related to some other changes in different chemical constituents [42]. From the obtained results, it could be noticed that, beef burger patties recorded significant decrease ($p \leq 0.05$) in pH values when compared with the control sample. On the other hand, the pH value increased continuously in all beef burger throughout frozen storage. The increment rate was slight decreased as the addition level of galangal (powder) increase, whereas, the control sample exhibited the highest pH value at any time of frozen storage. The increment of pH values for all tested beef burger throughout frozen storage may be attributed mainly to breakdown of beef burgers protein during storage resulting in formation of some basic compounds such as volatile basic nitrogen compounds, amines and hydrogen sulfide, leading to increase the pH value [22].

3.5. Physiochemical Properties of Beef Burgers as Affected by Substitution Levels of Galangal (Extract) and Frozen Storage Periods at −18˚C ± 2˚C for 6 Months

It seems from Table 5. That TBA values of the beef burger with the added either

Table 4. Effect of addition of different proportions galangal (powder) on physiochemical properties of beef burgers during frozen storage at −18˚C for 6 months.

Storage period	Thiobarbituric acid value (TBA) mg malonaldehyde/kg sample			
	Control	1.5%	2.5%	3.5%
Zero time	0.92 ± 0.02[a]	0.75 ± 0.15[b]	0.58 ± 0.15[c]	0.53 ± 0.2[d]
Month	1.16 ± 0.15[a]	0.97 ± 0.02[b]	0.61 ± 0.015[c]	0.47 ± 0.20[d]
3 months	1.53 ± 0.02[a]	1.3 ± 0.021[b]	0.85 ± 0.15[c]	0.75 ± 0.15[d]
6 months	2.04 ± 0.20[a]	1.84 ± 0.016[b]	1.17 ± 0.20[c]	0.9 ± 0.021[d]
		Protein		
Zero time	19.67 ± 0.68[a]	19.66 ± 0.03[b]	19.56 ± 0.04[c]	19.48 ± 0.03[d]
Month	19.52 ± 0.13[a]	19.48 ± 0.12[b]	19.44 ± 0.13[c]	19.37 ± 0.9[d]
3 months	18.96 ± 0.02[a]	18.86 ± 0.02[b]	18.81 ± 0.03[c]	18.76 ± 0.04[d]
6 months	18.82 ± 0.04[a]	18.75 ± 0.45[b]	18.74 ± 0.12[c]	18.68 ± 0.03[d]
		PH value		
Zero time	6.94 ± 0.01[a]	6.92 ± 0.01[d]	6.85 ± 0.02[c]	6.75 ± 0.01[d]
Month	7.02 ± 0.01[a]	7.02 ± 0.01[d]	6.93 ± 0.15[c]	6.86 ± 0.15[d]
3 months	7.14 ± 0.02[a]	7.11 ± 0.15[d]	7.10 ± 0.38[c]	7.06 ± 0.15[d]
6 months	7.21 ± 0.03[a]	7.16 ± 0.04[d]	7.14 ± 0.15[c]	7.11 ± 0.010[d]

Mean ± SD; with different superscripts in a row differ significantly ($p < 0.05$). Values ± SE; in the same line with different letters are significantly different at ($p < 0.05$).

Table 5. Effect of addition of different proportions galangal (extract) on physiochemical properties of beef burgers during frozen storage at 18˚C - 2˚C for 6 months.

Storage period	Thiobarbituric acid value (TBA) mg malonaldehyde/kg sample			
	Control	5%	10%	15%
Zero time	0.92 ± 0.02[a]	0.74 ± 0.02[b]	0.57 ± 0.15[c]	0.51 ± 0.01[d]
month	1.16 ± 0.15[a]	0.95 ± 0.15[b]	0.72 ± 0.21[c]	0.60 ± 0.15[d]
3 months	1.53 ± 0.02[a]	1.27 ± 0.021[b]	0.84 ± 0.10[c]	0.72 ± 0.02[d]
6 months	2.04 ± 0.20[a]	1.84 ± 0.015[b]	1.15 ± 0.020[c]	0.90 ± 0.01[d]
		Protein		
Zero time	19.67 ± 0.68[a]	19.56 ± 0.31[b]	19.50 ± 0.05[c]	19.46 ± 0.06[d]
month	19.52 ± 0.13[a]	19.38 ± 0.13[b]	19.35 ± 0.31[c]	19.32 ± 0.13[d]
3 months	18.96 ± 0.02[a]	18.75 ± 0.02[b]	18.71 ± 0.30[c]	18.67 ± 0.04[d]
6 months	18.82 ± 0.04[a]	18.65 ± 0.04[b]	18.61 ± 0.03[c]	18.58 ± 0.03[d]
		PH value		
Zero time	6.94 ± 0.01[a]	6.91 ± 0.01[b]	6.83 ± 0.02[c]	6.72 ± 0.01[d]
month	7.02 ± 0.01[a]	7.01 ± 0.01[b]	6.91 ± 0.01[c]	6.85 ± 0.03[d]
3 months	7.14 ± 0.02[a]	7.12 ± 0.03[b]	7.07 ± 0.15[c]	7.04 ± 0.01[d]
6 months	7.21 ± 0.03[a]	7.17 ± 0.05[b]	7.11 ± 0.01[c]	7.08 ± 0.02[d]

Mean ± SD; with different superscripts in a row differ significantly ($p < 0.05$). Values ± SE; in the same line with different letters are significantly different at ($p < 0.05$).

galangal (extract) was significantly ($p < 0.05$) lower than control during the period of the experiment. Moreover, it was also noticed that the addition of galangal (powder) is more effective as an antioxidant as compared with the addition of galangal (extract). Similarly, [43] reported that galangal extract as an antioxidant was effective against TBA formation when incorporated into the meat during frozen storage. It was also observed that there was a decrease in the percentage of protein for the burger to which galangal extract was added, where the percentage of decrease was relatively higher than the burger to which galangal powder was added during storage periods [44]. Lower ($p < 0.05$) pH was noted in the raw beef burger samples with galangal (extract) compared to non-additive control. In the present study, the lower pH in the treatment samples might be due to the strong activity of bioactive compounds from the galangal (extract). An increase in the pH value was also observed during storage periods [45].

3.6. Changes in Microbiological Load of Beef Burger Incorporated with Galangal (Powder) during Frozen Storage

In this study, frozen storage (at −18˚C for 6 month) stability for microbiological aspects of beef burger patties samples, including total Plate count (T-C) *Escherichia coli* (*E-coli*), mold and yeast counts (M-Y), *Salmonella spp.* (*Salm.*) and *Staphylococcus aureus* (*S. aureus*) were examined periodically at month intervals during frozen storage for 1, 3 and 6 months. Through the results obtained from Table 6. From statistics, it could be noticed that significant differences ($P \leq 0.05$) in microbial counts (Total Plate count, Escherichia coli, mold and yeast counts, *Salmonella spp.* and *Staphylococcus aureus*) between all beef burger patties samples at zero time of frozen storage, and you may notice that there is no growth of salmonella bacteria at the time of zero and over storage periods. After that, the counts of the former microbial were recorded a significant increase ($P \leq 0.05$) throughout the period of freezing storage 1, 3 and 6 months as the result of their adaptation to freezing conditions. On the other hand, it is noticeable that the microbial load decreases with the increase in the addition, as the percentage of addition 3.5% recorded the highest decrease in the microbial count compared to the control, it could be mainly attributed to the antimicrobial and antioxidant properties phenols and flavonoids. It is worth noting that the microbial quality standards tested for beef burger were within the permissible limits of the Egyptian [22] [46].

3.7. Changes in Microbiological Load of Beef Burger Incorporated with Galangal (Extract) during Frozen Storage

The use of galangal extract in this study was to inhibit the growth of microorganisms during the storage period; the results are shown in a Table 7. Those significant differences ($p \leq 0.05$) high in galangal extract in microbial counts (*Total Plate count*, *Escherichia coli*, *mold and yeast counts*, *Salmonella ssp. and Staphylococcus aureus*) between all beef burger patties samples at zero time of frozen storage, also is no growth of salmonella bacteria at the time of zero and

Table 6. Changes in microbiological (log cfu/g) properties of beef burger incorporated with galangal (powder) during frozen storage period at 18˚C - 2˚C.

Microbiological content	Storage zero time			
	addition levels of galangal powder			
	Control	1.5%	2.5%	3.5%
T-C	5.20 ± 0.28[a]	2.65 ± 3.74[b]	ND	ND
E-coli	1.00 ± 1.41[a]	ND	ND	ND
M-Y	5.00 ± 0.00[a]	5.00 ± 0.00[b]	2.50 ± 3.53[c]	ND
Salm.	ND	ND	ND	ND
S. aureus	2.10 ± 0.17[a]	ND	ND	ND
Storage period 1 month				
T-C	5.50 ± 0.00[a]	5.15 ± 0.21[b]	2.50 ± 3.53[c]	ND
E-coli	1.85 ± 0.07[a]	ND	ND	ND
M-Y	5.15 ± 0.21[a]	5.00 ± 0.00[a]	2.75 ± 3.88[b]	ND
Salm.	ND	ND	ND	ND
S. aureus	2.15 ± 0.21[a]	ND	ND	ND
Storage period 3 month				
T-C	5.65 ± 0.07[a]	5.30 ± 0.42[b]	2.80 ± 3.95[c]	2.50 ± 3.53[d]
E-coli	2.00 ± 0.00[a]	ND	ND	ND
M-Y	5.50 ± 0.14[a]	5.15 ± 0.21[b]	5.00 ± 0.00[c]	2.50 ± 3.53[d]
Salm.	ND	ND	ND	ND
S. aureus	2.50 ± 0.00[a]	1.25 ± 1.76[b]	1.00 ± 1.41[c]	ND
Storage period 6 month				
T-C	5.85 ± 0.07[a]	5.30 ± 0.42[b]	5.00 ± 0.00[c]	2.65 ± 3.74[d]
E-coli	2.55 ± 0.07[a]	ND	ND	ND
M-Y	5.80 ± 0.14[a]	5.25 ± 0.35[b]	5.15 ± 0.21[b]	2.50 ± 3.53[c]
Salm.	ND	ND	ND	ND
S. aureus	2.65 ± 0.07[a]	2.15 ± 0.21[b]	2.00 ± 0.00[c]	1.20 ± 1.69[d]

Mean ± SD; with different superscripts in a row differ significantly ($p < 0.05$). Values ± SE; in the same line with different letters are significantly different at ($p < 0.05$). ND: not detected. *T-C*: *Total Plate count*; *E-coli*: *Escherichia coli*; *M-Y*: *molds and Yeasts count*; *Salm.*: *Salmonella spp. Staph.*: *Staphylococcus aureus.*

over storage periods. Then, the counts of the former microbial were recorded high significant increase ($p \leq 0.05$) throughout period of freezing storage 1, 3 and 6 month as the result of their adaptation on freezing conditions. It is noticeable that the microbial load decreases with the increase in the addition, as the percentage of addition 3.5% recorded the noticeable increase decrease in the microbial count compared to the control; it could be mainly attributed to the antimicrobial and antioxidant properties of phenols and flavonoids. It worth to note

Table 7. Changes in microbiological (log cfu/g) properties of beef burger incorporated with galangal (extract) during frozen storage at −18˚C.

Microbiological content	Storage zero time			
	addition levels of *Alpinia galanga* extract			
	Control	5%	10%	15%
T-C	5.20 ± 0.28[a]	5.00 ± 0.00[b]	2.50 ± 3.53[c]	ND
E-coli	1.00 ± 1.41[a]	ND	ND	ND
M-Y	5.00 ± 0.21[a]	5.00 ± 0.00[a]	2.50 ± 3.53[c]	2.50 ± 3.53[c]
Salm.	ND	ND	ND	ND
S. aureus	2.10 ± 0.17[a]	1.00 ± 1.41[b]	ND	ND
Storage period 1 month				
T-C	5.50 ± 0.00[a]	5.00 ± 0.00[b]	5.00 ± 0.00[b]	5.00 ± 0.00[b]
E-coli	1.85 ± 0.07a	ND	ND	ND
M-Y	5.15 ± 0.21[a]	5.00 ± 0.00[b]	2.50 ± 3.53[c]	2.50 ± 3.53[c]
Salm.	ND	ND	ND	ND
S. aureus	2.15 ± 0.21[a]	1.00 ± 1.41[b]	1.00 ± 1.41[b]	ND
Storage period 3 month				
T-C	5.65 ± 0.07[a]	5.35 ± 0.07[c]	5.15 ± 0.21[b]	5.15 ± 0.21[b]
E-coli	2.00 ± 0.00[a]	1.00 ± 1.41[b]	1.00 ± 1.41[b]	ND
M-Y	5.50 ± 0.14[a]	5.02 ± 0.35[b]	5.00 ± 0.00[c]	2.50 ± 3.53[d]
Salm.	ND	ND	ND	ND
S. aureus	2.50 ± 0.00[a]	2.00 ± 0.00[b]	1.00 ± 1.41[c]	ND
Storage period 6 month				
T-C	5.85 ± 0.07[a]	5.65 ± 0.07[b]	5.50 ± 0.00[c]	5.30 ± 0.00[d]
E-coli	2.55 ± 0.07[a]	2.40 ± 0.00[b]	2.00 ± 0.00[c]	1.00 ± 1.41[d]
M-Y	5.80 ± 014[a]	5.15 ± 0.21[a]	5.15 ± 0.21[a]	2.80 ± 0.14[d]
Salm.	ND	ND	ND	ND
S. aureus	2.65 ± 0.07[a]	2.15 ± 0.21[b]	1.15 ± 1.62[c]	1.00 ± 1.41[d]

Mean ± SD; with different superscripts in a row differ significantly ($p < 0.05$). Values ± SE; in the same line with different letters are significantly different at $p < 0.05$. ND: not detected. *T-C*: *Total Plate count*; *E-coli*: *Escherichia coli*; *M-Y*: *molds and Yeasts count*; *Salm.*: *Salmonella spp. Staph.*: *Staphylococcus aureus.*

that the microbial quality standards tested for beef burger were within the permissible limits of [47]. By comparing Table 6 and Table 7 of galangal powder and galangal extract, the table of galangal powder recorded a lower number of microbial growths during storage periods than galangal extract percentage of Even in the high percentage of adding galangal extract 15%.

3.8. Sensory Evaluation of Beef Burger with Galangal Powder Added

The organoleptic properties of meat products were greatly affected by the ingre-

dients used in processing treatments and by storage conditions. They also correlated significantly with the physiochemical, chemical and microbiological quality criteria of these products. Sensory evaluation, together with estimation criteria have been used extensively to assess the quality of meat products. Therefore, the organoleptic evaluation was carried out in order to evaluate the color, taste, odor, tenderness, texture, appearance and overall acceptability of beef burger treatments as affected by addition of galangal powder at different levels of (1.5%, 2.5% and 3.5%) during frozen storage at −18˚C up to 6 months compared with the control samples; you may notice from the sensory evaluation Table 8. That there was ($p \leq 0.05$) alteration in all sensory quality criteria between beef burger samples containing galangal powder with different percentages of addition compared to the control. While, the increment of add level 3.5% in the product caused decreased sensory properties of beef burger patties when compared with the control sample over different storage periods but, the odor recorded the significant highest rating on the level of addition percentages and at different storage periods. On the other hand, the percentage of addition, 5%, was the closest to the control, and sometimes it was the best in many sensory characteristics over storage periods. The above-mentioned data are in accordance with those obtained by [48].

Table 8. Sensory properties of beef burgers as affected by substitution levels of galangal (powder) and frozen storage period at −18˚C.

Storage period month	Substitution levels of galangal powder (M ± SE) Storage period			
	Color			
	Control	1.5%	2.5%	3.5%
Zero time	9.25 ± 0.50^{a}	8.93 ± 0.06^{b}	8.80 ± 0.01^{c}	8.67 ± 0.03^{d}
Month	8.96 ± 0.63^{a}	8.86 ± 0.02^{b}	8.78 ± 0.01^{c}	8.66 ± 0.02^{d}
3 months	8.86 ± 0.10^{a}	8.82 ± 0.02^{b}	8.74 ± 0.11^{c}	8.60 ± 0.13^{d}
6 months	8.81 ± 0.01^{a}	8.61 ± 0.10^{b}	8.60 ± 0.20^{c}	7.42 ± 0.02^{d}
	Odor			
Zero time	8.75 ± 0.50^{d}	8.95 ± 0.06^{c}	9.03 ± 0.15^{b}	9.07 ± 0.01^{a}
Month	8.73 ± 0.10^{d}	8.93 ± 0.10^{c}	9.01 ± 0.01^{b}	9.05 ± 0.01^{a}
3 months	8.60 ± 0.06^{d}	8.89 ± 0.07^{c}	8.90 ± 0.15^{b}	9.00 ± 0.15^{a}
6 months	8.58 ± 0.03^{d}	8.84 ± 0.03^{c}	8.86 ± 0.06^{b}	8.88 ± 0.06^{a}
	Texture			
Zero time	8.99 ± 0.01^{a}	8.94 ± 0.06^{b}	8.86 ± 0.20^{c}	8.83 ± 0.01^{d}
Month	8.92 ± 0.10^{a}	8.89 ± 0.03^{b}	8.84 ± 0.15^{c}	8.82 ± 0.01^{d}
3 months	8.86 ± 0.02^{a}	8.84 ± 0.06^{b}	8.80 ± 0.25^{c}	8.74 ± 0.04^{d}
6 months	8.84 ± 0.15^{a}	8.76 ± 0.05^{b}	8.65 ± 0.51^{c}	7.48 ± 0.07^{d}
	Taste			
Zero time	8.52 ± 0.01^{d}	8.88 ± 0.05^{a}	8.86 ± 0.10^{b}	8.84 ± 0.02^{c}
Month	8.50 ± 0.57^{d}	8.86 ± 0.01^{a}	8.84 ± 0.10^{b}	8.82 ± 0.15^{c}

Continued

3 months	8.48 ± 0.03[d]	8.83 ± 010[a]	8.78 ± 0.03[b]	8.70 ± 0.03[c]
6 months	8.43 ± 0.03[d]	8.74 ± 0.06[a]	8.12 ± 0.56[b]	7.22 ± 0.02[c]
		Tenderness		
Zero time	8.92 ± 0.06[a]	8.87 ± 0.15[b]	8.85 ± 0.15[c]	8.76 ± 0.11[d]
Month	8.86 ± 0.02[a]	8.85 ± 0.11[b]	8.84 ± 0.02[c]	8.75 ± 0.10[d]
3 months	8.81 ± 0.01[a]	8.80 ± 0.03[b]	8.73 ± 0.04[c]	8.64 ± 0.01[d]
6 months	8.51 ± 0.20[a]	8.01 ± 0.01[b]	7.72 ± 0.02[c]	7.47 ± 0.41[d]
		Appearance		
Zero time	8.92 ± 0.02[a]	8.98 ± 0.01[b]	8.84 ± 0.03[c]	8.78 ± 0.15[d]
Month	8.91 ± 0.01[a]	8.90 ± 0.14[b]	8.82 ± 0.32[c]	8.76 ± 0.11[d]
3 months	8.82 ± 0.01[a]	8.80 ± 0.40[b]	8.70 ± 0.02[c]	8.66 ± 0.04[d]
6 months	8.65 ± 0.04[a]	8.52 ± 0.25[b]	7.62 ± 0.04[c]	7.64 ± 0.03[d]
		Overall, acceptably		
Zero time	8.97 ± 0.01[a]	8.99 ± 0.05[b]	8.90 ± 0.01[c]	8.88 ± 0.01[d]
Month	8.89.0.10[a]	8.88 ± 0.10[b]	8.87.020[c]	8.85 ± 0.12[d]
3 months	8.77 ± 0.25[a]	8.85 ± 0.03[b]	8.76 ± 0.06[c]	8.70 ± 2.26[d]
6 months	8.33 ± 0.28[a]	8.67 ± 0.26[b]	7.51 ± 0.15[c]	7.40 ± 0.14[d]

Mean ± SD; with different superscripts in a row differ significantly ($p < 0.05$). Values ± SE; in the same line with different letters are significantly different at ($p < 0.05$).

3.9. Sensory Evaluation of Beef Burger with Galangal Extract

Sensory evaluation of beef burgers supplemented with galangal extract revealed high quality as shown in **Table 9**. The sensory characteristics that were obtained from adding 15% of galangal extract to beef burger were odor, texture and tenderness of tenderness, where the highest significant rating was recorded on the level of addition percentages and in different storage periods the percentage of 5% of galangal extract added to the beef burger recorded the highest quality ratios compared to the control. Also, there is ($p \leq 0.05$) a difference in sensory quality parameters in all beef burger samples added to galangal extract in different percentages of addition compared to the control over different storage periods. These results are in harmony with [13]. It was noticed from comparing **Table 8** and **Table 9** the sensory evaluation of the burger added to galangal powder and extracting the values obtained in evaluating the color better in the burger to which galangal powder was added in all the additions and over the storage periods, while the values of smell, texture and freshness were recorded higher in the burger to which the extract was added, where the highest values were recorded in percentages The addition and storage periods, on the other hand, the taste of the burger with galangal powder added to it was better, as the percentage of %5 addition was recorded as the highest values, better than the control.

Table 9. Sensory properties of beef burgers as affected by substitution levels of galangal (extract) and frozen storage period at −18˚C.

Storage period month	Substitution levels of galangal extract (M ± SE) Storage period			
	Color			
	Control	5%	10%	15%
Zero time	9.25 ± 0.50[a]	8.87 ± 0.10[b]	8.79 ± 015[c]	7.70 ± 0.02[d]
Month	8.96 ± 0.63[a]	8.81 ± 010[b]	8.76 ± 0.15[c]	7.63 ± 0.02[d]
3 months	8.86 ± 0.10[a]	8.79 ± 0.02[b]	8.73 ± 0.03[c]	7.60 ± 0.03[d]
6 months	8.81 ± 0.01[a]	8.68 ± 0.20[b]	8.65 ± 0.03[c]	7.53 ± 0.46[d]
	Odor			
Zero time	8.75 ± 0.50[d]	9.03 ± 010[c]	9.05 ± 0.48[b]	9.08 ± 010[a]
Month	8.73 ± 0.10[d]	8.84 ± 0.10[c]	8.92 ± 0.06[b]	9.00 ± 0.05[a]
3 months	8.60 ± 0.06[d]	8.78 ± 0.15[c]	8.90 ± 0.07[b]	8.91 ± 0.08[a]
6 months	8.58 ± 0.03[d]	8.70 ± 0.08[c]	8.85 ± 0.08[b]	8.88 ± 0.15[a]
	Texture			
Zero time	8.99 ± 0.01[d]	9.20 ± 0.06[c]	9.24 ± 0.05[b]	9.30 ± 0.10[a]
Month	8.92 ± 0.10[d]	8.91 ± 0.06[c]	8.96 ± 0.07[b]	9.10 ± 017[a]
3 months	8.86 ± 0.02[d]	8.82 ± 0.01[c]	8.88 ± 0.16[b]	9.00 ± 0.15[a]
6 months	8.84 ± 0.15[d]	8.70 ± 0.43[c]	8.76 ± 0.02[b]	8.81 ± 0.02[a]
	Taste			
Zero time	8.52 ± 0.01[c]	8.86 ± 0.05[a]	8.83 ± 0.15[b]	8.81 ± 0.15[d]
Month	8.50 ± 0.57[c]	8.84 ± 0.10[a]	8.82 ± 0.01[b]	8.78 ± 0.02[d]
3 months	8.48 ± 0.03[c]	8.75 ± 0.04[a]	8.80 ± 0.02[b]	7.76 ± 0.20[d]
6 months	8.43 ± 0.03[c]	8.51 ± 0.10[a]	8.45 ± 0.50[b]	7.68 ± 0.20[d]
	Tenderness			
Zero time	8.92 ± 0.06[d]	9.10 ± 0.62[c]	9.12 ± 0.10[b]	9.14 ± 0.02[a]
Month	8.86 ± 0.02[d]	8.92 ± 0.07[c]	8.96 ± 0.06[b]	9.00 ± 0.01[a]
3 months	8.81 ± 0.01[d]	8.81 ± 0.01[c]	8.88 ± 0.21[b]	8.91 ± 0.72[a]
6 months	8.51 ± 0.20[d]	8.76 ± 0.02[c]	8.85 ± 0.03[b]	8.89 ± 0.03[a]
	Appearance			
Zero time	8.92 ± 0.02[a]	8.86 ± 0.15[b]	8.85 ± 010[c]	8.82 ± 0.02[d]
Month	8.91 ± 0.01[a]	8.85 ± 0.01[b]	8.80 ± 0.06[c]	8.50 ± 0.02[d]
3 months	8.81 ± 0.01[a]	8.76 ± 0.03[b]	8..77 ± 0.04[c]	7.80 ± 0.03[d]
6 months	8.65 ± 0.04[a]	8.62 ± 0.03[b]	8.28 ± 0.47[c]	7.53 ± 0.03[d]
	Overall, acceptably			
Zero time	8.97 ± 0.01[a]	8.96 ± 0.60[b]	8.87 ± 0.20[c]	8.83 ± 0.01[d]
Month	8.89 ± 0.10[a]	8.91 ± 0.07[b]	8.81 ± 0.03[c]	8.70 ± 0.30[d]
3 months	8.77 ± 0.25[a]	8.80 ± 0.20[b]	8.74 ± 0.41[c]	7.79 ± 0.15[d]
6 months	8.33 ± 0.28[a]	8.61 ± 0.02[b]	8.59 ± 0.15[c]	7.74 ± 0.10[d]

Mean ± SD; with different superscripts in a row differ significantly ($p < 0.05$). Values ± SE; in the same line with different letters are significantly different at ($p < 0.05$).

4. Conclusions

From this study the most important points are.

- Aromatic and rhizomatous plant, *Alpinia galanga* used in various biological activities and. *Alpinia galanga* is rich in photochemical and minerals. It is an important source for various types of active compounds that poses many biological activities. Since *A. galanga* is known for it has huge biological potential. Several chemicals present in the plant show a wide pharmacological and medicinal property.
- The galangal in this study showed potential to be used as a natural antioxidant in food products. Having phenolic and flavonoid compounds with a milder odor makes it advantageous for use with more varieties of food products when compared to other herbs and spices that have pungent terpenes as their antioxidative components, it also showed the use of galangal powder is better than the extract, as the microbiological effect was higher in the powder than in the extract in an acceptable proportion, despite the fact that it contains antioxidants, phenols and flavonoids, where it is believed that the method of preparing the extract has an effect on the antioxidants.
- Smell was recorded at the addition level of 10% and 15% in the extract a higher percentage than powder at the addition level of 2.5% and 3.5%, as the strength of the smell was higher during the storage periods, while the general acceptance varied between the samples Added to galangal powder and galangal extract.
- Also, this study showed that samples containing galangal powder in a ratio of 2.5% and 3.5% and extract galangal in a ratio of 10% and 15% contained lower values than the control group during storage periods. Also, a decrease in the proportion of protein in both powder samples and the extract by a small percentage, and there was no deterioration of the protein, with TBA a lack of whether the powder samples or the extract compared to the control group during storage periods.
- By comparing galangal to these commercially available antioxidants, as galangal is a natural food ingredient without any known toxic effects and has increasing use in the preparation of ethnic foods, galangal may be a possible source of natural antioxidants for food use. The present results are useful to use galangal in fortification of meat products to improve the nutritionally and healthy safe this study has technological value, as well as economically important.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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