UTILIZATION OF GINGER AS A NATURAL ANTIOXIDANT AND ANTIMICROBIAL IN BAKERY PRODUCTS

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SUMMARY

This study was achieved to evaluate the Ginger (Zingiber offcinale Roscoe) as chemical composition, minerals content and fraction and identification of phenolic acids and flavonoids compounds by HPLC. The results showed that the ginger had rich in various nutritional compositions like protein, crude fiber, vitamins and minerals content. Results from HPLC found that the major and medium compounds from phenolic acids were pyrogallol, vanillin, p -hydroxbenzoic acid and p- coumaric, gallic, alpha-coumaric, ferullic,catechol, caffeic, chlorgenic and salcilic acids. Meanwhile flavonoids compounds were hispertin,kampferol, narengin, rutin, apegnin, rosmarinic, quercetin, luteolin and hisperidin compounds.

Ginger was partially substituted with wheat flour at different levels 5, 10 and 15%, to produce butter cake and biscuits then sensory evaluation and anti-microorganisms during storage period (four weeks for butter cake and six weeks for biscuits) were estimated in bakery products. From the results, it could be found when added 5.0 and 10.0 % ginger to wheat flour give acceptability butter cake and biscuits. Meanwhile when add high concentration 15% ginger give not acceptability in the bakery products. Moreover when added ginger to butter cake and biscuits and the results during storage period found that the ginger had natural compounds as antibacterial and antifungal.

Therefore it could be recommended that the butter cake and biscuits with ginger until level 10% give bakery product the best acceptability and antibacterial and fungal.

Keywords: ginger, natural antioxidant and antimicrobial.

INTRODUCTION

Ginger (Zingiber officinale Roscoe) is the best source in different chemical nutritional. The health benefits of ginger are more than anything else that may be caused by phenolic compounds. The researchers have confirmed that ginger has to various biological activities, like antioxidant, antimicrobial, anticancer, chronic heart disease protective, respiratory protective and lowering blood sugar (Mao *et al*., 2019).

Ginger essential oil possess had contained major compounds lipophilic characteristics and making as antifungal (Nerilo *et al*., 2016). As well as, ginger essential oil had effectiveness as antibacterial and antitoxins (Yamamoto-Ribeiro *et al*., 2013). Furthermore, ginger had contained the terpinene compound that the powerful antifungal characteristics and lowering the expression of genes aflatoxin (Moon *et al*., 2018). Moreover, fresh ginger was found as antivirus in respiratory tract cell lines for humans (Chang *et al*., 2013). In a clinical experimental, the ginger extract reduced markers relevant to liver functions in Egyptian (Abdel-Moneim *et al*., 2013).

Ginger had contained antioxidant components exhibit higher activities thus it can also be utilized as an antioxidant supplement (Adel and Prakash, 2010). Ginger powder, also had contained in the nutrition compounds, these ingredients can be utilized to become better the nutritional value of food by adding ginger powder (Tusneem *et al*., 2017).

Regarding the health benefits, blends from wheat and ginger powder mixture to prepare of bread and biscuits give to increase the nutritional and health situation for consumers (Ajanaku *et al*., 2011).

The aim of this study was to utilize the ginger as a natural antioxidant and had contained a high amount from protein and crude fiber which used to improve the nutritional value and increases the shelf life of the bakery products.

MATERIALS AND METHODS

Materials:

Wheat flour 72% extraction was obtained from Grain Soils and Flour Mills Organization at Saudi Arabia. The fresh ginger and other ingredients for butter cake and biscuits preparation were purchased from the local market at Jeddah, Saudi Arabia.

Methods:

Preparation of ginger powder:

According to Shirshir *et al*. (2012) the fresh ginger was washed with tap water to remove dirt and sliced up to 2 to 3 mm with a knife then sundried for 20 hr up to the moisture have contained 9 - 11%. After that the dried ginger slices were grounded to a

fine powder and packaged in polythene bags and stored at room temperature to analysis.

Nutritional composition of ginger

Chemical composition as total protein, fat, ash, crude fiber and total carbohydrates were determined according to AOAC (2012). In addition the mineral contents (zinc, manganese, copper, calcium, iron, sodium phosphorus, and potassium) were determined according to AOAC (2012).

Ascorbic Acid (Vitamin C) content was determined by the 2, 6- dichlorophenol indophenol titrimetric methods (Rnganna, 1979).

Total carotenoids were extracted and determined from ginger in80% acetone according to Collin and Watts (1983).

Quantitative determination of flavonoids by HPLC:

Quantitative determination of flavonoids compounds for ginger were performed using High Performance Liquid Chromatography (HPLC) Beckman model equipped with four solvent delivery system quaternary pump (LPG 3400 SD) including a diode array detector (DAD 3000) with 5 cm flow cell, a manual sample injection valve equipped with a 20 µl loop and Chromeleon 6.8 system manager as data processor (Zuo *et al*., 2002). Each compound was identified by its retention time and by spiking with standards under the same conditions. The quantification of the sample was done by the measurement of the integrated peak area and the content was calculated using the calibration curve by plotting peak area against the concentration of the respective standard sample.

Quantitative determination of phenolic compounds by HPLC:

Phenolic compounds of ginger were determination by HPLC according to the method of Goupy *et al*. (1999) as follow: 5 gm of samples were mixed with methanol and centrifuged at 10000 rpm for 10 min and the supernatant was filtered through a 0.2 µm Millipore membrane filter then 1-3 ml was collected in a vial for injection into HPLC Hewlett Packard (series 1050) equipped with auto sampling injection, solvent degasser, ultraviolet (UV) detector set at 280 nm and quaternary HP pump (series 1050). The phenolic acid standards were dissolved in a mobile phase and injected into HPLC. Retention time and peak area were used to calculation of phenolic compounds concentration by the data of Hewlett Packard software.

Preparation of butter cake fortified ginger:

The ingredients as wheat flour 72% extraction and ginger powder were used in the preparation of butter cake according to Mizukoshi *et al*. (1979). Ginger powder at levels 5,10 and 15% was added separately to wheat flour 72% extraction and mixed using 50g French butter, 100g sugar, 3.0g baking powder, 75.0 g egg, 3.0g vanilla and 7.0g skim milk mixing to give three blend butter cake also, control cake was prepared from wheat flour 72% extraction.

The butter cake formulas were baked at 190° C for 25 minutes and it was allowed to cool on racks for about one hour before evaluation.

Sensory evaluation of butter cake fortified ginger

The organoleptically evaluation for different blends of butter cake was estimated by ten experienced panelists according to AACC (1985).

Preparation of biscuits fortified ginger:

The control biscuits were made from wheat flour 72% extraction. The wheat flour 72% extraction was mixed with to ginger at 5, 10 and 15% based on the dry weight of the flour. The biscuit dough was rolled out to a thickness of 10 mm, using a rolling pin, and then cut into rounds using a 5 cm diameter biscuit cutter. The cut biscuits were baked at 170°C for 8 min and cooled at room temperature for 20 min. The biscuits were stored in sealed plastic bags at −20°C for analysis according to Klunklin and Savage (2018).

Sensory Evaluation of biscuits:

Taste panel evaluation of biscuit samples was similarly conducted using fifteen panel members selected randomly (that are familiar with quality attributes of local biscuits) to access color, taste, and crispness as quality parameters. A 9-point hedonic scale quality analysis as described by Larmond (1977).

Determination of microbiological analysis for butter cake and biscuits during storage period:

Biological activity as the total count of bacteria and fungi were estimated by the plate methods of Onuorah and Akinjede (2004) in butter cake and biscuits made from ginger during storage at room temperature for four weeks in cake and six weeks for biscuits. Plates of biological activity were incubated in an incubator at 30 °C for three days.

Statistical analysis:

The obtained data were exposed to analysis of variance. Duncan's multiple range tests at ($P \leq 0.05$) level was used to compare between means. The analysis was carried out using the PRO ANOVA procedure of Statistical Analysis System SAS, (2004).

RESULTS AND DISCUSSION

Nutritional constituents of ginger:

The chemical composition of ginger powder was determined and the finding at the moisture content of the ginger was 8.23%, this means that the shelf life of ginger powder has to continue for a long time. The crude protein in ginger was recorded with 5.68 % this result is confirmed with Odebunmi *et al*. (2010), who found that ginger contained low protein content. Moreover, the fat content of ginger was 6.23% compared to the protein content of 5.53% was illustrated by Nwinuka *et al*. (2005) to ginger. These results indicated that fat content was large and most of the biologically active is found in the structure of dry ginger (Weiss, 2002).

The crude fiber and ash content were found 11.24 and 6.82% in ginger compared with approval the confirmed with Ajayi *et al*. (2013) who obtained in percentages in the two varieties of ginger (white and yellow types) were crude fiber (21.90, 8.30%), ash (4.95, 7.45%), and moisture (3.95, 4.63%) contents, respectively. It is noticeable that ginger powder would available a sufficient quantity of minerals content which appropriate with growth and development.

Moreover, ascorbic acid and total carotenoids content were determined in ginger and the results were found by 11.02 and 81.15 mg/ 100 g, respectively. The ginger powder contained a wealthy source of minerals content, vitamins and also has essential nutritional compositions (Agrahari *et al*., 2015).

Table (1): Proximate analysis of ginger on dry weight

Chemical analysis g/100g	Ginger g/100g	Minerals content mg/100g	Ginger mg/100g
Moisture	8.23±0.35	Zinc	13.92±0.94
Protein	5.68±0.27	Manganese	15.15±1.05
Fats	6.23±0.26	Copper	10.75±0.93
Ash	6.82±0.21	Calcium	23.23±2.16
Crude fiber	11.24±0.93	Iron	27.95±2.31
Total carbohydrates	70.03±3.58	Sodium	20.11±1.94
Ascorbic acid (mg/100g)	11.02±1.07	Phosphorus	74.0±3.51
Total carotenoids (mg/100g)	81.15±4.56	Potassium	40.12±2.94

All value in this table represents the mean ± SD (n = 3).

The mineral content (mg /100 g) detected in ginger rhizome powder were determined and the results indicated that the phosphorus was the highest element in ginger by7 4.0 mg/100g followed by potassium, iron, calcium and sodium to be 40.12, 27.95, 23.23 and 20.11 mg/100g, respectively. Moreover ginger had contained manganese, zinc and copper were 15.15, 13.92 and 10.75 mg/100g, respectively. These results are confirmed with Aremu *et al*. (2005) which they found that the ginger which a decrease in sodium/potassium ratio in the diet is related to elevated blood pressure. Moreover, Afzal *et al*. (2001) showed that the function of ginger was lowering high blood pressure. Calcium and phosphorus content was the average amounts in ginger powder and these results are confirmed with Adanlawo and Dairo (2007) which they reported that when calcium was found up to a high ratio of the bone and blood required to be done for normal functioning of cardiac muscles, and regulation of cell permeability using phytochemical from ginger extract.

Polyphenolic compounds are usually famous as the greatest phytochemical molecules which had contained natural antioxidant characteristics in the plants (Andreu *et al*., 2018 and Zahoor *et al*., 2018). Polyphenolic and flavonoids compounds from ginger extract were fractionated using HPLC apparatus and the identification is recorded in Tables (2 and 3).

Table (2) and Figure (1) showed that the phenolic compounds from ginger extract were fractionated using HPLC and the results are illustrated that the pyrogallol, vanillin, p -hydroxbenzoic acid and p-coumaric acids were the highest amount by 22.0, 20.76, 15.84 and 9.51mg/100g, respectively. Meanwhile, the medium amounts of compounds were gallic, alpha-coumaric, ferulic, catechol, caffeic, chlorogenic and salicylic acids were 5.17, 4.72, 4.54, 3.93, 2.69, 2.48 and 2.03 mg/100g, respectively, The minor phenolic compounds of the ginger extract were caffeine, protocatechuric and ellagic acids wich represent 1.65, 1.58 and 1.47 mg/100g, respectively, whilst, 3-OH- Tyroso l,4- amino benzoic and curcumin acids were the lowest from the extract of ginger. These results are agreement with Syama *et al*. (2017) shown that the ginger extract was fractionated to ellagic, syringic, gallic, ferulic, cinnamic acids, and quercetin. These compounds explained the positive attachment among the greatest phytochemical compounds and key enzymes for preventing cardiovascular diseases.

Also, this biological activity had contained a strong to antioxidant which to scavenging free radicals scavenging and likewise, ferulic acid inhibited lipid oxidation (Göçer and Gülçin, 2011). Also, they identified the quantity of natural antioxidants in foods and medicinal plants.

Table (2): Phenolic compounds content in methanol extract from ginger extract

Phenolic compounds	mg/100g
Gallic acid	5.17
Pyrogallol	22.00
Caffeine	1.65
Caffeic	2.69
Protocatechuic	1.58
chlorogenic	2.48

Table 2. continue

Catechol	3.93
P-Hydroxypenzoic acid	15.84
Salycilic	2.03
Ellagic	1.47
Ferulic	4.54
4- Amino-benzoic	0.38
3-OH- Tyrosol	0.93
Vanillin	20.76
Alpha-coumaric	4.72
P-coumaric	9.51
Curcumin	0.32

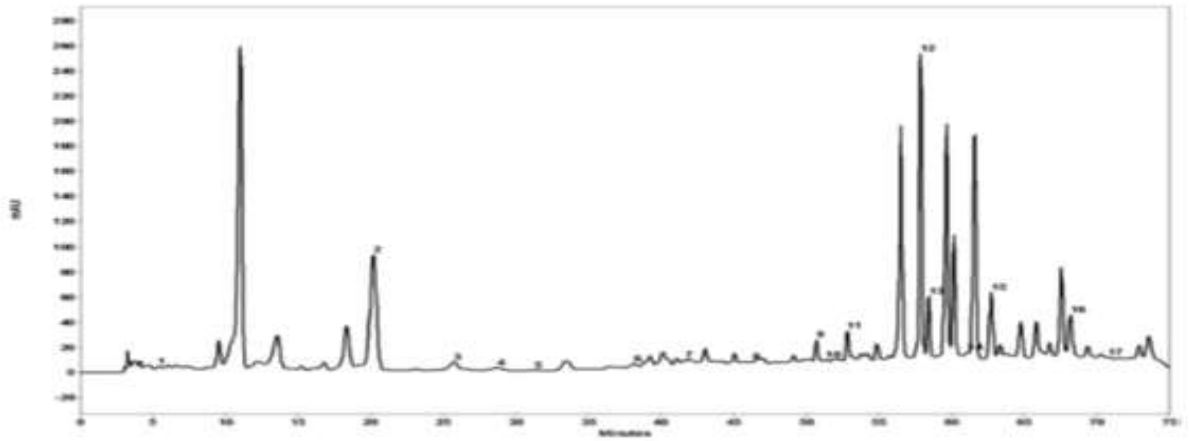

Figure (1). HPLC chromatograms for phenolics compounds content (mg/100g) in ginger extract

The results presented in Table (3) and Figure (2) showed that the phenolic compounds contents of the ginger extract. From the results, it could be noticed that the hispertin showed the highest content (14.12 mg/100g) followed by kampferol (13.23 mg/100g) then narengin (12.27 mg/100g), rutin (11.48 mg/100g), apegnin (11.21 mg/100g), rosmarinic (10.55 mg/100g) and quercetin (10.21mg/100g). However, medium contents were observed for luteolin (7.92 mg/100g) and hisperidin (6.07 mg/100g), whereas quercetrin was the lowest amounts in the ginger extract. These results are confirmed by Kumar and Pandey (2013) who found that the flavonoids like quercetin, apigenin, hesperidin, and luteolin compounds had contained the possibility of anti-inflammatory. Han *et al*. (2012) reported that more polyphenolic compounds like kaempferol, rutin, luteolin, and resveratrol had effectiveness versus doxorubicin-stimulation cardiotoxicity. Furthermore, flavonoids are found in various parts of plants, making them with many roles.

Also, it has contained the greatest phenolic groups in the plants. It could be caused to their significance in human health. Moreover, it also is beneficial to have the ability to understand flavonoids concentration and biological activities which have the possibility as treatment agents, and also dominating the goodness of food and medicinel (Ghasemzadeh *et al*., 2010a, b).

Table (3): Flavonoids compounds content in ginger extract

Flavonoids compounds	**mg/100g**
Luteolin	7.92
Narengin	12.27
Rutin	11.48
Hisperidin	6.07
Rosmarinic	10.55
Quercetin	10.16
Quercetrin	2.90
Hispertin	14.12
Kampferol	13.32
Apegnin	11.21

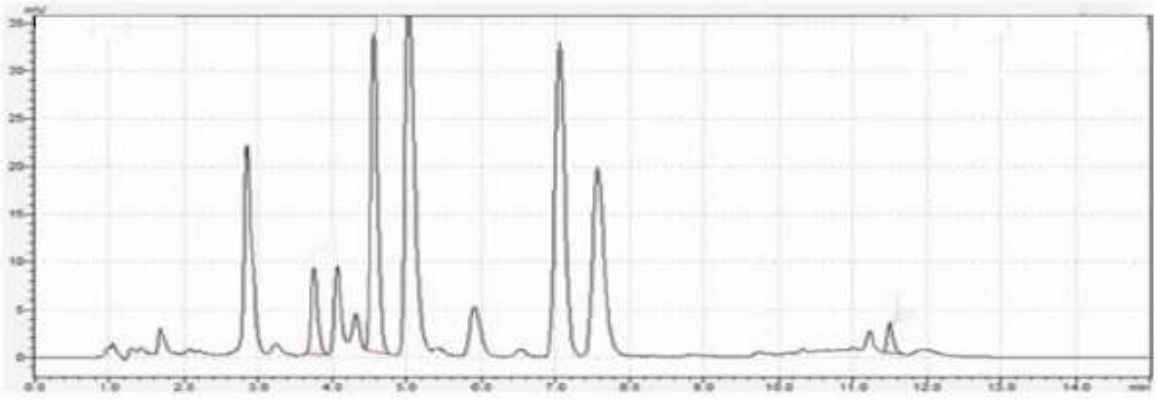

Figure (2). HPLC chromatograms for flavonoids compounds content (mg/100g) in ginger extract

Sensory evaluation of butter cake from ginger:

The sensorial characteristics (taste, odor, texture, crust color, crump color, general appearance and overall acceptability) of the produced butter cake samples (control butter cake sample and butter cake was the partial replacement of wheat flour with 5, 10 and 15% from dry ginger) were evaluated and the obtained results in Table (4). The results reported that there were no significant variations shown in the sensory characteristics of butter cake between the control sample and 5 and 10 % level of replacement with ginger powder. Meanwhile, the butter cake made from 15% ginger showed low overall acceptability than 5 and 10% butter cake, this means that when the ginger with a high concentration in butter cake the taste and color were decreased. These results are confirmed by Hu *et al*. (2007), who found that the dark color of cookies has immediately connected to the highest fiber content in ginger powder.

Furthermore, the browning of the cookies could also happen may be caused to caramelization and Maillard reactions, as the protein in ginger and wheat flour is reacted with sugar during the baking process (Mohsen *et al*., 2009).

Table (4): Effect of ginger powder on the sensory evaluation of butter cake

Overall acceptability 100	General Appearance 15	Crumb color 15	Crust color 15	Texture 15	Odor 20	Taste 20	Types of additions
96.91	14.89^{a} ±0.99	14.89^{a} ±0.61	14.78^{a} ±0.74	14.85^{a} ±0.97	19.20^{a} ±0.81	18.30^{a} ±.0.98	Control
94.49	14.31^{b} ±0.04	14.30^{ab} ±0.72	14.24^{a} ±0.74	14.42^{a} ±0.97	19.10^{a} ±0.63	18.12^{a} ±0.09	5% Ginger
90.96	13.91^{ab} ±0.67	13.68^{b} ±0.09	13.65^{b} ±0.48	14.15^{a} ±0.28	18.00^{b} ±0.12	17.57^{b} ±0.23	10% Ginger
80.45	$12..34^{c}$ ±0.43	11.18^{c} ±0.87	11.31^{c} ±0.34	12.85^{b} ±0.35	16.62^{c} ±0.35	16.15^{b} ±0.21	15% Ginger

All value in this table represents the mean ± SD (n = 3).Means in the same column followed by different letters are significantly (P≤0.05) different.

Biological activity in butter cake during storage period:

Microbiological spoilage from microbial growth may be due to an economic loss for both manufacturers and consumers. It could be caused by packaging and storage conditions (Saranraj and Geetha, 2012).

Total bacteria and fungi count were determined in butter cake with ginger at 5, 10 and 15% respectively, during storage period (four weeks) and the results are reported in Tables (5). The results showed that the total count of microorganisms was slightly increased in butter cake when ginger increasing during the storage period. The total count of bacteria for butter cake from ginger was added 15% ranged from 20.5 to 33.6 $\times 10^{-6}$ CFU after four weeks and the total count of fungi was parallel to the bacteria count. Ginger cake products are good sources of natural antioxidants, therefore the butter cake prevention from growth bacteria and fungi when ginger increasing in butter cake products.

The growth of spoilage macrobiotic in foods is not harmful to human health but it has an effect on the shelf-life, textural properties, and overall acceptability of the final products also impacts the consumer choices. Therefore, inhibition of microbial growth in foods is of most importance for food

production. Likewise, could be needed for new methods, worthy of lowering or completely remove food borne pathogens and spoilage bacteria (Bondi *et al*., 2017).

Table (5): Microorganisms counts in butter cake from ginger during storage period

Total fungi count × 10^{-2} CFU			Total bacteria count × 10^{-6} CFU			Types of addition
4weeks	2weeks	Zero time	4weeks	2weeks	Zero time	
58.4±0.41 [a]	50.1±0.47 [a]	37.9±0.38 [a]	42.8±0.12 [a]	35.2±0.16 [a]	20.7±0.27[a]	Control
53.3±0.15 [b]	47.3±0.38 [b]	36.5±0.31 [a]	40.4±0.94 [b]	30.4±0.76[b]	20.5±0.34 [a]	5% Ginger
50.9±0.38 [c]	45.5±0.32 [c]	35.2±0.34 [a]	35.2±0.18 [c]	25.1±0.97[c]	20.2±0.05 [a]	10% Ginger
47.2±0.34 [d]	40.4±0.36 [d]	35.9±0.35 [a]	33.6±0.27 [d]	23.3±0.59[d]	20.5±10.14 [a]	15% Ginger

All value in this table represents the mean ± SD (n = 3).Means in the same column followed by different letters are significantly (P≤0.05) different.

Sensory characteristics of biscuits fortified with ginger:

Biscuits are a snack food that more people are eating, and may cause them to be readily available and have a shelf-life. For these reasons, biscuits are greatly favored as bakery product (Caleja *et al*., 2017). Biscuits cannot be regarded as a healthy snack food for the reason it had contained a rich amount of total carbohydrates and fats, also low levels of fiber, and a lowering amount of protein as it is generally prepared from butter, and sugar (Park *et al*., 2015).

The results in Table (6) illustrated that the sensory properties of biscuits made from wheat flour and its blends with at different ginger levels 5, 10 and 15%, respectively. The results reported that the acceptable for color, taste, and crispness/aroma in biscuit samples when added 5 and 10% ginger. Whilst, 15% of ginger biscuit mostly had a significantly lower for the tested attributes when compared with the control biscuit sample. This fragile nature of ginger biscuits was regarding the low gluten content and development in the flour (Okaka and Isieh, 1990).

The *coetlor* of the ginger biscuits was usually lowering acceptability at high concentration may be probably caused to Maillard reactions and caramelization during baking.

Table (6): Sensory evaluation of biscuits fortified with ginger

Average	Crispiness/Aroma	Taste	Color	Types of addition
8.5±0.90 [a]	8.5±0.86 [a]	8.5±0.82 [a]	8.5±0.91[a]	Control
8.0±0.76 [b]	8.0±0.78 [b]	8.0±0.79 [b]	8.0±0.92[b]	5% Ginger
7.5±0.63 [c]	7.5±0.61 [c]	7.5±0.64 [c]	7.5±0.70[c]	10% Ginger
6.4±0.50 [d]	6.4±0.43 [d]	6.2±0.49 [d]	6.5±0.51[d]	15% Ginger

All value in this table represents the mean ± SD (n = 3).Means in the same column followed by different letters are significantly (P≤0.05) different.

Biological activity in biscuits during storage period:

Total microorganisms count determined to biscuits prepared with ginger at levels 5, 10 and 15% during the storage period (6 weeks), and the results are tabulated in Table (7). From the results, it could be found that the increment percentage of the total bacteria count after six weeks was decreased from 85.35% to 58.67% for biscuits made from 15% ginger when compared with control biscuits. The ginger had contained more constituency which has anti microorganisms influence due to it had contained rich amounts of natural antioxidants (Atai *et al*., 2009).

Furthermore, the total fungi count was elevated in control biscuits by 95.19% after six weeks during the storage period. Whilst, it was 71.52% for of ginger biscuits at 15 % level. Antimicrobial activity is generally applied by using the plant extract to control bacterial disease. Fresh and dried ginger extracts inhibit the growth of E. coli and Staphylococcus aureus, similar to some standard antibiotics (Njobdi *et al*., 2018). Its extracts exhibit antibacterial activity owing to the presence of gingerols (Hindi *et al*., 2014).Ginger methanol extract contained steroids and flavonoids, which are antimicrobial agents (Mohamedin *et al*., 2018).

Table (7): Microorganisms count in biscuits made from ginger during storage period

Total fungi count × 10^{-2} CFU				Total bacteria count × 10^{-6} CFU				Type of addition
6 weeks	4 weeks	2 weeks	Zero time	6 weeks	4 weeks	2 weeks	Zero time	
89.2 ±0.52 [a]	80.1 ±0.34 [a]	65.3 ±0.15 [a]	45.7 ±0.11 [a]	29.1 ±0.14 [a]	25.4 ±0.91 [a]	19.1 ±0.73[a]	15.7 ±0.25[a]	Control
85.3 ±0.10 [b]	75.1 ±0.28 [b]	62.3 ±0.38 [b]	45.5 ±0.24[a]	27.2 ±0.38 [b]	24.5 ±0.01 [b]	18.5 ±0.26[b]	15.8 ±0.31[a]	5% Ginger
81.4 ±0.76 [b]	70.3 ±0.43 [b]	58.2 ±0.28 [b]	45.4 ±0.28[a]	25.4 ±0.19 [b]	22.4 ±0.92[c]	17.9 ±0.07[bc]	15.4 ±0.22[ab]	10% Ginger
77.7 ±0.29 [d]	65.5 ±0.68 [d]	50.1 ±0.59 [d]	45.3 ±0.26[a]	23.8 ±0.53 [d]	20.4 ±0.94[d]	17.2 ±0.27[c]	15.0 ±0.10[b]	15% Ginger

All value in this table represents the mean ± SD (n = 3).Means in the same column followed by different letters are significantly (P≤0.05) different.

CONCLUSSION

Ginger had contained a rich amount of a natural antioxidant like phenolic acids, flavonoids compounds, also chemical nutrition compounds as protein, crude fiber and minerals content. Therefore the uses of ginger and wheat flour 72% extraction were to produce butter cake and biscuits at different levels 5, 10 and 15% to improve the nutritional and sensory attributes of the butter cake and biscuits without adversely affecting great their properties. The sensory evaluation reported that when added ginger at level 5 and 10% to wheat flour to prepared butter cake and biscuits to give high acceptability from the bakery products had contained natural components which antibacterial and antifungal.

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الملخص العربى

استخدام الزنجبيل كمضاد طبيعى للأكسدة ومضاد للميكروبات بمنتجات المخبوزات

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أجريت هذه الدراسة لتقييم الزنجبيل (Zingiber Officinale Roscoe) من حيث التركيب الكيميائي ومحتوى المعادن، وتحديد الأحماض الفينولية والمركبات الفلافونويد بواسطة جهاز HPLC .أظهرت النتائج أن الزنجبيل غني بالمركبات الغذائية المختلفة مثل البروتين والألياف الخام والفيتامينات والمعادن. وجدت نتائج HPLC أن المركبات الرئيسية والمتوسطة من الأحماض الفينولية كانت بيروجالول ، فانيلين ، حمض هيدروكسي بنزويك ، ب- كوماريك ، جاليك ، ألفا كوماريك ، فيروليك ، كاتيكول ، كافيك ، كلوروجينيك ، وأحماض الساليسيليك. وفي الوقت نفسه ، كانت مركبات الفلافونويد هي مركبات هيسبيرتين ، كايمبفيرول ، نارينجين ، روتين ، أبجينين ، روسمارينيك ، كيرسيتين ، لوتولين ، ومركبات هسبريدين.

أجرى استبدال الزنجبيل جزئيًا بدقيق القمح بمستويات مختلفة ٥ و ١٠ و ١٥ ٪ لإنتاج كيك الزبدة والبسكويت ، ثم تم تقدير التقييم الحسي ومضادات الميكروبات خلال فترة التخزين (أربعة أسابيع لكيك الزبدة وستة أسابيع للبسكويت) في منتجات المخبوزات. من النتائج ، تبين أن إضافة ٥ و ١٠ ٪ من الزنجبيل إلى دقيق القمح يعطي قبول زبدة الكيك والبسكويت. وفي الوقت نفسه ، عند إضافة تركيز عالٍ من الزنجبيل بنسبة ١٥ ٪ ، لا يُعطى قبول في منتجات المخابز ولدى المحكمين. علاوة على ذلك عند إضافة الزنجبيل إلى كيك الزبدة والبسكويت ووجدت النتائج خلال فترة التخزين أن الزنجبيل يحتوي على مركبات طبيعية كمضاد للبكتيريا ومضاد للفطريات.

.يمكن أن نوصى بأنتاج كيك الزبدة والبسكويت بالزنجبيل حتى مستوى ١٠٪ يعطي منتج من المخبوزات أفضل قبول ومضاد للبكتيريا والفطريات

الكلمات المفتاحية: الزنجبيل ، مضادات الأكسدة الطبيعية ومضادات الميكروبات.