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Influence of Aqueous Extract of Ginger and Garlic on Shelf Life Studies of Plantain Fingers (*Musa paradisiacal*) at Ambient and Refrigerated Conditions

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Abstract

Large quantities of plantain produced in Nigeria are wasted during post-harvest handling and storage which result in nutritional and economic losses which is mostly caused by deterioration of the ripe plantain fingers. Therefore, there is need to understand these physiological changes during handling and storage to minimize these losses. Matured green plantain fingers were treated with 20% (w/v) and 40% (w/v) aqueous extract of ginger and garlic using standard methods. Proximate, physico-chemical, and estimation of storage life and sensory evaluation of plantain were determined. The study showed that ripening of plantain increase the pH, vitamin C, total soluble sugar, titratable acidity, moisture, ash, fat, protein while there was reduction in crude fibre and carbohydrate for both untreated and treated samples. Sample treated with 40% (w/v) ginger and garlic extract had the highest pH value (6.17 ± 0.06%), vitamin C (63.60 ± 0.53 mg/100g), titratable acidity (0.07 ± 0.00%), and moisture content (60.03 ± 0.21%). Sugar sample treated with 40% (w/v) and 20% (w/v) ginger and garlic extract had the highest value of 60.33 ± 0.58% while sample treated with 20% (w/v) ginger and garlic extract had the highest value for ash (6.58 ± 0.05%),protein(1.81 ± 0.01%) and carbohydrate (25.24 ± 0.36). Storage studies revealed that the untreated sample ripened by the 6th day of storage, sample treated with 20% (w/v) ginger and garlic extract ripened by the 14th, sample treated with 40% (w/v) ginger and garlic extract ripened by the 16th day while Sample treated with 20% (w/v) ginger extract had the highest overall acceptability of 4.5 ± 1.00. In conclusion, it was observed that 40% (w/v) ginger and garlic extract extend the shelf life of plantain to 16 days and compared to the control which lasted for 6 days.

Keywords: *Ginger; Garlic; Plantain; Physicochemical; Storage Studies*

Introduction

Plantain (*Musa* spp) belong to the genus Musa, a perennial crop that grows well in a wide range environment and has become major food crop in the humid and sub-humid region of Africa [1]. It is a major source of energy for millions of people in these regions [2]. The pulp is low in protein with estimated value of 4 g/kg in green unripe plantain fingers and 9 g/kg in the fully ripe finger and a higher level of about 72 g/kg is found in the peel which makes the peel suitable stuff for ruminants' animal especially in ripe form. In Nigeria, plantain is processed into various products such as "elubo" (dried half-ripe plantain flour), "dodo" (fried sliced ripe plantain pulp), and chips (fried unripe plantain pulp). Many natural preservatives have revealed their importance in the preservation of plantain fingers and extend its shelf-stability due to post harvest spoilage by fungi and bacteria. The shelf-life of plantain decreases as external temperatures increases over the range of 15 - 35°C with storage period by 1 - 2 days [3]. At this temperature, plantain fruits stored will experience chilling and these plantains are best stored at ambient temperatures because of the physiological problems associated with low temperature storage. The method of storage of plantain tends to have effects on the ripening and spoilage of the plantain fruit [4]. The colour of the fruits, moisture content, weight loss, peel colour, change in composition of sugar and microbial load/count is used as a parameter to under these effects [4]. The antioxidant properties of herbs, spices, plant and other food extracts are apparently related to their phenolic content, suggesting that antioxidant action is similar to that of synthetic phenolic antioxidants [5]. Due to concerns about toxicological safety of synthetic antioxidants such as butylated hydroxy anisole (BHA) and butylated hydroxytoluene (BHT), naturally derived antioxidants are perceived as better and safer than synthetics. Moreover; natural antioxidants are reported to be more powerful than the synthetic antioxidants, especially, rosemary, sage, and green tea extracts. Therefore, natural antioxidants are very important for human health [6]. Natural plants are considered an important target to investigate in order to provide a new source of natural antioxidants and/or antimicrobial

agents from a safety view point. Consequently, there is a practical need for the screening and selection of natural antioxidants as effective alternatives in the prevention of food deterioration [7]. Several plants with very high nutritive values exist and yet remain unexploited for human and animal benefits [7]. Therefore, the search for, and development of other antioxidants and antimicrobials of natural origin are highly desirable.

Garlic (*Allium sativum*) is a perennial plant with an underground bulb composed of pungent bulblets commonly called cloves. Garlic contains at least 33 sulphur compounds like Allin, Allicin, Trisulphide, S-allyl cysteine, Vinyl dithines Allyl propyl. Extracts of both ginger and garlic possess antibacterial, antimicrobial and antifungal properties that can help to extend the shelf life of plantain thereby delay the ripening time.

Ginger (*Zingiber officinale*) is a popular spice, grown everywhere in Nigeria that is widely used as a spice and food seasoning due to its sweet aroma, high antioxidant activity and pungent taste and effective microbial agents [8,9]. Ginger in its fresh as well as dried form, has been used both in medicine and as a spice for several centuries. Fresh spices are perishable in nature and the causes of spoilage are improper handling, growth of spoilage microorganisms, action of naturally occurring enzymes, chemical reactions. It contains some chemical which neutralize unstable free radicals formed as a result of various metabolic processes in the body. Soaking ginger in hot water, cold water and alcohol helps to extract the phytochemical present. In addition, the use of low temperature storage to retard and stabilize microbial growth in food is well documented [7,9]. Many papers have reported ginger antioxidant activity against the oxidation of lipid in various model systems such as lard, vegetable oils, oil water emulsion [10]. This antioxidant effect was shown to be linked to the presence of gingerol related compounds and diaryl heptanoid [10].

Aim of the Study

The aim of the study is to investigate the influence of aqueous extract of ginger and garlic on proximate and physicochemical of plantain fingers stored at ambient and refrigerated conditions.

Materials and Methods

Plantain sampling

Mature hands with well-developed and rounded fingers, were selected from a bunch of *Musa paradisiacal* fruits obtained from a farm at Ikorodu, Lagos state. They were transported to the laboratory in a basket and used immediately. Fresh and wholesome garlic and ginger free from defects were obtained from Oyingbo Market, Lagos. The spices were kept in an aerated place away from contamination before use.

Spice extraction

Extracts from the spices were prepared by washing, cutting, dicing. 20g and 40 g of the spices were weighed accordingly. The weighed spices were homogenized with Philips Blender HR200 (China) with a break of 10s, operating for 2 minutes at high speed. The homogenate were passed through two layers of muslin cloth to remove unwanted materials and volume made to 100 ml with distilled water. The extracts were kept away from light by covering them with foil paper. Plantain fingers were coated with 20% (w/v) and 40% (w/v) garlic and ginger respectively under laboratory conditions and then allowed to air-dry. The treated fruits were stored at an average ambient condition. Analyses of plantain during the ripening process were carried out at the following stages: initial, pale green, green and yellow and all yellow.

Chemical analyses

Proximate composition decomposition

Moisture content was determined using the standard method of Official methods of analysis Association of Analytical Chemists [11] with oven drying of 5g of pulverized plantain at 105°C until a constant weight was obtained. The protein content of a 1.0g sample was analyzed using the Kjeldahl Method as described by AOAC [11]. Protein content was obtained as % total nitrogen x6.25. Fat was extracted using 5g of sample in Soxhlet apparatus using petroleum ether (boiling point range 40 - 60°C) as the solvent according to AOAC [11]. Ash content was determined by the incineration of 2.0g of sample placed in a muffle furnace and maintained at 550°C for 5h as described in the method. Crude fibre was obtained by digesting 2.0g of sample with H_2SO_4 and NaOH and incinerating the residue in a muffle furnace maintained at 550°C for 5h. Carbohydrate determination was obtained by subtracting the sum of percentage moisture, ash crude fibre, fat and protein from 100.

Total soluble solids determination

Total soluble solids (TSS) content of a solution was determined by the index of refraction as described by Tigist., *et al* [12]. pH was carried out according to the procedure described by AOAC [11] using Jenway 3310 pH meter which have been previously calibrated with buffers of 4 and 9. Titratable acidity was carried out according to the procedure described by Tigist., *et al* [12]. The Vitamin C content was determined using titrimetric method described by AOAC [11] using 2,6-dichlorophenol-indophenol, stabilizing agent and 50% trichloro-acetic acid (TCA) in a glass with distilled water.

Shelf life studies using colour of the peel

The storage life will be expressed as the time between storage when the peel was green and when the plantain became ripe (yellow peel). Daily observation for colour change on the peel was made throughout the period of storage. The criteria for determining the colour change during ripening was based on three pattern of colour during ripening. The peel colour changes of plantain during storage were recorded according to modified method of Anonymous [13].

Organoleptic evaluation

Organoleptic evaluation was carried out on the cooked samples at the initial stage and during the ripening period by 10 semi-trained panelists. A five-point hedonic scale was utilized based on the procedure adopted by Baiyeri [14]. They assessed the taste, colour, and smell of the samples using the five-point hedonic scale, where 1 = poor, 2 = fair, 3 = good, 4 = better and 5 = excellent. A cut off mark of 3 was selected as a basis for acceptability.

Statistical analysis

Data were analyzed by the one way analysis of variance (ANOVA) model using the International Business Machines Statistical Package for the Social Sciences (IBM SPSS 20.0). The results were reported as an Average value analysis (Mean ± SD). Differences between treatments were determined by fisher's least significance difference (LSD) method and statistical significance was set at $P. < 0.05$.

Results and Discussion

Proximate composition of untreated and treated plantain fingers

From table 1a, the result of the moisture content revealed that there was a gradual increase in the moisture content of the samples during ripening process. The increased moisture may probably be due to the breakdown of the pectin compound of plantain by the natural enzymes pectinase [15]. The increase in the moisture content was consistent with the report of Aboua [16] and Makanjuola., et al. [17] for plantain during ripening process. For untreated sample, the highest percentage moisture content was 50.97% while the lowest value was 48.07% (Table 1a). There was no significant different for sample treated with 20% ginger and garlic extract, the highest percentage moisture content for both samples were 57.80% and the lowest was 48.27% (Table 1a). However, for sample treated with 40% ginger and garlic extract it was also recorded that there was no significant different the highest percentage moisture content was 60.03% and the lowest was 48.27% respectively. The result for the ash content determination shows that there was an increase in ash content as ripening progress. The enhanced ash content might probably be due to the release of minerals and ions from the plantain, because of the acidic nature of the sample [15,17]. For untreated sample, the highest percentage ash content was 5.60% while the lowest value was 5.47%. There was no significant different between treated samples 20% and 40% ginger and garlic extract, and the highest sample treated with 20% ginger and garlic was 6.58% while the lowest value was 5.51%. The highest value of sample treated with 40% ginger and garlic was 6.55% and the lowest value was 5.47%. The result for fat content indicates that there was an upward trend in fat content of the samples. For untreated sample, the highest fat content was 1.90% and the lowest was 1.86%. There was no significant different between the treated sample 20% ginger, garlic and 40% ginger and garlic, the highest value for sample treated with 20% ginger and garlic extract was 2.09% while the lowest value was 1.86% while for sample treated with 40% ginger and garlic extract the highest value was 2.26% and lowest value was 1.86%. The value for protein content of the samples revealed that the protein content as ripening progress. The value obtained for untreated plantain sample has the highest value of 1.55% and the lowest value of 1.42% table 1 and there was no significant different between the treated samples, the highest value for 20% ginger and garlic extract was 1.81% and the lowest value was 1.42%. This finding was in agreement with the work of Akomolafe and Aborisade [3]. The value of crude fibre showed a decrease in the crude fibre as the plantain samples ripened, the highest value for untreated sample was 6.47% and the lowest value was 5.03%, for samples treated with 20% ginger and garlic extract, there was no significant difference, the highest value was 6.47% and the lowest value was 5.67% and for samples treated with 40% ginger and garlic extract also there was no significant difference. The highest value was 6.47% and the lowest value was 4.02%. The decrease in percentage crude fibre content could be to enzymatic hydrolysis of the pectin content by pectinase [15]. The value for carbohydrate content for both treated and untreated samples revealed that there was a gradual decrease in carbohydrate content as ripening progress. The value obtained from untreated sample indicated that the carbohydrate content decreased from 36.55% when green to 34.41% when yellow, while there was no significant difference between the treated samples for 20% ginger and garlic. The carbohydrate content decrease from 36.55% to 25.36% and for 40% ginger and garlic the percentage carbohydrate content decreased from 36.55% 25.24% (Table 1a). The reduction in carbohydrate content might be as a result of the conversion of starch by various natural enzymes that include amylase and pectinase to sugar [15,17].

Ripening Stages	% Moisture	% Ash	% Fat	% protein	% Crude fibre	%Carbohydrate
Initial green	48.27 ± 0.91	5.47 ± 0.02	1.86 ± 0.03	1.42 ± 0.02	6.47 ± 0.16	36.55 ± 0.30
Pale green	48.07 ± 0.35	5.51 ± 0.01	1.87 ± 0.01	1.44 ± 0.02	6.41 ± 0.01	36.33 ± 0.25
Green and yellow	48.84 ± 0.66	5.55 ± 0.01	1.88 ± 0.02	1.52 ± 0.01	6.26 ± 0.11	35.74 ± 0.04
All Yellow	50.97 ± 0.66	5.60 ± 0.01	1.90 ± 0.00	1.55 ± 0.01	5.03 ± 0.03	34.41 ± 0.06

Table 1a: *Proximate composition on untreated plantain at ambient condition.*

Ripening Stages	% Moisture	% Ash	% Fat	% protein	% Crude fibre	% Carbohydrate
Initial green	48.27 ± 0.91	5.47 ± 0.02	1.86 ± 0.03	1.42 ± 0.02	6.47 ± 0.16	36.55 ± 0.30
Pale green	52.60 ± 0.71	6.30 ± 0.25	1.90 ± 0.01	1.49 ± 0.03	6.42 ± 0.17	30.52 ± 0.22
Green and yellow	54.94 ± 0.31	6.46 ± 0.01	1.92 ± 0.02	1.63 ± 0.02	6.03 ± 0.16	28.41 ± 0.18
All yellow	57.80 ± 0.26	6.58 ± 0.05	2.09 ± 0.07	1.81 ± 0.01	5.67 ± 0.32	25.36 ± 0.14

Table 1b: *Proximate composition of plantain treated with 20% ginger extract at ambient condition.*

Ripening Stages	% Moisture	% Ash	% Fat	% protein	% Crude fibre	% Carbohydrate
Initial Green	48.27 ± 0.91	5.47 ± 0.02	1.86 ± 0.03	1.42 ± 0.02	6.47 ± 0.16	36.55 ± 0.30
Pale green	52.60 ± 0.17	6.30 ± 0.25	1.90 ± 0.01	1.49 ± 0.03	6.42 ± 0.17	36.55 ± 0.30
Green and yellow	54.94 ± 0.31	6.46 ± 0.01	1.92 ± 0.02	1.63 ± 0.02	6.03 ± 0.16	28.41 ± 0.18
All Yellow	57.80 ± 0.26	6.58 ± 0.05	2.09 ± 0.07	1.81 ± 0.01	5.67 ± 0.32	25.36 ± 0.14

Table 1c: *Proximate analysis on plantain treated with 20% garlic extract store at ambient condition.*

Ripening Stages	% Moisture	% Ash	% Fat	% protein	% Crude fibre	% Carbohydrate
(Initial) Green	48.27 ± 0.91	5.47 ± 0.02	1.86 ± 0.03	1.42 ± 0.02	6.47 ± 0.16	36.55 ± 0.30
Pale green	51.00 ± 0.36	5.98 ± 0.14	1.89 ± 0.01	1.56 ± 0.02	6.58 ± 0.07	32.64 ± 0.04
Green and yellow	55.24 ± 0.56	6.25 ± 0.04	1.91 ± 0.01	1.62 ± 0.03	5.97 ± 0.28	28.10 ± 0.01
All Yellow	60.03 ± 0.21	6.55 ± 0.22	2.22 ± 0.21	1.75 ± 0.02	4.02 ± 0.17	25.24 ± 0.36

Table 1d: *Proximate analysis on plantain treated with 40% ginger extract stored at ambient condition.*

Ripening Stages	% Moisture	% Ash	% Fat	% protein	% Crude fibre	% Carbohydrate
Initial green	48.27 ± 0.91	5.47 ± 0.02	1.86 ± 0.03	1.42 ± 0.02	6.47 ± 0.16	36.55 ± 0.30
Pale green	51.00 ± 0.36	5.98 ± 0.14	1.89 ± 0.01	1.56 ± 0.02	6.58 ± 0.07	32.64 ± 0.04
Green and yellow	55.24 ± 0.56	6.25 ± 0.04	1.91 ± 0.01	1.62 ± 0.03	5.97 ± 0.28	28.10 ± 0.01
All Yellow	60.03 ± 0.21	6.55 ± 0.22	2.22 ± 0.21	1.75 ± 0.02	4.02 ± 0.17	25.24 ± 0.36

Table 1e: *Proximate analysis on plantain treated with 40% garlic extract store at ambient condition*

Values are expressed as Mean ± SD, different letters within the same column are significantly different (P < 0.05).

Physicochemical properties of untreated and treated plantain fingers

From the result obtained, it was observed that ripening of plantain increase the pH, vitamin C, total soluble sugar, titratable acidity, For physico-chemical analysis sample treated with 40% (w/v) ginger and garlic extract had the highest value for pH (6.17 ± 0.06%), vitamin C (63.60 ± 0.53 mg/100g), titratable acidity (0.07 ± 0.00%), For total soluble sugar sample treated with 40% (w/v) and 20% (w/v) ginger and garlic extract had the highest value of (60.33 ± 0.58%). Results from table 2a indicate that the pH value for untreated and treated samples increased gradually. Generally, the pH of fruits increases as fruits undergo ripening. Citric acid has also been shown to be the main acid in fruit juice, with pH of fruit normally between 4.0 and 4.5 [18]. Acidity is often used as an indication of maturity as acid decreases on ripening of fruit. It has also been reported that upon ripening of tomato fruit, malic acid disappears first, followed by citric acid, suggesting the catabolism of citrate via malate. The increased in pH value could be due to the presence of alkaline elements that enhanced the ripening, thereby making it nutritionally stable for consumption [9]. The result obtained for both treated and untreated samples the level of vitamin C content increased as ripening progress. For untreated plantain sample, the highest value for vitamin C content was 52.89 mg/100g, while the lowest value was 48.85 mg/100g, there was no significant difference between samples treated 20% and 40% ginger

and garlic extract. For sample treated with 20% ginger and garlic extract the highest value for vitamin C content was 57.60 mg/100g and the lowest value was 48.85 mg/100g for sample treated with 40% ginger and garlic extract the highest value was 63.60 mg/100g while the lowest value was 48.85 mg/100. It was observed that there was increase in sugar content for the entire sample. Increased in sugar content may probably brought about by the enzymatic conversion of carbohydrate and pectin by amylase and pectin as present. From the result obtained for titratable acidity there is significant difference between samples treated with 40% ginger and garlic extract when compared to untreated and 20% ginger and garlic sample. The increase in sugar content might be as a result of decrease in carbohydrate content, by the conversion of starch (carbohydrate) by various natural enzymes that include amylase and pectinase to sugar [9]. The degree of increase in TSS value for different extract treatments might be due to the modified internal atmosphere and physiological aspects of plantain fruits, suppressed respiration and metabolic processes, which involve in increasing TSS at different magnitudes.

Ripening Stages	pH	Vitamin C (mg/100g)	Total soluble sugar (% Brix)	Titratable Acidity (% citric acid)
Initial Green	5.00 ± 0.00	48.85 ± 0.37	45.33 ± 0.58	0.02 ± 0.00
Pale green	5.20 ± 0.00	49.15 ± 0.13	47.00 ± 0.00	0.03 ± 0.00
Green and Yellow	5.30 ± 0.10	50.06 ± 0.04	49.00 ± 0.00	0.03 ± 0.01
All Yellow	5.50 ± 0.10	52.89 ± 0.02	52.00 ± 0.00	0.04 ± 0.00

Table 2a: *Physico-chemical properties on untreated plantain stored at ambient condition.*

Ripening Stages	pH	Vitamin C (mg/100g)	Total soluble sugar (% Brix)	Titratable Acidity (% citric acid)
Initial Green	5.00 ± 0.00	48.85 ± 0.36	45.33 ± 0.58	0.02 ± 0.00
Pale green	5.53 ± 0.57	54.10 ± 0.91	54.67 ± 0.58	0.03 ± 0.00
Green and Yellow	5.70 ± 0.00	55.60 ± 0.26	57.00 ± 0.00	0.04 ± 0.00
All Yellow	5.97 ± 0.06	57.60 ± 0.62	60.33 ± 0.58	0.04 ± 0.03

Table 2b: *Physicochemical properties of plantain treated with 20% ginger extract stored at ambient condition.*

Ripening Stages	pH	Vitamin C (mg/100g)	Total soluble sugar (% Brix)	Titratable Acidity (% citric acid)
Initial Green	5.00 ± 0.00	48.85 ± 0.36	45.33 ± 0.58	0.02 ± 0.00
Pale green	5.53 ± 0.57	54.10 ± 0.91	54.67 ± 0.58	0.03 ± 0.00
Green and yellow	5.70 ± 0.00	55.60 ± 0.26	57.00 ± 0.00	0.04 ± 0.00
All Yellow	5.97 ± 0.06	57.60 ± 0.62	60.33 ± 0.58	0.04 ± 0.03

Table 2c: *Physicochemical properties on plantain treated with 20% garlic extract stored at ambient condition.*

Ripening Stages	pH	Vitamin C (mg/100g)	Total soluble sugar (% Brix)	Titratable Acidity (% citric acid)
Initial green	5.00 ± 0.00	48.85 ± 0.36	45.33 ± 0.58	0.02 ± 0.00
Pale green	5.33 ± 0.06	55.14 ± 0.86	53.00 ± 0.00	0.03 ± 0.00
Green and yellow	5.87 ± 0.06	57.04 ± 0.25	56.33 ± 0.58	0.04 ± 0.00
All Yellow	6.17 ± 0.06	63.60 ± 0.53	60.33 ± 0.58	0.07 ± 0.00

Table 2d: *Physicochemical properties of plantain treated with 40% ginger extract stored at ambient condition.*

Ripening Stages	pH	Vitamin C (mg/100g)	Total soluble sugar (% Brix)	Titratable Acidity (% citric acid)
Initial green	5.00 ± 0.00	48.85 ± 0.36	45.33 ± 0.58	0.02 ± 0.00
Pale green	5.33 ± 0.06	54.14 ± 0.86	53.00 ± 0.00	0.03 ± 0.00
Green and yellow	5.87 ± 0.06	57.04 ± 0.25	56.33 ± 0.58	0.04 ± 0.00
All Yellow	6.17 ± 0.06	63.60 ± 0.53	60.33 ± 0.58	0.07 ± 0.03

Table 2e: *Physicochemical properties on plantain treated with 40% garlic extract store at ambient condition.*

Values are expressed as Mean ± SD, different letters within the same column are significantly different (P < 0.05).

Shelf life of plantain fingers treated aqueous extract of ginger and garlic

Shelf life is the period from harvesting up to the last edible stage. Climacteric fruits such as plantain give off ethylene gas during ripening [19] which increases considerably as the ripening processes advance [20]. Ripening in fruits is proceeded by softening, with the resultant effect of increased moisture content of the fruits.

As observed in all samples during storage days, chemical treatment inhibits the action of ripening, cell wall break down and softening of all samples examined. Hence enzymatic action of ripening and cell wall break down were slow down during storage. Significant variation was obtained among the various extract treatment used in relation to shelf life extension of plantain fingers. From table 3, the colour of the treated and untreated plantain sample was determined based on the time when the peel becomes yellow. Daily observation for colour change on the peel was made throughout the period of storages. The peel colour changes of plantain sample were recorded according to modified method by Baiyeri [14]. From the result it was observed that the untreated sample ripped within a period of 6 days, and also the samples treated with 20% ginger and garlic extract delay the ripening time within a period of 14 days while the sample treated 40% ginger and garlic extract delay the ripening time with a period of 16 days. From the study it showed that extract with higher concentration is more effective than extract with lower concentration with an interval of 2 days. The treatments of fruit with garlic extract with combination of other extracts prolong the shelf life of ripe plantain 13 - 14 days and 12 - 13 days when compared with 6 - 7 days for untreated fruits [21]. The treatments delay the fruit softening by diminishing the rate of starch and pectin degradation [21]. The combined and interaction effects of different aqueous extract treatments were significant on shelf life extension of plantain fingers. The extended shelf life experienced by the plantain fingers may be due to low temperature as a result of the inhibition of ripening rates as contributed by the reduced physiological process, decay and weight loss.

Days of Treatment	Control	T_1	T_2	T_3	T_4
0	Green	Green	Green	Green	Green
2.	Pale green	Green	Green	Green	Green
4.	Pale green with yellow	Green	Green	Green	Green
6.	All yellow	Pale green	Pale green	Pale green	Pale green
8.	All yellow	Pale green with yellow tip	Pale green with yellow tip	Pale green	Pale green
10.	All yellow	Pale green with yellow	Pale green with yellow	Pale green with yellow	Pale green with yellow
12.	All yellow	More yellow than green.	More yellow than green	Yellow and pale green	Yellow and pale green
14.	All yellow	All yellow	All yellow	More yellow than green	More yellow than green
16.	All yellow	All yellow	All yellow	All yellow	All yellow

Table 3: *Shelf life of plantain fingers treated aqueous extract of ginger and garlic*

Green: Pre-Climacteric Phase; Pale Green: Pre-Climacteric Phase; Pale Green with yellow tip: Climacteric Phase; Pale Green and trace of yellow: Climacteric Phase; more yellow than green: Climacteric Phase; All yellow: Climacteric Phase.

Sensory properties of untreated and treated plantain fingers stored at ambient temperature

From table 4, it was revealed that the samples were assessed based on three parameters such as taste, smell and colour. From the result obtained from aqueous extract of ginger and garlic on plantain stored at ambient condition does not have any effect on the sensory parameter in respect to consumer acceptability. From the panelist the sample with the highest overall acceptability is sample treated with 20% (w/v) ginger extract with a significance difference of $P < 0.05$ [22].

Samples	Taste	Smell	Colour	Overall acceptability
Control	3.60 ± 0.09	3.33 ± 0.57	3.25 ± 0.5	3.75 ± 0.51
T_1	3.80 ± 0.63	3.33 ± 0.57	3.50 ± 1.29	4.50 ± 1.00
T_2	3.90 ± 0.63	3.33 ± 0.58	4.00 ± 0.82	4.00 ± 0.00
T_3	4.30 ± 0.87	3.67 ± 0.77	40.00 ± 1.15	4.25 ± 0.96
T_4	4.60 ± 0.67	4.67 ± 0.58	4.50 ± 1.00	4.25 ± 0.97

Table 4: *Sensory evaluation of plantain fingers treated with aqueous extract of ginger and garlic.*

Values are expressed as Mean ± SD, different letters within the same column are significantly different ($P<0.05$). T_1: Sample treated with 20% ginger extract, T_2: Sample treated with 40% ginger extract, T_3: Sample treated with 20% garlic extract, T_4: Sample treated with 40% garlic extract.

Conclusion

The percentage moisture content, ash, fat, protein for untreated and treated sample increased as ripening progressed while percentage crude fibre and carbohydrate decreased as ripening progress for proximate composition from when the plantain was green peel and all yellow. For chemical analysis such as pH, vitamin C, total soluble sugar, titratable acidity increased as ripening progress. The results showed that plantain improved its nutritional composition, and chemical composition and quality as ripening advances. It may be concluded that significant variation existed due to the effects of different aqueous extract treatments with respect to prolongation of shelf life. The longer shelf life of plantain fingers with above mentioned extract treatments might be related to the slower changes in chemical components. Therefore from the result obtained, sample treated with 40% ginger and garlic extract is more effective than sample treated with 20% ginger and garlic extract probably as a result of high concentration.

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