



Pre-Treatment Effects on Some Proximate and Phytochemical Components of Peeled and Unpeeled Ginger Powder

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ABSTRACT

Pre-treatment effects on the quality of oven –dried peeled and unpeeled ginger, grown locally from Kadjebi in the Volta Region of Ghana was evaluated by determining proximate and phytochemical content using conventionally accepted methods. The pre-drying treatments under investigation were dipping in 10% citric acid solution, dipping in 10% ascorbic acid solution, dipping in 10% sodium chloride solution and a control. The pre-treatments resulted in varied results in the pH, protein, vitamin C and TTA readings. The vitamin C content of the treated peeled and unpeeled samples, with ascorbic acid scored the highest value of $0.54 \pm 0.01 \text{ mg}/100 \text{ ml}$ for peeled and $0.95 \pm 0.01 \text{ mg}/100 \text{ ml}$ for unpeeled ginger. No significant difference was observed between the control of both peeled and unpeeled samples with respect to the protein content. However, there were significant differences in the treated peeled and unpeeled ginger samples. Peeled ginger, pre-treated with citric acid recorded the highest protein value of $9.63 \pm 0.11\%$. Unpeeled ginger samples exhibited higher antioxidant components than peeled ginger samples.

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Introduction

Ginger (*Zingiber officinale*) is a monocotyledonous perennial herb in the family *Zingiberaceae*, grown mainly for its spicy and aromatic rhizomes. It is an important tropical horticultural plant valued for its aroma, flavour and also medicinal properties. Ginger rhizome is consumed either fresh or after drying. Traditionally, ginger is preserved after harvest by sun drying. In Ghana, cultivation of ginger serves as the main livelihood for farmers engaged in that activity. However the harvested rhizomes are mostly faced with rapid deterioration before the products reach the market as a result of compact packaging in sacks with soil on the rhizomes, poor roads and transportation leading to huge post-harvest losses especially during the rainy season.

Drying is essentially important for preservation of agricultural crops for future use. It preserves crops by removing enough moisture from it to avoid decay and spoilage. While water content of most agricultural produce is greater than 50%, that of properly dried food varies from 5-25%, depending on the food (1). Ginger has been used as a spice and as natural additives for more than 2000 years (2). It has been identified as an herbal medicinal product with pharmacological effect. Ginger suppresses prostaglandin synthesis through inhibition of cyclooxygenase- 1 and cyclooxygenase- 2. In traditional Chinese and Indian medicine, ginger has been used to treat a wide range of ailments including stomach aches, diarrhoea, nausea, asthma, respiratory disorders (3). Perusal of literature indicates very scanty information on the application of pre-treatments to improve the hygienic quality of locally grown ginger for domestic and export markets. As ginger is widely used both as a spice and for its medicinal properties, the present study was undertaken to determine the nutritional composition of

dry ginger as well as its antioxidant activity and components. Therefore this work seeks to investigate the quality of peeled and unpeeled ginger powder by pre-treating the fresh ginger with recommended food grade chemicals.

Materials and Methods

Sample preparation

Fresh ginger samples were procured from Kadjebi, in the Volta Region of Ghana. The ginger was sorted, washed, and divided into two. One half was peeled and the other, left unpeeled. The peeled and unpeeled samples were then cut into smaller pieces and subjected to the following treatments;

- Soaking in 10% citric acid for 5 minutes.
- Soaking in 10% ascorbic acid for 5 minutes
- Soaking in 10% sodium chloride for 5 minutes..
- The control.

Prepared samples were placed in strainers to remove excess water. The slices were then loaded on stainless steel trays and were oven dried at 70°C and dehydrated for 24h to moisture content of about 10 per cent. The dry ginger was milled in a Christy and Norris Laboratory mill to pass through a 20-mesh sieve. The ground ginger was packed in polyethylene bags and stored in a desiccator for further use.

Physicochemical analysis

All the physicochemical analyses were done using the official methods of AOAC (2000).

Phytochemicals analysis

Extraction Process

Extraction was performed according to the method of (4) with some modifications. 0.5 grams of each sample were extracted in 10 ml of 60% ethanol. The mixture was placed in a conical flask (wrapped with an aluminium foil) and agitated at 200 rpm with orbital shaker for 1 hour at 25°C .

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Additional 10 ml of ethanol was used to re-extract the plant residue and the supernatants pooled. The extract was then separated from the residue by filtration through Whatman No. 1 filter paper.

Determination of Phenolic Content

The polyphenolic contents (PC) were measured by the Folin-Ciocalteu (FC) method using Gallic acid as standard (5) with modifications. Briefly, 50 μ l of the extract was mixed with 3ml of distilled water (dH₂O) and 250 μ l of FC reagent. The mixture was allowed to stand for 5 minutes, and then 750 μ l of 20% Na₂CO₃ was added. The resulting mixture was vigorously shaken on Vortex 2 Genie shaker for two minutes. After incubation of the resulting reaction mixtures for 30 min at room temperature absorbance values were measured at 760nm using a UV-VIS Spectrophotometer (Shimadzu, 1201, Japan). All determinations were performed in triplicate. A calibration curve was prepared using serial dilutions of 5mg/ml, 10mg/ml, 15mg/ml, 20mg/ml and 25mg/l from a stock solution of 1 mg/ml gallic acid dissolved in methanol. 50 μ l each of these solutions was treated like the samples and a calibration linear regression equation $y = 1.1353x + 0.0007$, $R^2 = 0.9993$ developed [y = absorbance and x = gallic acid conc (mg/ml)].

The polyphenolic content in each extract were calculated from the calibration curve and final results were recalculated and expressed as gallic acid equivalents per gram of dry ginger sample (mg GAE/g_{dw}).

Determination of Flavonoid Content

The aluminum chloride colorimetric assay method (6) was employed to evaluate total flavonoid content (TFC) in the samples using quercetin as standard. 500 μ l of extracts were mixed with 1500 μ l of 99.9% ethanol (EtOH), 100 μ l of 1 M potassium acetate, 100 μ l of 10% aluminum chloride and 3000 μ l of distilled water. The mixture was shaken vigorously and left to stand in the dark at room temperature. The resulting mixtures were incubated for 30 minutes at room temperature and corresponding absorbance measured at 415 nm. All determinations were carried out in triplicates. A standard calibration curve was constructed using quercetin standard solutions of 12.5 μ g/ml, 25 μ g/ml, 50 μ g/ml, 75 μ g/ml and 100 μ g/ml. 500 μ l of each standard was treated in the same manner as the samples above and calibration linear regression equation $y = 0.0062x + 0.0027$ ($R^2 = 0.9991$) generated. Flavonoid content of each extract was determined from the curve and the final results recalculated and expressed as microgram quercetin equivalent per gram of dry ginger sample (μ g QE)/g_{dw}).

Determination of DPPH Free Radical Scavenging Activity

The free radical scavenging activity was determined using 2, 2-diphenyl-1-picrylhydrazyl (DPPH) assay as described by (7). 200 μ l of extracts were each added to 3800 μ l of 0.004% DPPH in methanol. After 60 minutes of incubation at room temperature in the dark, the absorbance was measured at 517 nm. A blank sample containing only methanol was used to zero the spectrophotometer. Ascorbic acid (Vitamin C) was used for comparison. Each experiment was performed in triplicate. Radical scavenging activity (I %) was calculated as follows:

$$I\% = [(Abs_0 - Abs_1) / Abs_0] * 100$$

Abs₀ = absorbance of 0.004% DPPH without analyte.

Abs₁ = absorbance of 0.004% DPPH plus the test compound.

Statistical Analysis

Analysis was performed in triplicate. Results are expressed as mean \pm standard deviation or pooled standard error. Statistical analysis was done using Statgraphics version

16.1. Two-way ANOVA was used to test whether there were a significant difference the various treatment conditions. A significant difference was considered at the level of $p < 0.05$.

Results and Discussions

The study was conducted to find out the effects of the various pre-drying treatments in the quality of dehydrated ginger powder. The results of the various analysis are presented in Tables 1 and 2. Pre-treating both peeled and unpeeled ginger samples with NaCl, citric acid and ascorbic acid showed varied effects in comparison to the control with respect to the various parameters analysed. Comparing the pH values of peeled and unpeeled ginger samples within the same treatment showed no significant difference with the exception of the control. However, a general decreasing trend in pH was observed among the different treatments used with citric acid recording the least values (Table 1). According to (8), among all organic acids used to pre-treat green mussel, *Perna viridis*, the citric acid had a lower pH when compared with those pretreated with lactic and acetic acids. There were no significant differences observed in the TTA of peeled and unpeeled ginger samples treated with NaCl and ascorbic acid, which rightly correlates with the pH values obtained. However, the control and the citric acid treated samples were significantly different and also correlate well with the pH values obtained.

The vitamin C content remained unchanged in both peeled and unpeeled control samples (Table 1). However, varying results were observed in the treated peeled and unpeeled samples, with ascorbic acid treated samples scoring the highest value of 0.54 \pm 0.01 for peeled and 0.95 \pm 0.01 for unpeeled ginger. The canning of banana slices in solution containing 0.2% of L-ascorbic acid induced increases 13 times in the level of vitamin C in the final product according to (9). The low vitamin C content reported after pre-treatment with citric acid is due to the fact that citric acid prevents the oxidation degradation of vitamin C to other dehydroascorbic acid derivatives by scavenging oxygen according to (10). Furthermore, citric acid provides a low pH which inhibits enzymatic degradation of vitamin C. The Vitamin C content of a produce is also subject to degradation during processing and cooking (11).

No significant difference was observed between the control of both peeled and unpeeled samples with respect to the protein content. However, there were significant differences in the treated peeled and unpeeled ginger samples. Peeled ginger, pre-treated with citric acid recorded the highest protein value of 9.63 \pm 0.11. According to (12), mushroom samples steeped in citric acid, irrespective of drying methods used, exhibited higher contents crude protein as compared to control powder.

The profile of total phenolic contents of pretreated ginger samples was expressed as gallic acid equivalents per gram of dry ginger sample (mg GAE/g_{dw}) in Table 2. Antioxidant activities of plant extracts were usually linked to their phenolic content. Hydrogen donating characteristics of the phenolic compounds is responsible for the inhibition of free radical induced lipid ability to scavenge free radicals and give oxygen species such as singlet oxygen, superoxide free radicals and hydroxyl radicals (13), though, it is well accepted that non phenolic antioxidants might also contribute to the antioxidant activity of plant extract (14; 15). In this study, it was observed that high phenolic contents were recorded in unpeeled samples as compared to the peeled ginger samples. The highest total phenolic content of 29.93 \pm 0.26 mg GAE/g dw was in the ascorbic acid treated unpeeled ginger.

Table 1. Effect of different chemical treatments on some proximate properties of peeled and unpeeled ginger powder.

Treatments	Protein (%)		pH		Vitamin C (mg/100ml)		TTA	
	Peeled	Unpeeled	Peeled	Unpeeled	Peeled	Unpeeled	Peeled	Unpeeled
Control	6.83±0.11 ^a _y	7.18±0.11 ^a _x	5.96±0.03 ^a _w	5.77±0.03 ^b _w	0.12±0.01 ^a _x	0.12±0.01 ^a _x	0.22±0.01 ^a _x	0.07±0.01 ^b _y
NaCl	6.65±0.11 ^b _y	8.58±0.11 ^a _w	5.76±0.03 ^a _x	5.81±0.03 ^a _w	0.08±0.01 ^b _y	0.12±0.01 ^a _x	0.07±0.01 ^a _z	0.06±0.01 ^a _y
Citric Acid	9.63±0.11 ^a _w	5.08±0.11 ^b _y	3.53±0.03 ^a _z	3.54±0.03 ^a _y	0.03±0.01 ^a _z	0.03±0.01 ^a _y	0.48±0.01 ^b _w	0.53±0.01 ^a _w
Ascorbic Acid	8.93±0.11 ^a _x	4.90±0.11 ^b _y	4.21±0.03 ^a _y	4.23±0.03 ^a _x	0.54±0.01 ^b _w	0.95±0.01 ^a _w	0.18±0.01 ^a _y	0.18±0.01 ^a _x

means ± standard error three replicates

^{a-b} alphabet with different letters on the same row are significantly different ($P \leq 0.05$)

^{w-z} alphabet with different letters on the same column are significantly different ($P \leq 0.05$).

Table 2. Effect of different treatments on the phytochemicals of peeled and unpeeled ginger powder.

Treatments	Total Phenolics (mg GAE /g DW)		Total Flavonoid (mg GAE /g DW)		DPPH (%)	
	Peeled	Unpeeled	Peeled	Unpeeled	Peeled	Unpeeled
Control	18.21±0.26 ^b _y	20.81±0.26 ^a _y	15.55±0.49 ^b _y	18.57±0.49 ^a _y	26.13±0.38 ^b _y	31.56±0.38 ^a _{xy}
NaCl	19.76±0.26 ^b _x	21.83±0.26 ^a _x	19.87±0.49 ^a _x	21.16±0.49 ^a _x	27.79±0.38 ^b _x	32.36±0.38 ^a _x
Citric Acid	16.83±0.26 ^b _z	20.10±0.26 ^a _y	13.56±0.49 ^b _z	17.16±0.49 ^a _y	24.88±0.38 ^b _y	30.90±0.38 ^a _y
Ascorbic Acid	24.07±0.26 ^b _w	29.93±0.26 ^a _w	25.05±0.49 ^b _w	30.01±0.49 ^a _w	36.79±0.38 ^b _w	39.38±0.38 ^a _w

means ± standard error three replicates

^{a-b} alphabet with different letters on the same row are significantly different ($P \leq 0.05$)

^{w-z} alphabet with different letters on the same column are significantly different ($P \leq 0.05$).

The higher phenolic content can be partially explained by the treatment with ascorbic acid which tends to have higher antioxidant activity and correlates well with total phenolic content (16).

Total flavonoid contents of the peeled and unpeeled ginger are shown in Table 2. Among the phenolic compounds are flavonoids which possess biological activities such as antioxidative, anti-inflammatory and antiatherosclerotic activities. The antioxidative properties of flavonoids can be linked to several different mechanisms, such as scavenging of free radicals, chelation of metal ions, such as iron and copper, and inhibition of enzymes responsible for free radical generation. Depending on their structure, flavonoids are able to scavenge practically all known ROS. The many pharmacological effects of phenolic compounds and flavonoids are linked to their ability to act as strong antioxidants and free radical scavengers, to chelate metals, and to interact with enzymes, adenosine receptors, and bio membranes (17). Ascorbic acid treated ginger samples had the highest values of 25.05±0.49 and 30.01±0.49 mg GAE /g dw for peeled and unpeeled ginger respectively while citric acid treated samples had the least values. These differences may be attributed to ascorbic acid which is presumed to have higher antioxidant properties than citric acid.

DPPH is a stable free radical in methanol or aqueous solution and accepts an electron or hydrogen radical to turn into stable diamagnetic molecule. It is usually used as a substrate to evaluate the antioxidative activity of antioxidants (18), thus we have estimated the antioxidant activity through free radical scavenging of ginger. Free radical scavenging potency of the samples is seen in Table 2 which showed the highest DPPH radical scavenging activity in ascorbic treated samples followed by NaCl treated samples. In a study, by (19), DPPH radical scavenging activity of methanol extract was found to be in a range of 32 – 90.1% in 100 mg of 18 different ginger species.

Conclusion

It can be concluded that ginger is a good source of antioxidant especially in the unpeeled form and most of the antioxidant components exhibit higher activities in alcoholic

media as determined by different assays. Hence, apart from its medicinal properties, ginger can also be used as an antioxidant supplement. More also, citric acid, ascorbic acid and sodium chloride pre-treatments used in the study had significant effects on the proximate and phytochemical parameters of peeled and unpeeled ginger powder.

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References

- [1] Bhandary, U; Sharma, J.N and Zafar, R . Effect of protection action of Ethanolic Ginger (*Zingiber officinales* extract in cholesterol fed rabbits. J. Ethnopharm, 1997, vol 61(2),pp 167-175.
- [2] Bartley J, Jacobs A. Effects of drying on flavour compounds in Australian-grown ginger (*Zingiber officinale*). J. Sci. Food Agric, 2000, vol 80(2): pp 209-215.
- [3] Grzanna R, Lindmark L, Frondoza C. Ginger-A herbal medicinal product with broad anti-inflammatory actions. J. Med. Food, 2005, vol 8(2);pp 125-132
- [4] J.H. Yang, H.C. Lin, J.L. Mau, "Antioxidant properties of several commercial mushrooms", Journal of Food Chemistry, 2002, vol 77(2), pp 229-235.
- [5] Singleton, V.L. Orthofer, R. Lamuela-Raventós, R.M. and Lester, P. "Methods in Enzymology", ed., Academic Press. 1999, pp 152-178
- [6] Zhishen J, Mengcheng T, Jianming W. The determination of flavonoid contents in mulberry and their scavenging effects on Superoxide radicals, Food chem. 1999, vol 64: pp 555-559.
- [7] W. Brand-Williams, M.E. Cuvelier, and C. Berset, "Use of free radical method to evaluate antioxidant activity", Lebensm Wiss Technology, 1995, vol 28, pp. 25-30.
- [8] Masniyom, P. and Benjama, O. Effect of lactic, acetic and citric acids on quality changes of refrigerated green mussel, *Perna viridis* (Linnaeus, 1758) Songklanakarin J. Sci. Technol., 2007, 29(4) : 1123-1134.
- [9] Jaworska G , Kmiecik W. , Słupski J. Effect of technological measures on the quality of canned banana

desserts, EJPAU,2004, 7(1), #05. Available Online: <http://www.ejpau.media.pl/volume7/issue1/food/art-05.html>

(10) G.M. Sapers and R.L. Miller "Heated ascorbic/citric acid solution as browning inhibitor for pre-peeled potatoes", Journal of Food science, 1995, vol 60, pp 762-766.

(11) S.K. Lee, and A.A. Kader "Preharvest and postharvest factors influencing vitamin C content of horticultural crops", Journal of Postharvest Biology Technology, 2000, vol 20 (3), pp 207-220.

[12] Dunkwal, V., Jood, S. and Singh, S. Physico-chemical properties and sensory evaluation of Pleurotus Sajor Caju powder as influenced by pretreatments and drying methods. Br. Food J. 2007,vol 109, pp749–759.

[13] Hall, C. Structure-Activities of natural antioxidants. In "Antioxidant Methodology. in vivo and in vitro. concepts., Ed. by Aruoma, OI and Cuppett, SL, AOAC press:1997, Champaign, IL.

[14] Hassimotto N, Genovese M, Lajolo F. Antioxidant activity of dietary fruits, vegetables, and commercial frozen fruit pulps. J. Agric. Food Chem., 2005 vol 53(8):pp 2928-2935.

[15] Harish R, Shivanandappa T. Antioxidant activity and hepatoprotective potential of *Phyllanthus niruri*. Food Chem. 2006, vol 95(2):pp 180-185

[16] Velioglu YS, Mazza G, Gao L, Oomah BD . Antioxidant activity and total phenolics in selected fruits, vegetables, and grain products. J Agric Food Chem, 1998,vol 46: pp4113-4117.

[17]Mitra, K. and Uddin, N. Total Phenolics, Flavonoids, Proanthocyanidins, Ascorbic Acid Contents and *In-Vitro* Antioxidant Activities of Newly Developed Isolated Soya Protein. Discourse Journal of Agriculture and Food Sciences, 2014, Vol. 2(5): 160 -168

[18]Duh P, Tu Y, Yen G. Antioxidant activity of aqueous extract of ham jzur (*Chrysanthemum morifolium* Ramat). LWT. J. Food Sci. Tech.,1999, vol 32:pp 269-277.

[19]Chen I, Chang C, Ng C, Wang C, Shyu Y , Chang T. Antioxidant and antimicrobial activity of *Zingiberaceae* plants in Taiwan. Plant Food Hum. Nutr.,2008, vol 63(1):pp 15-20.