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Nutritional and Anti-Nutritional Composition of Banana Peels as Influenced by Microwave Drying Methods

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***Abstract*—**The influence of microwave drying methods on the nutritional and anti-nutritional composition and physical characteristics of banana peels was investigated. Banana peels were assessed for physical properties such as yield, pH value, bulk density, water holding capacity (WHC) and oil holding capacity (OHC). The results showed that, the yield of banana peels and pH value was significantly ($P < 0.05$) decreased by microwave drying (11.20% and pH 5.08, respectively) compared with control. Bulk density was increased by microwave drying and recorded 62.03 g/100 ml. The banana peels flour demonstrated that the highest WHC was 8.65 g water/g dry sample and OHC was 6.73 g oil/g dry sample compared to control. The results observed a significant decrease ($P < 0.05$) in moisture, fiber and total carbohydrates content of banana peels; whereas, the rates of ash, protein and fat content were increased after drying by microwave compared with control. The lignin content of banana peels was significantly increased ($P < 0.05$) by microwave drying and the recorded value was 8.31% dw. The results also revealed that the ascorbic acid content was significantly decreased by microwave drying and recorded 18.32 mg/100 g dw vis. 23.51 mg/100 g dw for control. With regarding the anti-nutrients, phytates, alkaloids, oxalates and hydrogen cyanides levels in banana peels, it was in the threshold value mentioned as safety restrict. These results demonstrated that the levels of phytates, alkaloids, oxalates and hydrogen cyanides were decreased by microwave drying methods which recorded 4.07%, 5.45%, 0.85% and 32.15%, respectively.

***Keywords*—**Banana peels, microwave drying, physical characteristics, nutritional composition, anti-nutritional composition.

I. Introduction

BANANA having a place with the family Musaceae are a standout amongst the most tropical organic products of the planet. Banana peel accounts about 40% of overall weight of the fresh fruit [1]. Banana peels have different medical advantages to amazing dietary status, and it treats the intestinal sore, looseness of the bowels, diarrhea, ulcerative colitis, nephritis, gout, heart infection, hypertension and diabetes [2].

Potential applications for banana peel depend upon its chemical composition. Banana peel is rich in dietary fiber (50% on a dry matter (dw) basis), proteins (7% dw), essential amino acids, polyunsaturated fatty acids and potassium [3].

The high value of organic content (lipids, proteins and carbohydrates) demonstrates that banana peels are great wellspring of carbohydrates and fibers. Higher fiber content moreover demonstrates that banana peels could help treat constipation and improve general health and wellbeing. Short shelf life and extended creation require improvement in non-conventional products of banana [4].

The banana peel like its banana flour accomplice can similarly offer nutritional products since the peel contains phytochemical compounds and enhanced with minerals like potassium, phosphorus, magnesium and calcium [5].

Banana peel is rich in phytochemical compounds mainly antioxidants. The total amount of phenolic compounds in banana peel has been represented for from 0.90 to 3.0 g/100 g dry weight [6]. As indicated by Someya et al. [7], it was rich in phenolics especially, in peel (907 mg/100 g dry wt.). It also contains antioxidant compounds including polyphenols, catecholamins and carotenoids. Dietary polyphenols, with the aid of its wonderful antioxidant properties that cross beyond the adjustment of oxidative stress, play a critical function in the prevention of degenerative diseases especially, cardiovascular diseases and cancer [8].

The banana peel contains some anti-nutritional factors variables tannins, oxalate, and phytate among others which could initiate antagonistics like depressive growth, reduced feed and vital organs damage in the body [9].

Some anti-nutritional factors may exert beneficial health effects on low concentrations. Hence, the manipulation of processing conditions and removal or decrease of certain unwanted components of food might be required [10].

The dehydration processes is an essential operation step utilized for reducing moisture content of banana peels. The utilization of new technologies, like microwave could decrease the drying time and save the quality of dried foodstuff. Microwave drying has accomplished extensive consideration in the past, gaining popularity because of its advantages over conventional heating such as decreasing the drying time of biological material with little quality loss [11]. The microwave heating method dehydrates food by interactions between the electromagnetic energy and polar molecules within the material [12]. Moreover, microwave applications result in faster and better rehydration compared with hot air drying process [13].

Hayat et al. [14] demonstrated that suitable microwave treatment might be an efficient manner to liberate and activate the bound phenolic compounds and to upgrade the antioxidant activity of fruit peels.

Currently, the increasing interest for natural sources of

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bioactive compounds and the popularity of the concept of functional foods, food products enriched with fruit peels are been created [15]. But the utility of fruit peels in nourishment supplementation relies upon emphatically on their chemical composition. The information on microwave drying effects on the nutritional and anti-nutritional factors in banana peels is scare. In the present study an attempt has been made to assess the influence of microwave drying method on the anti-nutritional factors (phytates, alkaloids, oxalate, and hydrogen cyanide) in banana peels. For this reason, the effect of the microwave drying method on the nutritional and ant-nutritional factors of banana peel was studied.

II. Materials and Methods

A. Materials

Banana peels were collected as a waste of other activities at Laboratory of Food Science and Technology, Food Technology Department, Food Technology and Nutrition Division, National Research Centre (NRC), Dokki, Cairo, Egypt.

B. Chemicals and Reagents

Analytical grade of chemicals and reagents were purchased from Sigma, Aldrich & Fluka Chemical Co. (St. Ouis, Mo, USA). The distilled water was prepared by distillation apparatus HAILTON (Kent CT9 4JG).

C. Preparation of Banana Peels

Banana fruits were washed and separated into pulp and peels. The peels were cut into small pieces. The banana peels were dipped in 0.5% (w/w) citric acid solution for 10 min. to reduce enzymatic browning. The solution was drained and dried on the perforated trays using the Microwave-drying Samsung (Model MF245) with oven cavity dimensions of 419 x 245 x 428 mm, operation frequency of 2.450 MHz, and power source of 230 V-50 Hz. The nominal microwave power out putting was 900 Ws, air temperature 40 °C /7 min.

Banana peels were milled using a blender (Braun KMM 30 mill), type 3045, CombiMax (Germany) to pass through 40 mesh screen sieve. The dried banana peels were immediately packed in polyethylene bags and stored at 4 °C in refrigerator until used.

Yield: The yield of banana peel flour was calculated by dividing the amount of flour produced by the amount of banana peel fresh used and the results were converted to g of flour/kg of banana. Banana peel flour has been stored in plastic packs in cold storage (4± 2 °C) [16].

D. Determination of Physical Characteristics

1. pH value

Banana peel flour suspension (8% w/v) was stirred for 5 min, allowed to stand for 30 min, filtered and the pH value of filtrate is measured using pH meter [17].

2. Bulk Density (BD)

A 20 g sample was placed into a 100 mL graduated cylinder. The cylinder was tapped for 10 times and the BD was decided by reading the final volume [18]. BD was calculated as:

$$BD = \text{Mass of Materials} / \text{Volume of Material after tapping}$$

3. WHC and OHC

25 mL of distilled water or corn oil were added to 1 g of dry sample and stirred and centrifuged at 3000 g for 20 min. The supernatant was decanting and the tubes were allowed to drain for 10 min at 45° angle. The WHO and OHC was calculated as g water or oil per g dry sample [19] after the residue was weighed.

E. Chemical Analysis

Chemical analysis of the banana peel fresh and dried samples was evaluated, namely moisture, protein, ash, fat and crude fiber according to the methods described previously in [20]. Total carbohydrates content was determined according to [21]:

$$\text{Carbohydrates \%} = 100 - (\text{moisture \%} + \text{protein \%} + \text{ash \%} + \text{fat \%} + \text{crude fiber \%})$$

All analyses were performed in triplicate.

1. Lignin Content Determination

The content of lignin was determined gravimetrically using 70% (v/v) H_2SO_4 solution according to [22] to hydrolyze the cellulose and hemicellulose in 2 g (W1) of sample and the remaining suspension was filtered with hot water. Then 30 mL of 70% H_2SO_4 was added into the mixture and the solid residue was then transferred to a pre-weighted porcelain crucible. The sample was dried at 105 °C for 24 h and the weight was recorded (W2). The residue was heated at 650 °C until all carbon is eliminated. After cooing, it was weighted (W3) and lignin content (%) was determined as follows:

$$(\%)\ \text{Lignin} = \{[(W2)-(W3)]/(W1)\} \times 100$$

2. Determination of Vitamin C (Total Ascorbic Acid)

2, 6-dichloroindophenol titrimetric method [23] is used to determine the vitamin C content of banana peel extracts. Results are expressed in mg ascorbic acid/g dry weight.

F. Determination of Anti-Nutrients in Banana Peel

The levels of anti-nutrients like phytates, alkaloids, oxalates and hydrogen cyanide content in banana peel were investigated.

1. Phytates Content

Banana peel flour (4 g) was soaked in 100 mL of 2% hydrochloric acid. For five hours, 25 mL of the filtrate was taken into a flask and was added of 5 mL of 0.3% ammonium thiocyanate solution. Titration of the mixture standard solution to iron(III) chloride until a brownish yellow colour was persisted for 5 min [24].

2. Alkaloids Content

Approximately 5 g of each sample was dispersed into 50 mL of 10% acetic acid solution in ethanol. The mixture was shaken after which allowed to stand for approximately about 4 h and then filtered. The filtrate was then evaporated to its original volume using hot plate. A drop concentrated ammonium hydroxide was added so as to precipitate the alkaloids. The precipitate was filtered with pre-weighed filters paper and it was then washed with 1% ammonium hydroxide solution. The filter paper containing the precipitate was dried on an oven at 60 °C for 30 min then transferred into desiccators to cool and then reweighed until a constant weight was obtained. The constant weights were recorded. The weight of the alkaloid is determined by weight difference between the filter paper and expressed as a percentage of the sample weight analyzed [25].

3. Oxalates Content

The sample (2 g) was digested with 10 mL of 6 M hydrochloric acids for 1 h and made up to 250 mL in a volumetric flask. The pH of the filtrate was adjusted using concentrated ammonium hydroxide solution until the colour of solution changed from salmon pink colour to a faint yellow colour. To precipitate the insoluble oxalate, the filtrate was treated with 10 mL of 5% calcium chloride solution and the suspension was centrifuged at 2500 rpm. The precipitate was completely dissolved in 10 mL of 20% sulphuric acid. The total filtrate resulting from the dissolution in sulphuric acid was made up to 300 mL. The aliquot of 125 mL of the filtrate was heated until near boiling point and then titrated against 0.01 N of standardized potassium permanganate solution to a faint pink colour which persisted for about 30 s [26].

4. Hydrogen Cyanides Content

The determination of hydrogen cyanide content of peels was determined by the procedure described by Suresh et al. [27].

G. Statistical Analysis

Data were subjected to statistically analysis of variance (ANOVA) p≤ 0.05 [28].

III. Results and Discussion

A. Physical Characteristics of Banana Peels as Influenced by Microwave Drying Methods

The results of physical characteristics of banana peels as influenced by microwave drying methods are given in Table I. These results demonstrated the yield of banana peel as decreased significantly (P< 0.05) by microwave drying and recorded 11.20% compared with control (12.85%). These results were steady with the earlier finding [29] which expressed that the yield of banana peels powder extended from 11-17%.

The pH value presented in Table I demonstrated that the pH value of banana peel reduced significantly (P< 0.05) by microwave drying (5.08) compared with control (6.06). These results are in agreement with those reported by Rodriguez-Ambriz et al. [16] who reported that the mean pH value of banana peel flour extended for 4.80 to 5.47. The pH differences might be attributed to depolymerisation resulting from the thermal treatments, remedies; consequently, producing acid terminal residues within the starch molecules [30].

The results presented in Table I also demonstrated that the levels of BD of the banana peels was significantly increased (P< 0.05) by microwave drying which recorded 62.03 g/100 ml dw compared with control which recorded 51.43 g/100 ml dw, and demonstrated a more compactness of the particles. These results are comparable to the levels obtained with banana peel (62 to 66 g/100 ml) [29] suggesting that the samples were light in weight which might be due the expected differences in varieties of cultivars.

BD is an indication of the porosity of a food product which may affect its package design and it is a function of its wet-ability; higher BD is a desired attribute for more r ease of dispensability of flour [31].

Table I presents the WHC and OHC of banana peel as affected by microwave drying methods. The banana peels flour demonstrated the highest WHC (8.65 g water/g dried sample); and OHC (6.73 g oil /g dried sample) compared to the control. This can be due to the decrease of initial moisture content of banana peel in comparison to the peel permitting the adsorption of greater water and oil. These results suggested that microwave drying has a highly significant effect on WHC and OHC of peel. According to these results, it seems that dried banana peel reveals a higher capacity to absorb water, being this property one of the most desirable characteristics for the functionality of dietary fiber [32]. These results are close to [33]. The WHC and OHC of banana peels were high values which was associated with the dietary fiber fraction contained in the peels. In addition, the correlation between OHC and the protein was very high (Table I). This suggested that the OHC of the flour source samples can also rely upon the total content of protein present [34]. Ferreira et al. [35] announced that each WHC and OHC associate with food quality because they are important functional properties. In general the mean OHC of all samples was increased by microwave drying and recorded 6.73 g oil /g dry samples.

TABLE I
Physical Characteristics of Banana Peel (% dw) as Influenced by Microwave Drying Method

Sample	Yield %	pH	BD (g/100ml)	WHC g water/g dry sample	OHC g oil /g dry sample
Control	$12.85^{a}\pm 2.0$	$6.06^{a}\pm0.02$	$51.43^{b}\pm3.04$	$7.72^{b}\pm2.02$	$5.43^{b}\pm2.0$
Microwave- drying	$11.20^{b}\pm1.0$	$5.08^{b}\pm0.02$	$62.03^{a}\pm3.0$	$8.65^{a}\pm2.0$	$6.73^{a}\pm2.0$
L. S. D at 5 %	1.02	0.02	2.39	0.02	0.03

-All values are means of triplicate determinations ± standard deviation (SD).
- Means within columns with different letters are significantly different (P < 0.05).

The major chemical compositions that enhance the water absorption capacity of flours are proteins and carbohydrates, since these constituents contain hydrophilic parts such as polar or charged side chain [36]. WHC was high since the recorded value was 8.65 g water/g dry sample. This could be due to high fiber content of peel which comprise of a large number of hydrophilic groups that absorb water. OHC identifies with the hydrophilic character of starches introduced to the flour [19] that is available in high quantity of green flour [19] and in lesser quantity in ripe flour.

According to Johnson [37], water could be held in capillary structures of the fiber as a result of surface tension strength, and also water should have interaction with molecular components of fiber through hydrogen bonding or dipole form. However, OHC relies upon on surface properties, overall charge density, thickness and hydrophobic nature of the fiber particle. WHC obtained for the microwave dried peel were higher than that presented previously [32].

Microwave drying affects the fibrous matrix modifying the structural characteristics and the chemical composition of the fiber (water affinity of its components) and promoting water retention to the detriment of oil retention [38].

Powder properties including BD, WHC and OHC affect the functional properties of the powder and are critical parameters for controlling quality [39].

B. Chemical Characteristics of Banana Peels

Table II summarizes the proximate composition of the banana peel as influenced by microwave drying methods. It is clear that there was a significant decrease ($P< 0.05$) in moisture content after drying banana peel by microwave. Control banana peel had moisture 90.84%, while after microwave drying the moisture content reduced to 7.77% dw. The moisture content of banana peel was close to [40] which was 6.39% dw and lower than the moisture content announced by Almeida et al. [41] which was 13.49 % dw.

Table II reported that there are significant differences ($P< 0.05$) between the ash content in control and microwave drying. Increased levels of ash content leads to a decrease in the moisture contents of the samples and vice versa. The highest value of ash content was detected in banana peels dried by microwave which recorded 20.79% dw compared to control, 15.97%. The variation in ash content relies upon plant species, geographical origins, their method of mineralization, in addition to effect of food processing by drying [42]. The results are in agreement with those reported by [40] which revealed that the ash content of banana peel flour was 22.2%.

The results (Table II) proved that there is a significant increase ($P< 0.05$) in protein content in banana peels dried by microwave compared with control. The protein content of control was found 7.31%, while after microwaving the protein content increased to 10.82% dw. The increase in protein content may be attributed to the fact that during microwaving some form of chemical transformation of starch fraction of water soluble components might have taken place and also this increase may be due to more efficient extraction [10]. The protein content was comparable to 10.44% [46], 9.10% [29] and 8.74% [40].

Protein helps in constructing and keeping up all tissues within the body, forms an important part of enzymes, fluids and hormones of the body and moreover shapes antibodies to fight infection and supplies energy [47].

Table II also demonstrated that there are significant differences ($P< 0.05$) between the fat content of control and microwave drying. The highest value of fat content was detected in banana peels dried by microwave which recorded 9.35% dw compared with control, 5.38%. These results are similar to those reported by [43] which was 7.9% and lower than value found in banana peel by [29], [44], [45] which were 11.26%, 13.10% and 11.60%, respectively. This is due to both the differences in varieties and geographical factors [46].

The crude fiber content of dried samples of lipid extraction analyzed by utilizing acid digestion and alkali digestion and the results was presented in Table II demonstrated that fiber content of banana peel as influenced by microwave drying. The results indicated that fiber contents in banana peel significantly decrease ($P< 0.05$) by microwave drying. The value of fiber content of control sample recorded 9.21%. These levels were decreased by microwave drying, 17.89% dw. This is due to the differences in varieties of cultivars which have shown previous research that the fiber content of 14.83 % in banana peel [41].

The high temperature leads to the reduced crude fiber content. This may be due to the degradation of pectin or other fibers including cellulose or hemicellulose all through drying process [48].

TABLE II
PROXIMATE COMPOSITION OF BANANA PEEL AS INFLUENCED BY MICROWAVE DRYING METHOD (% DW)

Components	Control	Microwave drying
Moisture	$90.84^a \pm 3.52$	$7.77^b \pm 1.02$
Ash	$15.97^b \pm 2.15$	$20.79^a \pm 1.15$
Protein	$7.31^b \pm 0.11$	$10.82^a \pm 2.0$
Fat	$5.38^b \pm 0.02$	$9.35^a \pm 0.11$
Crude fiber	$19.21^a \pm 2.0$	$17.89^b \pm 2.0$
*Total carbohydrates	$38.71^a \pm 3.0$	$33.38^b \pm 1.53$

-All values are means of triplicate determinations ± standard deviation (SD).
- Means within columns with different letters are significantly different ($P < 0.05$).
*Total carbohydrates: calculated by differences.

The results in Table II showed that the total carbohydrates content of banana peels is influenced by microwave drying. These results revealed that there is a significant decrease ($P< 0.05$) due to microwave drying. The value of total carbohydrates content of banana peels in control recorded 38.71%. These levels were decreased by microwave drying which recorded 33.38%. The levels of the total carbohydrates in banana peels were (33.38% dw). This might be due to the differences in varieties of cultivars. These results are similar to the result reported in a previous study [41] who found that the banana peels contained 32.39% carbohydrates. These results are comparable to the result which suggested that the banana peels are good sources of nutrients particularly carbohydrates and fiber. This indicated that the peels are helpful in the treatment of consumption and improve general health due to the high content of fiber. Moreover, the high level of carbohydrates to improve baked characteristics as an example, their texture and structures which might be attractive to baked goods [49].

C. Lignin Content of Banana Peels as Influenced by Microwave Drying

The results presented in Table III revealed that the levels of lignin samples are significant among the different types of the sample source. The results showed that there is a significant (P <0.05) increase in the lignin content in the banana peel dried by microwave. The recorded value was 8.31% dw compared with control (6.82% dw). The results demonstrated that microwave drying procedure has the highest effect on the retention of lignin content of banana peel. The generally low content of lignin around 6.82-8.31% dw in banana peel samples indicated the absence of secondary wall of tissue [50]. Emaga et al. [51] reported that the banana peels are also a good source of lignin (6-12%).

TABLE III
LIGNIN CONTENT OF BANANA PEEL AS INFLUENCED BY MICROWAVE DRYING METHOD (% DW)

Sample	Lignin
Control	$6.82^{b}\pm1.02$
Microwave -drying	$8.31^{a}\pm2.0$
L. S. D at 5 %	1.94

All values are means of triplicate determinations ± standard deviation (SD).
Means within columns with different letters are significantly different (P < 0.05).

D. Ascorbic Acid (Vitamin C) Content of Banana Peels as Influenced by Microwave Drying

Vitamin C is considered to be an antioxidant compound of natural origin in the diet [42]. Data in Table IV demonstrated the effect of microwave drying method on the levels of ascorbic acid in banana peel. The results confirmed that the highest value of ascorbic acid was detected in control which recorded 23.51 mg/100g dw in comparison to microwave drying (18.32 mg/100g dw). These levels decreased by microwave drying method. Ascorbic acid contents of banana peel reduced 22.08% with microwave drying. These results confirmed that ascorbic acid content was significantly (P< 0.05) decreased by microwave drying. This could be ascribed to the way that ascorbic acid is not steady at high temperature [53].

The vitamin C content found in the microwave dried banana peels was higher than those revealed for orange peel (16.25 mg of ascorbic acid/100g dw) and mandarin peel (12.32 mg of ascorbic acid/100g dw) [54]. Shyamala et al. [29] found that the vitamin C content was high in banana peels variety (Yelakkibale) (17.83 mg/100 g dw) contrasted with the other two variety and biochemical roles [58].

E. Anti-Nutritional Factors of Banana Peels as Influenced by Microwave Drying

The effect of microwave drying on the anti-nutritional factors of banana peels viz. phytates, alkaloids, oxalate, and hydrogen cyanide is shown in Table V.

TABLE IV
VITAMIN C (ASCORBIC ACID) OF BANANA PEEL AS INFLUENCED BY MICROWAVE DRYING METHOD (MG/100 G DW)

Sample	Vitamin C	Loss %
Control	$23.51^{a}\pm2.01$	-
Microwave -drying	$18.32^{b}\pm1.03$	22.08
L. S. D at 5 %	4.53	-

All values are means of triplicate determinations ± standard deviation (SD).
Means within columns with different letters are significantly different (P <0.05).

1. Phytates

Phytic acid found in plant materials is known for its chelating impact on certain essential mineral elements for instance, Ca, Mg, Fe and Zn to form insoluble phytate salts [55].

Data in Table V showed the levels of phytates content in banana peel as influenced by microwave drying. It is clear that there was a significant decrease (P< 0.05) in phytates after microwave drying which recorded 4.07% dw in comparison with control which recorded 6.98% dw. In this way, the drying method of the microwave reduced the level of the phytates were 41.69%. Likewise, Feumba et al. [46] announced that the phytates levels obtained in banana peels were 6.02% dw, and the phytates in fruit peels (pawpaw, pineapple, mango, apple, orange, pomegranate and watermelon) ranged from 0.70 ± 0.17 to 6.02 ± 0.61.

Earlier also, Wang et al. [56] mentioned a lower level in phytic acid contents of plant foodstuffs when they were subjected to various thermal treatment like microwave, autoclave etc. They attributed the decrease in phytate content due to the formation of insoluble complexes about phytates and other compounds.

Decrease of phytic acid contents has been attributed to low inositol and inositol phosphate by the action of free radicals generated during irradiation [57].

2. Alkaloids

The alkaloids levels of banana peels as influenced by microwave drying are given in Table V. Results showed that there is significant (P< 0.05) decrease by microwave drying method. The value of alkaloids content was distinguished from control sample which recorded 6.26% dw. These levels were reduced to 5.45% dw. Therefore, microwave drying was proved to be effective against reduction in alkaloids level (12.94%). The content of alkaloids in fruit peels is low where the levels ranged from 5.44 ± 0.72 and 16.19 ± 3.28. The highest alkaloids content was observed in pineapple peels, while the lowest content in orange peels [36]. The alkaloids content seen in the analyzed fruits is lower than 29.5% of alkaloids found in Irish potatoes [58]. These alkaloids caused gastrointestinal and neuron disorders [59], [60].

3. Oxalate

Oxalates can bind to calcium in food thereby rendering calcium inaccessible for ordinary physiological. The results in

Table V showed the oxalate content of banana peels as influenced by microwave drying. These results demonstrated that there was a significant decrease (P< 0.05) of the oxalate content of banana peels after microwave drying which recorded 0.85 mg/100 g dw compared with control, 1.93 mg/100g dw. Therefore, microwave drying was proved to be effective against reduction of oxalate level (55.96%) and it causes an acute heat stress which destroys the total oxalate [57].

Banana peel contains a low amount of anti-nutritional factors, where it is noted that the content of oxalate in the peels is 0.51 mg/g [61]. Oxalate consumption had been related to kidney diseases which may result to death. Dietary oxalate also promotes a calcium, magnesium and iron complex which is the basis of oxalate kidney stones [62].

4. Hydrogen Cyanide

Hydrogen cyanide is a great degree toxic substance formed by the activity of acids on metal cyanides [46]. The hydrogen cyanide content of banana peels as influenced by microwave drying is represented in Table V. It is clear from this table that there was a significant decrease (P< 0.05) in hydrogen cyanide content with microwave drying which recorded 118.53 mg/100g dw. These levels were decreased to 32.15 mg/100 g dw. The results showed that microwave drying reduced the level of hydrogen cyanide to 72.88%. These results are in agreement with those reported by Feumba et al. [46] who revealed that the hydrogen cyanide content found in banana peels was 116.26 mg/100g and the results comparable to 133 mg/100 g observed elsewhere [1]. High dose of hydrogen cyanide can cause death within few minutes, while low measurements may bring about solidness of the throat, chest, palpitation and muscle shortcoming. The outcome acquired falls inside the edge esteem (beneath 350 mg/100 g) announced as safety limit [1].

Microwave treatment causes an acute heat stress which destroys the hydrogen cyanide [57]. Montogomery [63] reported that liberated hydrogen cyanide is lost by volatilization and cyanide is rapidly converted in the thiocyanide compounds.

TABLE V
ANTI-NUTRIENTS LEVELS OF BANANA PEEL AS INFLUENCED BY MICROWAVE DRYING METHOD (% DW)

Samples	Phytates content (%)	Reduction %	Alkaloids Content (mg %)	Reduction %	Oxalate Content (mg %)	Reduction %	Hydrogen Cyanides content (mg %)	Reduction %
Control	6.98^{a} ±1.02	-	6.26^{a} ±1.0	-	1.93^{b} ±0.02	-	118.53^{a} ±3.0	-
Microwave -drying	4.07^{b} ±1.01	41.69	5.45^{b} ±1.0	12.94	0.85^{a} ±0.02	55.96	32.15^{b} ±3.03	72.88
L. S. D at 5 %	2.19		2.10		0.02		2.80	

-All values are means of triplicate determinations ± standard deviation (SD).
- Means within columns with different letters are significantly different (P < 0.05).

IV. CONCLUSION

Banana peels are source important of nutrients: Protein, fat, crude fiber and total carbohydrates, lignin, vitamin C (ascorbic acid) and anti-nutrients (phytates, alkaloids, oxalates and hydrogen cyanides). These components are considered to be within safe limits. Therefore, banana peels can be used as good ingredients for their health benefits in food products. These peels otherwise can be used as potential source of antioxidants for industrial application.

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