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Research Article

Analytical Quality and Acceptability of Baked and Fried Banana Chips

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Abstract

This study aimed to determine the nutritional profile and acceptability of two preparations of banana chips fried and baked. Standard methods were used to produce banana chips through baking and frying and to assess nutritive value and the acceptability of this product. The results obtained from this study indicated that Sudanese banana cultivar (Dwarf Cavendish) can be used for chips making. Fried banana chips were found to be better quality and acceptability when compared to potato chips. Baked banana chips were lower in quality and had weak acceptability compared with both fried banana chips and fried potato chips.

The study proved the possibility of promoting the use of banana that could had been wasted unnecessarily. The banana chips product was found to be a source of energy and minerals such as potassium and phosphorous, and its processing as snack was found to be simple, environmentally clean and can be produced at family level given the necessary precautions.

INTRODUCTION

Banana is giant, perennial, herbaceous monocotyledon, propagated vegetative, belonging to the family *Musaceae*, genus Musa [1]. It is one of the important tropical fruit crops in the world and is a major tropical food crop, it comes fourth after grapes, citrus and apples in word production and second after citrus in world trade [2].

Edible bananas are derived from either Musa acuminate or Musa balbisiana or a combination of both [1]. There are diploids, and tetraploids with chromosome numbers of 22, 33 and 44, the diploids are usually smaller plants than the triploids and tetraploids and generally have smaller branches and fruits. Tetraploids are the largest but there are not many of these, a number, however have been produced by artificial breeding [3].

Banana is grown in more than 120 countries providing sustenance to millions of people in Latin American Caribbean region. The plants are cultivated for their parthenoarpic, seedless fruits. Most fruit are consumed locally. Bananas for export account only about 10% of total world production [4].

It is not known exactly when and how bananas fruits were introduced in Sudan. In Sudan, banana is the most popular fruit for its nutritive value, low price and availability all year round. It is grown in almost every state, with annual production of 74 thousand metric tons [5]. The area cultivated with banana in Sudan is estimated at 41340 feddans with a total production of 400000 – 500000 tons per year. Banana production in Khartoum state is concentrated in the east and west bank of the river Nile. This mainly because of the suitable soils. The main cultivars of banana in Sudan are the Dwarf Cavendish. It is plagued with nematode that greatly decreases yields. More recently known cultivars of the giant Cavendish group such as Williams, Rubusta and Lacatan were introduced and are under trails at the field of Agricultural Research Corporation at Wad Madani [4].

Currently, there is very limited commercial processing of bananas. Most people consume bananas fresh, steamed or boiled. During bumper harvests, farmers sell bananas at give-away prices and many go to waste. Processing of banana to chips may add value to this fruit and reduce the wasted banana. .As banana consumed as a fresh fruit in Sudan so through processing of bananas, it is possible to obtain dried bananas almost called banana chips, which can be consumed as a snack and it will provide extra nutrients and calories [6].

Banana chips is a crispy snack food similar to potato chips, and there are several types of it e.g. banana figs, savoury banana chips and sweet banana chips.

Banana is highly nutritious and easily digestible than many other fruits. Digestion time of banana fruit is less (105 min) than apple (210 min) [7]. Bananas are popular for aroma, texture and easy to peel and eat, besides rich in potassium and calcium and low in sodium content [8]. The high content of carbohydrates makes banana a very good source of energy, for example, for people practicing sports. In addition to its high contents of carbohydrates, banana also is rich in vitamins and minerals. It is considered to be good for the treatment of gastric ulcer and diarrhea. Because they contain vitamin A, bananas act as an aid to digestion. Due to their high content of B6 vitamin, they help to reduce stress and anxiety. They are also considered beneficial for cancer prevention and heart diseases [9].

Banana chips are usually prepared by deep frying in oils, which will increase the fat content of the chips and consumption of this type of chips may affect the lipid profile of the consumers. Interest in low fat foods has recently increased. Therefore, an alternative method of preparing banana chips is needed to limits the amount of fats in the chips. This study aimed to determine the nutritional profile and acceptability of two preparations of banana chips (fried and baked).

MATERIALS AND METHODS

Unripe green bananas of the variety Dwarf Cavendish were obtained from El-Damazien State, Sudan.

Preparation of banana chips

Bananas are peeled and sliced thinly (2 mm thickness) and prepared in two ways.

1-The banana chips were fried in a stainless steel thermostated deep-fryer (Model Hamilton De Lux) containing Sunflower oil (5 kg) heated to 190° C. A batch of 3.0 kg of banana rounds were placed in the frying basket and the rounds were fried for 10 min. The temperature drop during frying was 10° C. The chips were allowed to drain for 20 sec, after which the chips were dabbed with tissue paper for 60 sec to remove excess oil.

2-3 kg of banana were baked in an oven at 250° C for 15-20 minutes or until crisp.

Proximate composition

Moisture, ash, protein, fiber and fat contents were determined according to the AOAC [10] methods. Carbohydrates were determined by difference.

Starch determination

Starch was determined according to Pearson [11], using two Fehling solutions.

Minerals determinations

Calcium, iron, sodium and potassium were determined by Atomic Absorption Spectrophotometer, PerkinElmer model 3110, London, UK [12]. Phosphorus was determined according to the method described by Chapman and Prat [13].

Energy determination

Energy was determined in kilocalories by the sum of multiplication of grams of protein, carbohydrates and fat by 4.3, 4.3 and 9.1, respectively.

Acceptability

Acceptability of chips was assessed organoleptically following the ranking tests according to the procedure described by Lhekorye and Nagoddy [14]. Thirteen panelists from Ahfad University staff and students (6 males and 7 females aged 18 – 30 years) were presented with coded different nine chips samples namely: potato chips + salt (act as control), baked banana chips +salt, fried banana chips + salt, potato chips + salt and vinegar, baked banana chips + salt and vinegar, fried banana chips + salt and vinegar, potato chips + sugar, baked banana chips + sugar and fried banana chips + sugar. Panelists were asked to evaluate 4 sensory attributes (texture, color, flavor and overall quality).

Statistical analysis

Three separate batches, for a particular treatment, were taken and analyzed separately and the figures were then averaged. Data were assessed by analysis of variance (ANOVA) [15], and by Duncan's multiple range test with a probability $p \leq 0.05$ [16] using SAS/STAT software, to examine the mean difference of the two methods used for the preparation of banana chips on the nutritional quality and the acceptability of the chips.

RESULTS AND DISCUSSION

The moisture content of unripe banana was found to be 71.2% this result agree with the result reported by Wills et al. [16](71.9%). When banana processed to prepare chips the moisture content of the two types of chips was found to be 3.50% and 11.48% for fried and baked banana chips, respectively (Table 1). This is may be due to water vaporization during baking and frying. Processing of banana to prepare chips lead to a significant ($p \leq 0.05$) increase in the ash content (Table 1). Unripe banana had a protein content 4.2% which is higher by 54.8% than that reported by Wills et al. [17]. This may be due to the different banana cultivars used. Bananas protein (1-2.5%), depending on genome type, variety, altitude, and climate [18, 19], increases over ripening process [20] (3.8-4.2%). Processing banana to chips lead to a decrease in the protein content by 29.55% and 20.45% in the two chips baked and fried, respectively (Table 1). Agunbiade et al. [21] reported 2.4% for the protein content of fried banana chips. Results showed that unripe banana contain 2.3% fat (Table 1).This result was higher than that reported by Wills et al. [17] (0.1%). This is may be due to the difference in cultivars used .Table (1) shows that banana chips has higher fat content than unripe banana, 3.3% fat content for baked chips and 10.5% for fried chips and this higher fat content in the fried chips is due to the residual remained oil after deep frying. The fiber content of the unripe banana was 4.5%, processing of banana to chips increase significantly ($p \leq 0.05$) the fiber content by 47% and 55% in baked and fried chips, respectively (Table 1).

Some nutrients may be lost during cooking (wet or dry) in two ways. First, by degradation, which can occur by destruction or by other chemical changes such as oxidation, and secondly by leaching into the cooking medium? The percentage loss will depend partly on the cooking temperature and on whether the food is prepared by frying or baking.

Minerals content

Table 2 shows the minerals content of the unripe banana and

banana chips. The calcium content of the unripe banana 24.0 mg/100g which is higher than that reported by Wills et al. [17] (5.0 mg/100g). When banana was processed to prepare chips, calcium content decreased significantly (p≤0.05) by 52.45% and 57.37% for baked and fried chips, respectively.

Phosphorous content significantly increased (p≤ 0.05) when banana was baked to prepare chips, but it was slightly increased in fried chips (Table 2). The iron content decreased when banana was processed by backing to chips, while it slightly decreased when banana was fried (Table 2). Sodium content was slightly increased in banana chips, while the potassium content significantly (p≤0.05) decreased by 75% and 55.43% in the two types of chips baked and fried, respectively (Table 2)

Potassium is most abundant mineral present in edible portion of banana, followed by phosphorus and calcium (Table 2). Amount of iron is high. Due to its nutritive value, processed banana when accompanied with some legume based products can be served as excellent baby food and snack food [22].

Starch, carbohydrates and energy contents

Starch, carbohydrates and energy contents of unripe banana and banana chips were showed in Table (3). Unripe banana contain 14.98% starch which is lower than 21.2% reported by Wills et al. [17]. This significant difference in starch content might be due to species and geographic variations. The starch content was increased significantly (p≤0.05) when banana processed to chips (Table 3). Carbohydrates content was significantly (p≤0.05) increased in banana chips, baked and fried, by approximately 500% and 400%, respectively (Table 3). The low carbohydrates content in unripe banana is due to its high moisture content [23]. This support the fact that banana is low in carbohydrates and could be used in losing weight [24]. Carbohydrate type in banana is resistant starch and non-starch polysaccharides, which have low glycemic index or low digestibility [25]. This property makes it an excellent ingredient for different functional and convenience foods like cookies [26] and chips [21]. Energy was significantly (p≤0.05) increased in banana baked and fried chips by 81.6% and 82.45%, respectively (Table 3).

Sensory evaluation of banana chips

The quality of the banana chips prepared by different processing method was presented in Table 4. Salted potato chips and fried banana chips of the addition (salt, sugar, salt and vinegar) were significantly (p≤0.05) accepted in texture, while the baked banana chips with all additions were found to be unacceptable (Table 4).

The chips, salted potato, salted banana and fried banana with sugar were found significantly (p≤0.05) acceptable in color. While the baked banana chips with different treatments were unacceptable (Table 4). Flavor of salted potato chips and all kinds of the fried banana chips were accepted, while all kinds of the baked banana chips were un-favored. The overall quality of all fried banana chips were superior and the baked banana chips with all additives were found to be significantly (p≤0.05) inferior types of chips among other treatments (Table 4).

CONCLUSION

Banana chips have a high market potential particularly when wasted banana is concerned, it represent a different source of nutrients well characterized by its mineral nutritional value and reasonable energy supply.

It was found that banana chips provide extra minerals especially phosphorus and potassium and a good source of energy. The results of this study revealed that it is possible to

Table 1: Proximate Analysis of Banana Chips.

Types of Chips	Moisture%	Ash%	Protein%	Fat%	Fiber%
Unripe banana	71.20(±4.53)^{a}	2.25(±0.70)^{b}	4.41(±0.19)^{a}	2.25(±1.06)^{b}	4.50(±2.12)^{a}
Baked Banana Chips	11.48(±0.05)^{b}	3.25(±0.00)^{b}	3.14(±0.12)^{b}	3.25(±0.35)^{b}	8.50(±0.70)^{b}
Fried Banana Chips	3.55(±0.04)^{b}	10.50(±0.50)^{a}	3.49(±0.12)^{b}	10.50(±0.70)^{a}	10.00(±1.41)^{b}

*Values are means ± (SD).
Mean followed by the same superscript are statistically similar (p≤0.05) according to Duncan's Multiple Range Test.

Table 2: Minerals Content of Banana Chips.

Types of Chips	Calcium mg/100g	Phosphorous mg/100g	Iron mg/100g	Sodium mg/100g	Potassium mg/100g
Unripe banana	24.40(±0.14)^{a}	96.80(±0.00)^{b}	2.44(±0.04)^{a}	2.20(±0.02)^{b}	230.00(±14.14)^{a}
Baked banana chips	11.60(±0.14)^{b}	136.00(±1.41)^{a}	1.50(±0.45)^{b}	2.75(±0.07)^{a}	57.50(±3.53)^{c}
Fried banana chips	10.40(±0.42)^{c}	97.65(±1.06)^{b}	2.21(±0.01)^{ab}	2.70(±0.00)^{a}	102.50(±3.53)^{b}

Values are means ± (SD).
Means followed by the same superscript are statistically similar (p≤0.05) according to Duncan's Multiple Range Test.

Table 3: Starch, Carbohydrates and Energy Contents of different banana chips.

Types of Chips	Starch%	Carbohydrates%	Energy kcal
Unripe banana	14.98(±0.94)^{b}	15.39(±4.36)^{c}	66.17 (±8.28)^{c}
Baked banana chips	57.55(±1.28)^{a}	73.63(±1.12)^{a}	359.69 (±1.10)^{b}
Fried banana chips	50.98(±1.22)^{b}	61.96(±0.08)^{b}	376.99 (±6.59)^{a}

Values are means ± (SD).
Means followed by the same superscript are statistically similar (p≤0.05) according to Duncan's Multiple Range Test.

Table 4: Sensory Evaluation of Baked and Fried Banana and Potato Chips.

Codes	Texture	Color	Flavor	Overall quality
A	19[a]	18[a]	19[a]	18[a]
B	38[b]	37[b]	39[b]	39[b]
C	14[a]	21[c]	18[a]	16[a]
D	27[c]	32[c]	23[c]	27[c]
E	36[b]	28[c]	36[b]	35[b]
F	15[a]	17[a]	19[a]	16[a]
G	23[c]	22[c]	23[c]	24[c]
H	35[b]	38[b]	35[b]	36[b]
I	19[a]	18[a]	18[a]	18[a]

A, potato chips + salt; B, baked banana chips +salt; C, fried banana chips + salt; D, potato chips + salt and vinegar; E, baked banana chips + salt and vinegar; F, fried banana chips + salt and vinegar; G, potato chips + sugar; H, baked banana chips + sugar; I, fried banana chips + sugar.
Ranks with the same superscript letter within columns are within the same range

reduce the fat content of banana chips by 69% using baking as a method of preparation of chips rather than frying. In general banana chips were well accepted by the panelists of both sexes and different ages. However, salty fried banana chips came in first order of preference followed by the control (potato chips). Baked banana chips were not accepted by the panelists.

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