



Comparative Study on Nutritional Composition of Six *Musa acuminata* Pulp Varieties Available in Zaria, Nigeria

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Authors' contributions

This work was carried out in collaboration among all authors. Author OBA was responsible for carrying out the experiment; management of the data generated and wrote the first draft of the manuscript. Authors TMA performed the statistical analysis and managed the analyses of the study. Author MNS carried out literature searches. Authors OAO and DBJ designed the research study, wrote the protocol, interpretations of results and review of the manuscript. All authors read and approved the final manuscript.

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ABSTRACT

Banana is one of the most widely distributed and consumed fruit in tropical and subtropical countries. In this study, six *Musa acuminata* varieties locally available in Zaria, Nigeria, were evaluated to determine their nutritional composition. Results from proximate composition demonstrated that lipid content was profoundly ($p < 0.05$) lower in *Musa acuminata* Red, calorie value was statistically ($p < 0.05$) lower in *Musa acuminata* AAB (Omini white) compared to all other species analyzed. Amino acid analysis indicated that histidine, isoleucine, lysine, methionine, phenylalanine, threonine, tryptophan and valine were significantly ($p < 0.05$) higher in the *M. acuminata* Red compared to other varieties in this study. Vitamin study showed that *Musa acuminata* Red had

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significant ($p < 0.05$) higher contents of vitamins A, B₃, C and E but significantly ($p < 0.05$) lower in B₁. Vitamin B₁ was significantly ($p < 0.05$) higher in *M. acuminata* AAA (Saro), while *M. acuminata* AAB (Omini white) was significantly ($p < 0.05$) lower in Vitamin A. Mineral analysis showed that *Musa acuminata* Red was statistical ($p < 0.05$) higher in potassium, iron, magnesium, calcium in comparison to other varieties of *Musa acuminata* pulp analyzed. In conclusion, high nutrient composition of *Musa acuminata* Red may be more advantageous over other varieties for use as functional food.

Keywords: *Musa acuminata*; nutritional and proximate compositions; amino acid analysis; vitamin and mineral analyses; functional food.

1. INTRODUCTION

Musa acuminata is an evergreen perennial plant, belonging to the family *Musaceae*. It is one of the most major fruit crops and the fifth most vital crop in world fare exchange after coffee, cereals, sugar, and cocoa [1]. It is grown in (sub)tropical and generally developing countries of the world with 71 million metric tons of desert banana mainly from the Cavendish cultivars [2]. It is plant can be easily grown in one's yard or gardens, flourishes well under tropical, moisture-rich, humid, low-lying farmlands. It has unique growth characteristics, its propagation by the division of the suckers [3]. It is a delicious fruit rich in fibre, carbohydrate, vitamins, minerals and phytochemicals [4].

Fruits like bananas offer great medicinal benefits. This is mostly on the grounds that bananas help in the body's maintenance of calcium, nitrogen, and phosphorus, all of which work to fabricate sound and recovered tissues [5]. It can be used to fight intestinal disorders like ulcers [4,5]. As a matter of fact, banana is one of the few fruits that ulcer patients can safely consume. It neutralizes the acidity of gastric juices, thereby reducing ulcer irritation by coating the lining of the stomach. Not only can bananas relieve painful ulcer systems, and other intestinal disorders, they can also promote healing [5].

The fruit is also used in the management of burns and wounds. For immediate pain relief, ripe banana can be beaten into a paste and spread over a burn or wound and cover with a cloth bandage. Its leaves as well can be used as a cool compress for burns and or wounds. Other traditional benefits of bananas include aiding in constipation and diarrhoea relief, treatment of arthritis, treatment of anaemia [1].

Other studies have also shown that *Musa acuminata* helps in combating hangovers,

mosquito bites, constipation, heart burn, ulcers, stress and temperature regulation (Vasso et al., 2017). Banana pulp contains tryptophan, an amino acid that plays a role in preserving memory and boosting mood [1].

A study on the effects of a single banana meal on plasma lipids and lipoprotein plasma oxidative stress and susceptibility of low density lipoprotein to oxidation revealed that the consumption of banana reduced the plasma oxidative stress and enhanced the resistance to oxidative modification of low density lipoprotein [6]. Animal studies have shown that banana peel has the potential to lower cholesterol level in the blood (Edenta et al., 2012). This is due to amount of dietary fibre known as pectin contained in banana pulp. The component of this dietary fibre in banana pulp is relatively constant during banana ripening. High potassium food like banana has also been reported to have potential to lower risk of stroke [1] It has also been found true that pectin in banana has all it takes to prevent colon cancer (Hou et al., 2013). A report by the American Health Association has it that, banana could be used with the help other herbs to lower blood pressure (Hever and Cronise, 2017). A few work have been done on the nutritional composition of *Musa acuminata* peel but no documented work on the comparative study of nutritional composition of the six varieties *Musa acuminata* pulp available in Zaria.

2. MATERIALS AND METHODS

2.1 Materials

2.2 Plant Sample Collection

Six different varieties of *Musa acuminata* namely; *Musa acuminata* Cavendish (Ahoru), *Musa acuminata* AAA (Saro), *Musa acuminata* Nain (Oranta), *Musa acuminata* Red (Omini red), *Musa acuminata* AAB (Omini white), *Musa acuminata* Colla (Omini gidi) were purchased

from Fruits Depot (Yanlemu) Dogarawa Area, Zaria. The fruits were identified at the herbarium unit Plant Science Department IAR, ABU, Zaria.

2.3 Sample Preparation

The six varieties of *Musa acuminata* were peeled and diced into smaller size. The diced samples were dried at 45°C for 72 hours. The dried *Musa acuminata* pulp were ground into powder and kept in an air tight plastic container at room temperature (25°C) for further analysis.

2.4 Determination of Proximate Composition

The chemical composition of the samples was determined using the standard methods of analysis of Association of Official Analytical Chemists [7]. Moisture content of the samples was determined by air oven (Gallenkamp) method at 105°C. The crude protein of the sample was determined using micro-Kjedhal method. Crude lipid was determined by Soxhlet extraction method using petroleum ether as extracting solvent. The ash content was determined using a muffle furnace set at 550°C for 4 hours until constant weight of ash is obtained. Crude fibre was determined using a standard method of [8]. The total carbohydrate content was determined through the difference of the sum of the others in relation to the total sample. That is, the sum of the percentage moisture, ash, crude lipid, crude protein and crude fibre was subtracted from 100. Calorie was done using a method described by Kai-Oliver [9].

2.5 Determination of Mineral Composition

Sodium Na, calcium Ca, potassium K, magnesium Mg, zinc Zn, iron Fe and manganese Mn content were determined using the method describe [10].

2.6 Determination of Amino Acid Profile of the Six *Musa acuminata* Pulp Varieties

The Amino acid profile of the pulp varieties was determined using method described as referenced [11]. Exactly 60 µl of the hydrolysate was loaded into Applied Biosystems PTH Amino Acid Analyzer. This was then dispensed into the cartridge of the analyzer. The Amino acid analyzer is aimed to separate and analyse free

acidic, neutral and basic amino acids of the hydrolysate. The sample was allowed to run for 76 minutes [11].

2.7 Determination of Vitamin Composition in the Six Varieties of *Musa acuminata* Pulp

Vitamin C (ascorbic acid) content was determined using a method described by Ogah [12]. Determination of Vitamin A (beta carotene), Vitamin B₁ (thiamine), Vitamin B₃ (niacin) and Vitamin E contents were determined by method described by Adepoju and Etukumoh [13].

2.8 Statistical Analysis

All statistical analysis were done using SPSS/20.0 software for windows. The results are expressed as mean ± standard deviation. The data were analyzed by one way analysis of variance (ANOVA) and Post hoc test. Differences between groups were compared using Duncan Multiple Range Test (DMRT). Significance was accepted at 0.05 level of probability ($p < 0.05$).

3. RESULTS AND DISCUSSION

The moisture content varied significantly and ranged between 8.85 to 18.20%, this could be as a result of difference in varieties. *Musa acuminata* Cavendish had the lowest while *Musa acuminata* red had the highest moisture content. Moisture content is an important component in relation to food quality, shelf life and application in food industry. Bananas have been reported to contain mainly water and carbohydrate [14]. The result from this study is in agreement with a report by Adubofour et al. (2016) which revealed that moisture contents of two varieties of ripe banana pulp has a very high moisture percentages. The moisture content of foods or its processed products gives an indication of its freshness and shelf life, and high moisture content subjects food items to increased microbial spoilage and short shelf life, which can lead to its deterioration [15].

As shown in Table 1, the fibre content varied from 11.03 to 15.65%. Studies have highlighted the linkage of dietary and functional fibres to positive health outcomes. The known health benefits of dietary fibre intake have been related to reduce blood cholesterol level, slow absorption of glucose, improved insulin sensitivity [16,1,17]. Out of the six *M. acuminata* pulp varieties, *Musa acuminata* red and *Musa acuminata* Colla

Table 1. Proximate composition of six different varieties of *Musa acuminata* pulp

Proximate Composition (%)	<i>Musa acuminata</i> Cavendish	<i>Musa acuminata</i> AAA	<i>Musa acuminata</i> Nain	<i>Musa acuminata</i> Red	<i>Musa acuminata</i> AAB	<i>Musa acuminata</i> Colla
Moisture	8.85±1.15 ^a	18.20±1.80 ^c	16.63±1.62 ^{bc}	17.57±2.43 ^{bc}	12.80±2.80 ^{a,b,c}	11.19±1.19 ^{ab}
Ash	4.25±0.25 ^c	2.95±0.15 ^a	3.08±0.02 ^b	2.95±0.50 ^a	7.21±0.51 ^e	5.92±0.13 ^d
Lipid	2.61±0.48 ^d	1.03±0.17 ^c	0.82±0.07 ^{bc}	0.29±0.13 ^a	0.53±0.28 ^{a,b}	0.36±0.05 ^{ab}
Protein	7.95±0.25 ^a	8.32±0.18 ^a	9.09±1.34 ^a	8.53±0.44 ^a	8.31±0.51 ^a	7.74±0.58 ^a
Fibre	11.75±1.65 ^{ab}	11.03±0.13 ^b	14.51±0.69 ^{bc}	15.45±0.36 ^{bc}	15.65±0.55 ^c	15.65±0.55 ^c
Carbohydrate	64.59±1.25 ^c	58.47±1.87 ^{a,b}	59.48±1.64 ^b	55.13±2.30 ^a	55.51±2.53 ^{ab}	61.40±0.73 ^{bc}
Calorie (Kcal/100kg)	5027±0.47 ^d	5636±0.05 ^e	5605±0.58 ^e	3276±0.21 ^b	2610±0.52 ^a	3427±0.15 ^c

Values are expressed as mean ±standard deviation of triplicate determinations; values with different superscript across the rows are significantly different ($p<0.05$)

Table 2. Amino acid profile of the six varieties of *Musa acuminata* pulp

Amino Acids	Amino acids (g/100g protein)	<i>Musa acuminata</i> Cavendish	<i>Musa acuminata</i> AAA	<i>Musa acuminata</i> Nain	<i>Musa acuminata</i> Red	<i>Musa acuminata</i> AAB	<i>Musa acuminata</i> Colla
Essential	Leucine	6.41±0.57 ^b	6.86±0.30 ^c	5.73±0.20 ^a	7.37±0.71 ^{c,d}	7.91±0.66 ^d	7.65±0.59 ^{c,d}
	Lysine	4.81±0.26 ^{a,b}	4.51±0.62 ^{a,b}	4.97±0.48 ^{a,b}	6.53±0.81 ^c	5.45±0.60 ^b	4.24±0.36 ^a
	Isoleucine	3.99±0.50 ^a	4.02±0.59 ^a	3.97±0.37 ^a	5.53±0.50 ^c	4.69±0.52 ^{a,b}	4.97±0.54 ^{a,b}
	Phenylalanine	4.43±0.84 ^a	5.65±0.74 ^a	6.22±0.78 ^b	8.57±0.76 ^c	4.81±0.76 ^a	4.78±0.74 ^a
	Histidine	5.52±0.50 ^b	5.77±0.26 ^b	3.96±0.50 ^a	7.22±0.59 ^c	3.95±0.32 ^a	6.02±0.49 ^b
	Tryptophan	3.82±0.82 ^c	3.30±0.18 ^{b,c}	2.24±0.50 ^{a,b}	7.55±0.98 ^d	1.55±0.26 ^a	4.48±0.68 ^c
	Valine	3.99±0.50 ^{a,b}	3.90±0.50 ^{a,b}	3.17±0.51 ^a	5.53±0.44 ^c	4.01±0.68 ^b	4.69±0.50 ^b
	Methionine	3.29±0.65 ^b	3.61±0.68 ^b	4.78±0.76 ^c	6.58±0.58 ^d	2.01±0.82 ^a	1.79±0.28 ^a
Non-essential	Threonine	4.05±1.73 ^b	3.06±0.54 ^a	3.44±0.52 ^a	4.88±0.37 ^c	2.61±0.25 ^a	3.22±0.31 ^a
	Arginine	8.29±0.64 ^d	5.47±0.47 ^a	6.24±0.50 ^{ab}	9.97±0.78 ^e	7.45±0.50 ^{bc}	7.09±0.38 ^c
	Tyrosine	3.22±0.20 ^c	2.64±0.25 ^{ab}	2.92±0.29 ^{bc}	3.48±0.40 ^c	2.12±0.25 ^a	2.51±0.36 ^{ab}
	Cysteine	3.59±0.84 ^a	3.80±0.50 ^a	3.10±0.54 ^a	9.94±0.84 ^b	12.68±0.46 ^c	3.48±0.20 ^a
	Alanine	3.68±0.50 ^a	4.24±0.50 ^{bc}	4.03±0.38 ^b	5.26±1.21 ^c	4.72±0.28 ^{bc}	4.56±0.34 ^{bc}
	Glutamate	12.99±0.48 ^a	12.48±0.52 ^a	12.54±0.99 ^a	15.29±0.29 ^c	12.20±0.32 ^a	13.90±0.25 ^b
	Serine	2.61±0.46 ^{ab}	3.53±0.42 ^{bc}	3.92±0.52 ^{bc}	4.67±0.60 ^d	2.26±0.57 ^a	3.55±0.81 ^{bc}
	Proline	3.96±0.48 ^a	3.61±0.24 ^{ab}	3.27±0.71 ^{ab}	5.89±0.84 ^c	3.39±0.48 ^b	2.54±0.50 ^a
Aspartic acid	14.22±0.35 ^{cd}	11.65±1.28 ^b	11.74±0.42 ^b	16.36±0.50 ^e	15.65±0.76 ^{d,e}	13.64±0.47 ^a	

Values are expressed as mean ±standard deviation of triplicate determinations; values with different superscript across the rows are significantly different ($p<0.05$)

were significantly ($p < 0.05$) higher in fibre content. This could make them potentially good as functional fruit.

Calorie values of the six varieties of *Musa acuminata* pulp samples varied from 2610.58 to 5636.76 kilocalories, which are comparable to report of FAO [18], with 3580 kcal/100 g of sweet banana. *Musa acuminata* AAA has the highest calorie value of 5636.76 kcal. With such energetic values, these varieties of banana could

provide the daily energetic needs of a normal individual [19].

Amino acid profile of the six varieties of *Musa acuminata* pulp revealed that all the essential amino acids viz., histidine, isoleucine, leucine, lysine, methionine, phenylalanine, threonine, tryptophan and valine are present in the six varieties of *Musa acuminata* pulp reported. *Musa acuminata* red pulp was significantly ($p < 0.05$) higher in most of the amino acids; glutamic acid

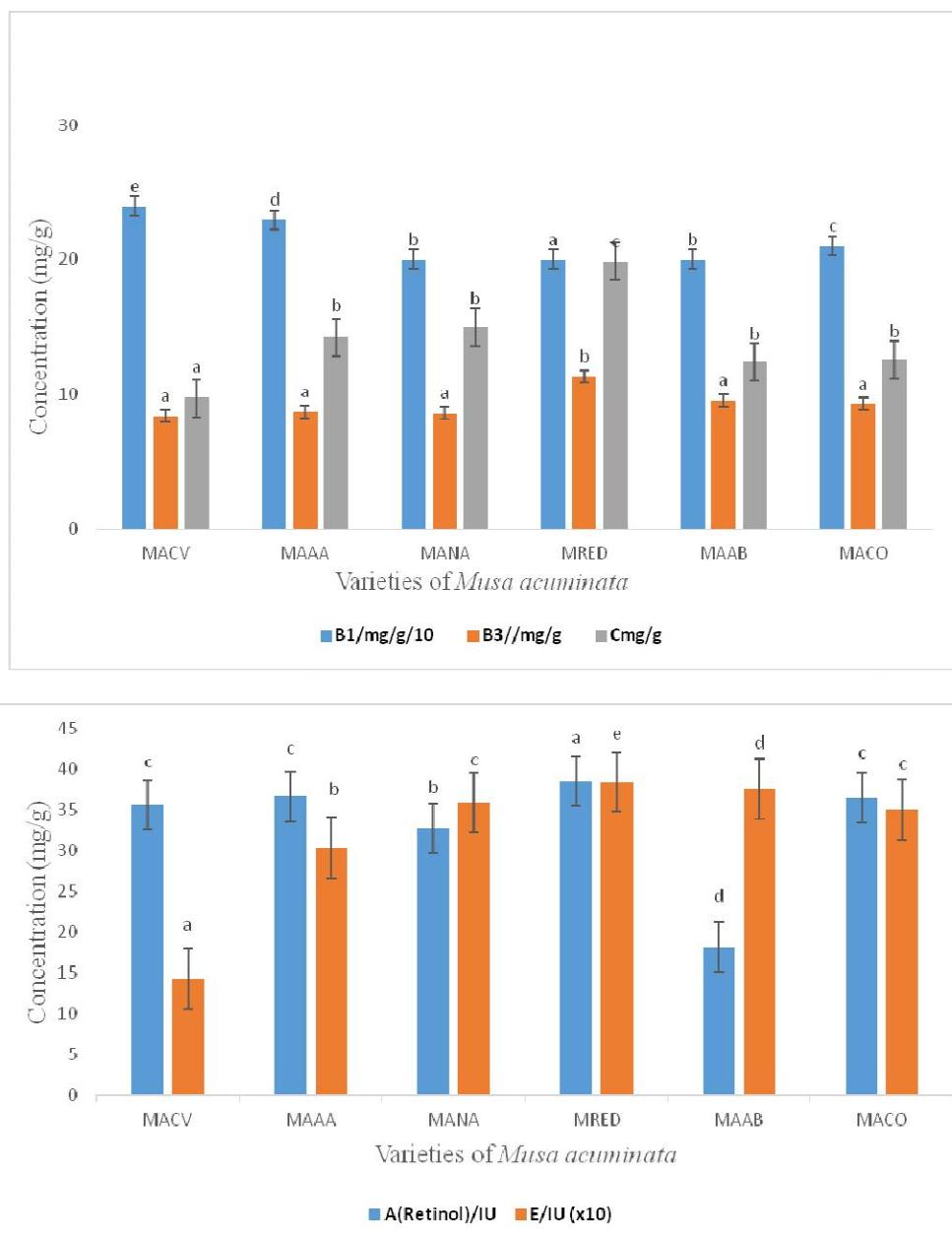


Fig. 1. Vitamins compositions of the six varieties of *Musa acuminata* pulp

Table 3. Mineral composition of the six varieties of *Musa acuminata* pulp

Mineral Composition (g/L)	<i>M. acuminata</i> Cavendish	<i>M. acuminata</i> AAA	<i>M. acuminata</i> Nain	<i>M. acuminata</i> red	<i>M. acuminata</i> AAB	<i>M. acuminata</i> Colla
K	286.94±0.20 ^d	265.56±0.04 ^a	274.70±0.01 ^b	284.09±0.02 ^c	301.12±0.03 ^e	326.78±0.03 ^f
Ca	443.57±0.3 ^c	486.52±0.0 ^d	347.71±0.01 ^b	693.68±0.02 ^f	337.24±0.01 ^a	667.67±0.01 ^e
Mg	69.60±0.21 ^a	92.86±0.01 ^d	92.39±0.11 ^d	106.30±0.01 ^e	85.31±0.02 ^c	81.32±0.01 ^b
Na	117.79±0.1 ^e	72.99±0.01 ^c	63.23±0.02 ^a	67.73±0.02 ^b	101.78±0.01 ^d	283.76±0.03 ^f
Micro elements						
Fe	1.12±0.02 ^a	3.90±0.05 ^d	1.55±0.17 ^b	4.87±0.01 ^e	2.74±0.16 ^{b,c}	2.93±0.20 ^c
Zn	20.58±0.04 ^c	27.43±0.03 ^d	11.27±0.04 ^a	99.36±0.01 ^e	17.13±0.04 ^b	99.20±0.01 ^e
Mn	1.43±0.12 ^b	1.46±0.11 ^c	0.87±0.18 ^a	1.01±0.04 ^b	1.98±0.01 ^d	1.91±0.06 ^c

Values are expressed as mean ± standard deviation of triplicate determinations; values with different superscript across the rows are significantly different ($p < 0.05$)

(15.29 g/100 g), aspartic acid (16.36 g/100 g), Tryptophan (7.55 g/100 g) and arginine (9.97 g/100 g). Parks [20] also reported the presence of all the 18 amino acids in different banana cultivars though in limited quantity. The presence of amino acid in the banana pulp is in agreement with a study that suggested that supplementation of a normal weight-maintaining diet with essential amino acid and arginine decreases plasma lipid and triacylglycerol [21].

The vitamin composition of the six varieties of the *Musa acuminata* pulp studied were revealed in the following range; vitamin A (beta carotene) 18.20 to 38.59 I.U, vitamin B₁ (thiamine) 19.56 to 23.88 mg/g vitamin B₃ (niacin) 8.38 to 11.32 mg/g vitamin C (Ascorbic acid) 9.74 to 12.58 mg/g and vitamin E (tocopherol) 140.36 to 376.50 I.U. Vitamin B₁ and vitamin B₃ contents of all *Musa acuminata* pulp were significantly (p<0.05) higher than Recommended Dietary Allowances with their values exceeding the RDA of 1.3 mg/day for adult males and 1.1 mg/ day for women -1.5 mg/ day pregnant/lactating of thiamine[22]. The values of B₁ (thiamine), B₃ (Niacin), obtained in the six varieties of *Musa acuminata* pulp were also higher than vitamins reported in some green banana and other selected vegetables marketed in Sindh Pakistan [23].

The vitamins composition of the six varieties of *Musa acuminata* pulp revealed in this study showed that vitamin C (19.86 mg/g) and Vitamin E (376.50 IU) content of *Musa acuminata* red pulp were significantly (p<0.05) higher compared with other varieties of *Musa acuminata* pulp. This is in agreement with a study by Yukawa et al. [24] that revealed that *Musa acuminata* red pulp is highly nutritious - the vitamins C and E content depends on how red the banana is. It further revealed that banana supplies the body with about 15 percent of recommended daily allowance (RDA) of Vitamin C, enhancing body's supply of cell-regenerating antioxidants and assisting immune system. Banana likewise contributes two percent of daily iron needs [24,25].

Mineral elements play important roles in health and disease states of humans and domestic animals. Diet is the source of essential elements in human body [26] . Table 3 showed the mineral composition of the six varieties of *Musa acuminata* pulp. Potassium composition of the six varieties of *Musa acuminata* studied ranged from 286.94 to 326.78 g/L with *Musa acuminata*

AAA having the lowest value while *Musa acuminata* colla had the highest value. It is an electrolyte, which conducts electrical impulses all through the body. It is also regarded as an essential nutrient because it is not produced naturally by the body [27]. Among fruits, banana is valued for potassium content, because of its role in maintaining the body's blood pressure [27].

Calcium content of the six varieties of *Musa acuminata* pulp in this study ranged from 337.27 to 693.63 g/L with *Musa acuminata* AAB having the lowest value while *Musa acuminata* red had the highest value. These values were significantly (p<0.05) higher than calcium content reported by Smitha et al., [25] which revealed that calcium content of banana varieties. High Calcium content of banana fruit make it a better antihyperlipidemic agent, as calcium helps in transporting of long chain fatty acid which helps in prevention of heart diseases, high blood pressure and other cardiovascular diseases [28].

Musa acuminata colla pulp exhibited highest sodium content (283.76 g/L) followed by *Musa acuminata* Cavendish pulp variety (117 g/L), sodium content was found to be minimum for *Musa acuminata* red pulp variety (63.23 g/L).

4. CONCLUSION

This work does provide the nutritional potentials of *Musa acuminata* pulp which revealed that in general; they are incredibly nutritious and can serve as a good source of fibre, amino acid, vitamins, macro and micro minerals that may be needed by scientists and researchers in nutraceutical industry.

The results showed that the six varieties of *Musa acuminata* pulp are highly nutritious. However, *Musa acuminata* Red is highly rich in nutrients than other varieties.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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