



Chemical Composition of Serendipity Berry (*Dioscoreophyllum cumminsii*) and Miracle Fruit (*Thaumatococcus daniellii*)

A. Ojo¹, V. N. Enujiugha², H. N. Ayo-Omogie² and O. A. Abiodun^{3*}

¹Department of Food Science and Technology, Osun State Polytechnic, Iree, Nigeria.

²Department of Food Science, Federal University of Technology, Akure, Ondo State, Nigeria.

³Department of Home Economics and Food Science, University of Ilorin, Nigeria.

Authors' contributions

This work was carried out in collaboration among all authors. Author AO designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors VNE and HNAO managed the analyses of the study. Author HNAO managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

Aims: To determine the chemical composition of serendipity berry (*Dioscoreophyllum cumminsii*) and miracle fruit (*Thaumatococcus daniellii*).

Study Design: The mean and standard deviation of the data obtained were analyzed.

Place and Duration of Study: Samples were prepared in Department of Food Science and Technology, Osun State Polytechnic, between November 2018 and December 2019.

Methodology: Chemical properties of two natural sweeteners namely the miracle fruit (*Thaumatococcus daniellii*) and serendipity berry (*Dioscoreophyllum cumminsii*) were studied in this work. The fresh fruits were obtained from a farm, sorted, washed and the tissues were scraped, dried in the oven at 45°C for 12 hrs, milled and packed in airtight plastic containers. Proximate, vitamins and amino acid contents of the sweeteners were determined.

Results: The results revealed that the protein contents of miracle fruit and serendipity berry were 75.57% and 62.54% respectively. Moisture contents of the sweeteners ranged from 56.95-58.33%

*Corresponding author: Email: Funmiabiodun2003@yahoo.com;

while ash contents ranged from 19.33-22.90%. The sweeteners had low carbohydrate and lipid contents. Crude fiber was not detected in miracle fruit but serendipity berry had crude fibre of 5.38%. The fruits had β -carotene contents ranging from 8.44 mg/100 g and 23.00 mg/100 g, vitamin C (20.40 mg/100 g and 22.01 mg/100 g) and vitamin D (17.02 mg/100 g and 19.02 mg/100 g) in miracle fruit and serendipity berry respectively. However, low values were recorded for vitamin E 0.55 mg/100 g and 0.89 mg/100 g in miracle fruit and serendipity berry respectively. The fruits had appreciable amount of essential amino acid which was above 50% of the total amino acid content. Miracle fruit had 51.96% and serendipity berry had 58.07% of the essential amino acid. Aromatic essential amino were 10.78 and 12.79% in miracle fruits and serendipity respectively.

Conclusion: This study showed that the two natural sweeteners are good source of essential nutrients and could be used as food supplements in our diet.

Keywords: Sweetener; miracle fruit; serendipity berry; amino acid; proximate composition.

1. INTRODUCTION

Intake of high caloric food causes obesity and related problems mainly due to consumption of refined sugars, which ultimately leads to higher probability of heart diseases, type II diabetes, sleep apnoea, certain types of cancer and osteoarthritis. The primary sources of these extra carbohydrates are sweetened beverages and other carbohydrate-rich foods. Although addition of artificial sugar-free sweeteners may replace sugar, they still have some side effects. As a consequence, using monellin and thaumatin a low-calorie, carbohydrate-free protein as natural sweeteners, would be an ideal option [1]. Sweet proteins have the potential to replace these artificial sweeteners, by acting as natural, good, low calorie sweeteners, as we know that proteins do not trigger a demand for insulin in these patients whereas sucrose does. There are seven known sweet and taste-modifying proteins, namely Brazzein, Thaumatin, Monelin, Curculin, Mabinlin, Miraculin and Pentadin [2]. Monellin was found to be 10,000 times sweeter than sucrose on a molar basis, followed by Thaumatin which is 3,000 times sweeter than sucrose. These proteins have been isolated from plants that grow in tropical rainforests. Although most of them share no sequence homology or structural similarity, Thaumatin shares extensive homology with certain non-sweet proteins found in other plants. The potential industrial applications of these proteins are the low calorie sweetener industry and the beverage, snacks, food and chocolate industries [3].

Thaumatinins are a class of intensely sweet proteins isolated from the fruit of the tropical plant *Thaumatococcus danielli*. The protein crystallizes in a hexagonal lattice after a temperature shift from 293 to 277 K. The structure has been solved at 1.6 Å resolutions.

Its fold was found to be identical to that found in three other crystal forms grown in the presence of crystallizing agents of differing chemical natures [4]. It consists of 207 amino acid residues with eight intra-molecular disulfide bonds and contains no free cysteine residues. It aggregates upon heating at pH 7.0 above 70°C, whereupon its sweetness disappears [4,5]. The protein is approximately 10,000 times sweeter than sugar on a molar basis [6]. It is a protein that tastes intensely sweet only to Old World monkeys and to higher primates, including man, as it has been found that the protein binds to certain elements in taste pores of Rhesus monkey foliate papillae [7,8]. Thaumatin has been approved for use in many countries as both a flavour enhancer and a high-intensity sweetener [9]. Monellin, a sweet protein, consists of two non covalently associated polypeptide chains, an A chain of 44 amino acid residues and a B chain of 50 amino acid residues [10]. The protein can be purified from the fruit of *Dioscoreophyllum cumminsii* grown in West Africa and is approximately 10,000 times sweeter than sugar on a molar basis and several thousand times sweeter on a weight basis [2]. Single-chain monellin (SCM), which is an engineered 94-residue polypeptide, has proven to be as sweet as native two. The main objective of this present study is to evaluate the nutritional qualities of two natural sweeteners (miracle fruit and serendipity berry).

2. MATERIALS AND METHODS

2.1 Materials

Miracle fruit (*Thaumatococcus danielli*) and serendipity berry (*Dioscoreophyllum cumminsii*) were obtained from a farm in Esa-Odo, osun state, Nigeria. The pods of miracle fruit were opened and the sweetener at the arils of the

seeds were carefully scraped, dried and milled. Also for serendipity berry, the tissue around the seed was scraped, dried and milled.

2.2 Analyses

Proximate analysis such as moisture, ash, fat, and protein contents of the samples was carried out using the AOAC methods [11]. Carbohydrate was determined by difference. Vitamin C was determined using 2,6 dichlorophenol visual titration method while vitamin D and E were done using AOAC methods [11]. β -carotene was carried out using Batool et al. [12] method.

2.3 Statistical Analysis

Data were subjected to Analysis of Variance (ANOVA) and differences between means were evaluated by Duncan's multiple range tests using SPSS (version 17.0). Significant differences were expressed at $P < 0.05$.

3. RESULTS AND DISCUSSION

Proximate compositions of two natural sweeteners, miracle fruit and serendipity berry are presented in Table 1. The moisture contents of miracle fruit and serendipity berry are 5.33% and 6.95% respectively. Moisture content is a measure of water content in the fruit sample [13]. The values were low compared to 30.21% reported for canarium schweinfurthii seed pulp by Ayoade et al. [14] and lower than 78.00% and 64.00% of the pulp and peel recorded for pear fruits by Mohammed et al. [15]. The moisture contents of the sweeteners compared favourably with other vegetables (72-92%) reported by Ogoloma et al. [16]. The ash content is an index of the total mineral content of food. The samples had values of 22.90% and 19.33% for miracle fruit and serendipity berry. These values were higher than three dates varieties Dagalla, Danmali and Fari of 3.00%, 3.33% and 3.17% reported by Uba et al. [17]. The crude fiber contents for miracle fruit and serendipity berry were 0.00% and 5.35%. These values were lower compared to the results recorded by Omowunmi and Ayoade [18] for wild date palm with 12.55%. The fat contents of miracle fruit 0.48% and 5.58% for serendipity berry is lower to the value obtained for the pulp 5.60% for pear fruit reported by Mohammed et al. [15]. The crude protein contents of the two sweeteners 73.57% for miracle fruit and 62.54% for serendipity berry. This is an indication that these two sweeteners are good source of protein, thus

can be a replacement for sugar and as well enrich food, since proteins are essential component of diet which supplies adequate amount of amino acids [19]. Carbohydrate composition was lower for both the sweeteners 2.14% miracle fruit and 7.44% serendipity berry. The values of carbohydrate make it safe for human consumption since people are avoiding food with high calories. Carbohydrate provide calories in diet [17]

Table 2 shows the vitamin contents of two sweeteners miracle fruit and serendipity berry. Vitamins are accessory factors, which must be presented in the food in minute amounts to enable growth, health and life to be maintained [20]. The carotene contents miracle fruit and serendipity berry are as follows 8.44mg/100g and 23.00 mg/ 100 g. The vitamin A reported in this study is lower than the vitamin A (57.25mg/100g) of the dried pulp of watermelon [21] but higher than the vitamin A of three varieties of date fruits: Trounja, Lagou and Gounla 0.7 mg/100 g, 1.2 mg/100 g and 0.9mg/100mg reported by Kumar [22]. The relatively high vitamin A content in the sweeteners indicated that it can play a vital role in bone growth and healthy vision [20]. Vitamin C contents of miracle fruit 20.40 mg/ 100 g and serendipity berry 22.01 mg/100 g. These results showed that the two sweeteners had higher values of vitamin C. Vitamin C have high antioxidant activity and it helps in maintaining the cellular membrane integrity. Also vitamin C has been reported to prevent formation of cancer [23]. The values of vitamin D obtained in this present work were high for the two sweeteners 17.02 mg/100 g for miracle fruit and 19.02 mg/100 g for serendipity berry. This implies that the fruits are a good source of vitamin D and underline their significance nutritionally in the diet. However, low values were recorded for vitamin E 0.55 mg/100 g for miracle fruit and 0.89 mg/100 g for serendipity berry.

Table 3 shows eighteen amino acid determined in the profile of miracle fruit and serendipity berry with highly remarkable concentrations when compared with the FAO/WHO [24] reference values for humans of all ages. The most dominant amino acids in the two sweeteners were glutamic acid miracle fruit 10.61 g /100 g and serendipity berry 10.37 g/100 g followed by aspartic acid (8.86 g/100 g and 7.74 g/100 g) then arginine (6.09 g/100 g and 5.28 g/100 g) for non essential amino acids, this was close to (13.19 g /100 g, 11.67 g/100 g and 6.09 g/100 g) reported for canarium schweinfurthii seed pulp by

Ayoade et al. [14]. Glutamic acid and aspartic acid are precursor from which the backbones of amino acid are formed and they are storage forms of nitrogen [15].

Table 1. Proximate composition of miracle fruit and serendipity berry (% dry weight)

Parameter	Miracle fruit	Serendipity berry
Moisture %	5.33±0.98	6.95±0.13
Crude protein %	70.24±0.54	55.59±0.23
Crude fiber %	0.00±0.00	5.35±0.14
Lipid %	0.48±0.01	5.58±0.42
Ash %	21.81±0.72	19.33±0.14
Carbohydrate %	2.14± 0.00	7.20±0.24

Mean ± standard deviation

Table 2. Vitamin contents of miracle fruit and serendipity berry (mg/100 g)

Parameter	Miracle fruit	Serendipity berry
Carotene	8.44±0.02	23.00±4.24
Vitamin C	20.40±0.18	22.01±5.08
Vitamin D	17.02±1.42	19.02±1.41
Vitamin E	0.55±0.07	0.89±0.02

Mean ± standard deviation

Table 3. Classification of Amino acid composition of miracle fruit and serendipity berry

Amino acid	Miracle fruit	Serendipity berry	FAO/WHO reference pattern (1991)
*Lysine	4.70±0.64	5.31±0.01	5.80
*Histidine	0.26±0.06	0.31±0.01	2.50
**Arginine	6.09±0.78	5.28±0.06	5.20
**Aspartic acid	8.86±0.21	7.74±0.57	7.70
**Threonine	8.98±0.04	8.35±0.49	3.40
Serine	3.65±0.07	3.14±0.07	7.00
Glutamic acid	10.61±0.56	10.37±0.05	14.70
Proline	4.26±0.15	4.26±0.15	10.70
**Glycine	5.87±0.07	5.87±0.07	2.20
Alanine	3.80±0.17	3.80±0.17	6.10
*Cystine	1.47±0.64	1.12±0.13	3.00
**Valine	5.58±0.04	7.40±0.01	5.00
**Methionine	0.64±0.05	6.30±0.01	2.50
**Isoleucine	4.27±0.38	6.50±0.07	2.80
**Leucine	7.15±0.38	6.01±0.09	1.10
**Tyrosine	4.56±0.12	6.31±0.26	1.10
**Phenylalanine	6.40±0.28	6.48±0.01	6.30
*Tryptophan	3.18±0.23	3.36±0.21	4.00

*Essential Amino acid

**Values higher than FAO/WHO reference pattern

Mean ± standard deviation

Also Arginine is necessary for human life especially in children's growth [23]. However, higher values were observed for miracle fruit and serendipity berry for phenylalanine (6.40 g/100 g and 6.48 g/100 g), tryptophan (3.18 g/100 g and 3.30 g/100 g), tyrosine (4.58 g/100 g and 6.31 g/100g), leucine (7.15 g/100 g and 8.35 g/100 g), threonine (8.98 g/100 g and 8.35 g/100 g), isoleucine (4.27 g/100 g and 6.50 g/100 g) and valine (5.58 g/100 g and 7.40 g/100 g). cystine (1.47 g/100 g and 1.12 g/100 g) and histidine (0.26 g/100 g and 0.31 g/100 g) had low values. When compared with the FAO/WHO reference pattern miracle fruit and serendipity berry are sources of essential amino acids. These results showed that the total amino acids for miracle fruit and serendipity berry are (90.35g/100g and 97.27g/100 g). The total essential amino acids are 46.95 and 56.50g/100g at 51.96% and 58.09% respectively while the non essential amino acids are (43.40g/100g and 40.77g/100g) at 48.03% and 41.91%. This revealed that these fruits contained above 50% concentration of nutritionally useful essential amino acids which implies that the fruits could be used as supplement. The sulphur containing amino acids (methionine and cystine) are (2.11g/100g and 7.42 g/100 g) and aromatic essential amino acids (phenylalanine and tyrosine) are (10.78 g/100 g and 12.79 g/100 g) respectively.

4. CONCLUSION

The proximate composition of the two sweeteners revealed that protein was high. The fruits had low values for lipid, crude fiber and carbohydrate. The values of vitamins obtained in this investigation showed that these fruits are good sources of vitamins A, C and D however, low values were recorded for vitamin E. The fruits contained appreciable amount of essential amino acid contents which was more than fifty percent of total amino acid. Moreover, miracle fruit and serendipity berry are good protein sources as they contained essential amino acid and nonessential amino acid thus, could be used as food supplement and good replacement for sugar.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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