Estimation of Phytochemical in Yam Flours and Sensory Attribute of Poundo Yam Produced from Yam and *Moringa oleifera* Seed Meal Blends

N. A. Kanu* and T. L. Kingsley

1National Root Crops Research Institute, Umudike Abia State, P.M.B. 7006, Nigeria.

Authors’ contributions

This work was carried out in collaboration between both authors. Author NAK designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Author NAK managed the analyses of the study. Author NAK managed the literature searches. Author TLK read and edited the manuscript. Both authors read and approved the final manuscript.

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ABSTRACT

The sensory characteristic can be quantified and defined by the use of the descriptive profile. A different cultivar of yam can be used for the production of poundo yam. The standard of a product is determined by the evaluation and its acceptability by a taste panelist. Four cultivars of yam; *Dioscorea alata*, *Dioscorea cayenensis*, *Dioscorea rotundata* and *Dioscorea bulbifera* were sourced and processed into flour. *Moringa* seed oleifera was defatted and the cake was blended at a different concentration of 5% and 10% with the yam flour. The qualitative phytochemical investigation of the yam flour and *Moringa oleifera* seed revealed the presence of, alkaloids, steroids, terpenoid oxalate, anthraquinone, phenol, saponins, tannins and flavonoids. Quantitative analysis showed that among the control samples *Dioscorea alata* (DAC), *Dioscorea Dioscorea bulbifera* (DBC), *cayenensis* (DCC) and *Dioscorea rotundata* (DRC). DRC and DAC have the highest values in the total phenol and total flavonoids. *Dioscorea cayenensis* recorded the highest value in steroid and saponin content. The flavonoids, steroid and terpenoid were improved by the inclusion of *moringa* seed meal at 5% and 10%. The result of the sensory analysis revealed that panellist preferred DRC in term of moldability, texture, taste and general acceptability. However, the...
samples with moringa seed meal at 5% and 10% inclusion compete favourably with the control samples. The inclusion of Moringa oleifera seed meal at 10% improved the pounded yam and was more accepted than the 5% in term of general acceptability.

**Keywords**: Yam varieties; phytochemicals screening; sensory attributes; pounded yam; moringa seed meal.

1. **INTRODUCTION**

Yam is one of the earliest angiosperms which belong to the family Dioscoreaceae. The most cultivated and economically important species are the *D. alata*, *D. rotundata* and *D. cayennensis* [1]. The main nutrient in yam is carbohydrate with some proteins, lipids, vitamins and minerals [2]. Yam as a herbal plant possesses other non-nutrient components with some health benefits attached to it [3]. Medicinal plant constitutes some chemical component that confers physiological action to the human body. Among the chemical constituents in a medicinal plant with health potential are the alkaloids, tannins, flavonoids, and phenolic compounds which are the most predominant [4]. Yam contributes extensively to food security as seen in the diversification of its uses in food formulation. It diversification starts from the farm through the cultivation of different varieties which gives rise to different uses and extending the availability of food [5]. Yam can be utilized industrially or domestically, the domestic uses are namely; fufu, flour, fried yam, cooked, amala, pounded yam etc. pounded yam is produced by processing yam into flour and reconstitution of the flour by stirring into a boiling water. Combination of the different plant with a great number of phytochemicals gives a stronger and better effect than using the phytochemical singly [6]. The incorporation of Moringa oleifera seed meal to yam flour will improve the nutritional and the phytochemical composition of the blend. Whichever method or plants are incorporated, quality of the end product is always considered to be an important factor, which the consumers look out for.

The quality attributes in products are their color, texture, and taste which differs from one processor/location to another [7]. The texture is a quality indicator which must be accessed first before all other sensory criteria like taste and colour are considered for consumer acceptability of the food products [8]. Hence the aim of this research is to evaluate the physochemical flour of four yam varieties and the quality attribute of pounded yam enriched with moringa seed meal.

2. **MATERIALS AND METHODS**

Four yam varieties (*Dioscorea alata*, *Dioscorea bulbifera*, *Dioscorea cayennensis* and *Dioscorea rotundata*) were sourced from Wuruku Market while Moringa oleifera seeds were collected from a local settlement in Umudike, Ikwuano Local Government Area of Abia State. The yam samples were processed into flour and the Moringa seeds were defatted to get moringa seed meal. Moringa seed meal at 5 and 10% were included into the different yam flour to form yam/Moringa seed meal. The blends were used to produce pounded yam. Standard method were adopted for quantitative, qualitative phytochemical and sensory attributes as described by Santhi and Sengottuvel [9], Gracelin et al. [10] and Iwe [11] respectively.

2.1 **Statistical Analysis**

Post Hoc analyses were carried out using the least significance difference (LSD) multiple range tests to test for significant difference among the means (P<.05). All statistical analyses were done using the IBM SPSS statistical Programme version 20.

3. **RESULTS**

3.1 **Phytochemical Screening of Yam and Moringa Seed Meal**

The results of the phytochemical screening of yam and Moringa seed meal are presented in Table 1. The screening of the yam flour and the moringa seed meal revealed the presence of some phytochemicals namely: steroid, terpenoid, oxalate, arthroquinine, phenol, saponins, tannins and flavonoid. The Table illustrated that the extract of the samples did not reveal the presence of steroid in Dioscorea alata, Dioscorea bulbifera and Dioscorea rotundata. Also Dioscorea cayennensis and Dioscorea rotundata did not show the presence of flavonoid and phenol.
3.2 Phytochemical Composition of Yam Flour, Moringa Seed Meal and the Blends

The results of the phytochemical composition of yam flour Moringa seed meal and the blend is presented in Table 2. Evaluation of the phytochemical contents of the various species of yam and Moringa seed meal used for treatment in this study showed the presence of phenolic compounds, flavonoids, steroids, saponins and terpenoids in significant amounts. The result indicated that the 5% and 10% inclusion of Moringa seed meal was able to cause a significant (P<.05) increase in the total phenol, for all tested samples. However, a significant decrease was also observed for some samples substituted with Moringa seed meal. There was a significant increase for steroid (DC95M5, DA95M5, DA90M10 and DC90M10), saponin (DA95M5, DA90M10) and terpenoid (DB95M5 and DB90M10).

3.3 Sensory Attributes of Poundo Yam Produced from Yam and Moringa Seed Meal Blend

The results of the sensory attribute of poundo yam produced from yam and Moringa seed meal blend are presented in Table 3. The result of the sensory evaluation as evaluated on 7-point hedonic scale is shown on the Table 3. There were significant differences (P>0.05) in all the sensory parameters. The panelists rated DRC, DAC and DCC and those of Moringa seed meal inclusion (DA90M10, DR90M10 and DC90M10) high in the scoring for mouldability, appearance and texture. However, the mouldability of Dioscorea bulbifera at control, 5% and 10% moringa seed meal inclusion level had the least.

4. DISCUSSION

4.1 Phytochemical Screening of Yam and Moringa Seed Meal

The presence of phenolic compounds such as phenol, flavonoids and tannins in plant show the potential antioxidant and free radical scavenging properties. Flavonoids are known to check lipid peroxidation and there is a correlation between flavonoid and antioxidant activity [12], alkaloids contain large group of nitrogenous compounds which are widely used as cancer chemotherapeutic agents [13]. Tannins possess anti carcinogenic potential and also reduce mutagenic activity of a number of mutagens due to their antioxidant property which prevents cellular oxidative damage and lipid peroxidation. Tannin also inhibits the generation of superoxide radicals thereby relieving oxidative damage to body cells [14,15]. The ability of tannins in the treatment of inflammations and ulcers has also been reported [16]. Most plants that contain tannins as their main component have been used for treating intestinal disorders such as diarrhea and dysentery [17].

Steroids and terpenoids increase protein synthesis, promote growth of muscles and bones and show some level of antiviral activities [14]. Saponins and glycosides are reportedly used to alleviate cardiac problems associated with hypertension. Saponins have been used to treat hypercholesterolaemia in humans, to bind to cholesterol in the body to inhibit the re absorption of the later thereby facilitating its excretion from the body [18].

4.2 Phytochemical Composition of Yam Flour, Moringa Seed Meal and the Blend

Plant materials are endowed with bioactive compounds which may be of benefit in the management of diseases. The presence of phytochemical may be responsible for the liver function modulatory effects of the yam species and Moringa seed meal observed in diabetic treated rats reported by previous worker [19].

Phytochemicals are plant secondary metabolite used as a defense mechanism to fight against predator. However, they have health benefiting potentials. They are known to confer important biological and pharmacological activities, such as anti-oxidative, anti-allergic, antibiotic, hypoglycemic and anti-carcinogenic [20]. Total phenolic compound are known as antioxidant by reacting with free radical and possesses free radical scavenging property [12], metal chelating activity, and singlet oxygen quenching ability hence protecting the cell against damage [21]. Total phenols represent a wider range of other plant secondary metabolite.

The decreased of total phenol as was observed at 5% Moringa seed meal inclusion could be attributed to the low total phenol content of Moringa seed meal. Thus, the low concentration caused a reduction in the initial higher value of the control sample and as the substitution increases then the value increases.
Table 1. Phytochemical screening of yam flour and *Moringa* seed meal

| Sample               | Alkaloids | Steroids | Terperoid | Oxacate | Anthroquinous | Phenol | Saponins | Tannins | Flavonoids |
|----------------------|-----------|----------|-----------|---------|---------------|--------|----------|---------|------------|
| *Dioscorea alata*    | +         | -        | ++        | +       | +             | +      | +        | +       | +          |
| *Dioscorea bulbifera*| +         | -        | +         | +       | +             | +      | +        | +       | +          |
| *Dioscorea cayenensis*| +         | +        | ++        | +       | ++            | +      | +        | +       | ++         |
| *Dioscorea rotundata*| +         | +        | ++        | +       | ++            | +      | +        | +       | ++         |
| MSM                  | +         | + +      | ++        | +       | +             | +      | +        | +       | ++         |

Key: + (Presence of the phytochemicals), ++ (Highly present) and (Absence of the phytochemical)

Table 2. Phytochemical compositions of yam flour, *Moringa* seed meal and blends

| Samples               | T. PHEL (mgGAE/100 g) | T. FLAVD (mg/Re/g) | STERD (mg/100 g) | SAP (mg/100 g) | TERPD (mg/100 g) |
|-----------------------|-----------------------|-------------------|------------------|---------------|-----------------|
| DRC                   | 1.78±0.01             | 0.50±0.00         | 30.24±0.002      | 0.27±0.01     | 1.18±0.02       |
| DAC                   | 1.32±0.02             | 0.70±0.00         | 17.55±0.00       | 0.06±0.00     | 1.25±0.00       |
| DCC                   | 1.61±0.01             | 0.60±0.00         | 23.76±0.01       | 0.19±0.00     | 0.39±0.00       |
| DBC                   | 1.27±0.12             | 0.80±0.00         | 15.53±0.02       | 0.05±0.00     | 1.56±0.00       |
| MRGA                  | 1.10±0.00             | 0.80±0.00         | 12.54±0.00       | 0.02±0.00     | 2.09±0.00       |
| DR95M5                | 1.67±0.02             | 0.50±0.00         | 26.32±0.10       | 0.23±0.00     | 0.29±0.00       |
| DR90M10               | 1.73±0.00             | 0.50±0.00         | 27.74±0.02       | 0.25±0.00     | 0.24±0.01       |
| DA95M5                | 1.44±0.00             | 0.70±0.00         | 18.89±0.02       | 0.08±0.00     | 1.00±0.00       |
| DA90M10               | 1.45±0.00             | 0.70±0.00         | 19.67±0.10       | 0.11±0.00     | 0.83±0.00       |
| DC95M5                | 1.57±0.00             | 0.60±0.00         | 21.44±0.10       | 0.15±0.00     | 0.51±0.00       |
| DC90M10               | 1.51±0.01             | 0.60±0.00         | 22.02±0.01       | 0.17±0.00     | 0.69±0.10       |
| DB95M5                | 1.16±0.02             | 0.80±0.00         | 13.00±0.00       | 0.03±0.00     | 1.87±0.17       |
| DB90M10               | 1.22±0.00             | 0.80±0.00         | 14.77±0.00       | 0.04±0.00     | 2.00±0.00       |

Values are means± SD of 3 replications. Means within a column with the same superscripts were not significant difference (P>0.05)

Key: DRC (*D. rotundata* control), DAC (*D. alata* control), DCC (*D. cayenensis* control and DBC (*D. bulbifera* control), MRGA (*Moringa* seed meal), DR95M5 (95% *D. rotundata & 5% moringa seed meal), DR90M10 (90% *D. rotundata & 10% moringa seed meal), A95M5 (95% *D. alata & 5% moringa seed), DA90M10 (90% *D. alata & 10% moringa seed meal), DC95M5 (95% *D. cayenensis & 5% moringa seed meal), DC90M10 (90% *D. cayenensis &10% moringa seed meal), DB95M5 (95% *D. bulbifera & 5% moringa seed meal), DB90M10 (90% *D. bulbifera & 10% moringa seed meal)
Table 3. Sensory attributes of poundo yam produced from yam flour and *Moringa* seed meal blends

| Samples            | Moudability | Appearance | Texture | Taste | G/A  |
|--------------------|-------------|------------|---------|-------|------|
| DRC                | 5.25±1.41   | 5.39ab±1.33| 5.43±1.71| 4.58±1.52| 5.61±1.08 |
| DAC                | 4.80bc±1.61 | 5.93±1.11  | 4.71ab±1.37| 4.43±1.73| 4.97bc±1.33 |
| DCC                | 4.60bc±1.74 | 4.60bc±1.32| 5.16±1.32| 4.63±1.27| 4.43±1.72 |
| DBC                | 4.82bc±1.51 | 4.27±1.87  | 3.92c±1.37| 3.80±1.71| 5.10abc±1.52 |
| DR95M5             | 3.93c±1.64  | 4.17±1.53  | 4.73ab±1.62| 4.53±1.55| 4.33±1.75 |
| DR90M10            | 4.93ab±1.68 | 4.60bc±1.56| 4.53cd±1.50| 4.56±1.43| 4.93bc±1.39 |
| DA95M5             | 4.27bc±1.48 | 5.00ab±1.55| 3.76cd±1.72| 4.56±1.41| 4.67cd±1.32 |
| DA90M10            | 5.43±1.49   | 5.23ab±1.61| 4.70ab±1.49| 4.66±1.52| 5.17abc±1.53 |
| DC95M5             | 4.30bc±1.67 | 5.10ab±1.32| 3.47cd±1.17| 4.30±1.84| 4.17d±1.66 |
| DC90M10            | 4.87ab±1.54 | 4.90bc±1.39| 4.57ab±1.85| 4.70a±1.34| 5.06abc±1.31 |
| DB95M5             | 4.21bc±1.61 | 4.69bc±1.60| 4.14cd±1.43| 4.24a±1.57| 3.72±2.10 |
| DB90M10            | 3.10±1.83   | 3.67±1.88  | 3.13d±1.33| 3.16b±1.57| 3.17±1.70 |

Values are mean ±SD of 3 replications. Means within a column with the same superscripts were not significant difference (P > 0.05)

Key: DRC (*D. rotundata* control), DAC (*D. alata* control), DCC (*D. cayenensis* control) and DBC (*D. bulbifera* control), MRGA (*Moringa* seed meal), DR95M5 (95% *D. rotundata* & 5% moringa seed meal), DR90M10 (90% *D. rotundata* & 10% moringa seed meal), DA95M5 (95% *D. alata* & 5% moringa seed meal), DA90M10 (90% *D. alata* & 10% moringa seed meal), DC95M5 (95% *D. cayenensis* & 5% moringa seed meal), DC90M10 (90% *D. cayenensis* & 10% moringa seed meal), DB95M5 (95% *D. bulbifera* & 5% moringa seed meal), DB90M10 (90% *D. bulbifera* & 10% moringa seed meal)
The variation of the total phenols as observed in this study may be attributed to the time of harvest and growing conditions [22].

Flavonoids and other phenolic compounds are common dietary components present in many beverages and foods; hence their presence in these yam species and Moringa seed is not surprising. Both flavonoids and phenolic compounds have demonstrated significant antioxidant activities and free radical scavenging effects. The ability of flavonoids to prevent coronary heart diseases and their usefulness in cancer management and prevention has also been reported by Lin et al., [23]. Flavonoids also have been implicated in wound healing, cellular regeneration and cytoprotection and as such may be of benefit in the treatment of ulcer [15, 24].

* Dioscorea bulbifera * has the highest total flavonoid when compared with the other control samples this is in line with the work of Ukom et al., [21] who evaluated the flavonoid content of some yam samples (*Dioscorea bulbifera, Dioscorea cayenensis* and *D. dumenterum*) and observed that *Dioscorea bulbifera* had the highest value while, *D. cayenensis* had the least value. There is no significant difference in between a particular control samples and it associated blend both at 5% and 10% *Moringa* seed meal. The variation of the total flavonoid as observed in this study may be linked to varietal differences as shown in the makeup of their genotype [25]. Flavonoids display free radical scavenging activity; in that they prevent the decomposition of hydrogen peroxide into free radical [26].

Steroids and terpenoids increase protein synthesis, promote growth of muscles and bones and show some level of antiviral activities [27]. Saponins and glycosides are reportedly used to alleviate cardiac problems associated with hypertension. Saponin has been used to treat hypercholesterolemia in humans. This is because it is believed to bind to cholesterol in the body to inhibit the re absorption of the later thereby facilitating its excretion from the body [15].

### 4.3 Sensory Attributes of Poundo Yam Produced from Yam and Moringa Seed Meal Blend

The higher mouldability score for DR90M10, DA90M10 and DC90M10 as compared with other samples with the *Moringa* seed meal may be associated with the particle size of the *Moringa* seed meal which is known to influence the quality attribute as reported by Ayodele et al., [28] that particle size distribution of wheat flour was observed to influence quality attribute of masa and tortillas production as the incorporation of wheat flour increases. Also, *Moringa oleifera* flour is known to increase viscosity. The increase concentration of defatted *Moringa* seed flour caused an increase in the viscosity and thickness of soup as reported by Sahay et al. [29]. Texture is a quality indicator which must be accessed first before all other sensory attributes like taste and appearance are considered for consumer acceptability of the food products [30]. The DRC having the highest for mouldability was an indication of its mealy nature. The mealy nature of *Dioscorea rotundata* was observed during the boiling where it demonstrated complete cell separation and rounding off, whereas *Dioscorea alata* is said to be waxy because it shows partial retention which is characterized by partial cell separation with no rounding off [31]. These properties are also reflected even at 5 and 10% levels of *Moringa* seed meal inclusion for both yam samples (*Dioscorea rotundata* and *Dioscorea alata*). The high score of *Dioscorea rotundata* and *Dioscorea cayenensis* when compared to *Dioscorea alata*, cannot be far from the starch content and the firmness of *Dioscorea alata* which has been reported to be low and thus responsible for it poor performance [32]. The easiness to mold, springiness, and less lumpy property found in *Dioscorea cayenensis* are the desires characteristic in pounded yam [33]. Furthermore, *Dioscorea alata* is more rigid in their cell disruption and also its high fiber content may contribute to the low score in the textural attributes [34].

The Tables showed that the sample DRC (*Dioscorea rotundata* control) was generally accepted by the panelists more than the other samples. This was so because it is the most preferred specie for the production of pounded yam [35]. The inclusion of *Moringa* seed meal improved the acceptability of some of the poundo yam. Sample DR90M10 (*Dioscorea rotundata*) DC90M10 (*Dioscorea cayenensis*), DA90M5, and DA90M10 (*Dioscorea alata*) at 5% and 10% *Moringa* seed were greatly improved in their level of acceptability by the test panelists. The acceptability of *Dioscorea alata* at 5% and 10% *Moringa* seed meal may be attributed to the white appearance of *Dioscorea alata* which seem to have a better appearance than all the
samples. This finding in the appearance of *Dioscorea alata* strongly agreed with the work of other researchers who reported that *D. alata* varieties were better than or not significantly different from *D. rotundata* in terms of appearance [36]. The general acceptability of *Dioscorea bulbifera* decreased significantly from the control sample (DBC), 5% and 10% *moringa* seed meal inclusion and had the least score. It was rejected by the panelists. This may be attributed to the lack of appealing quality [37] as compared to *Dioscorea alata* and *Dioscorea rotundata*.

There was no significant (P>0.05) different in the taste of the entire sample. The inclusion of *moringa* seed meal at 5 and 10% level did not alter the taste of the poundo yam. They compared favorably with the control samples. However, the *Dioscorea bulbifera* control and the sample containing both at 5% and 10% *Moringa* seed meal had the least scores for all the sensory attributes. This may be due to inclusion scored the least. This may be due to the distinctive flavor, which is one of the characteristic features of *Dioscorea bulbifera* [37].

**5. CONCLUSIONS**

The result of the study revealed that the quantitative screening of yam showed the presence of the following phytochemicals tannin, alkaloid, steroid, saponin etc, however, the inclusion of the *Moringa oleifera* seed meal elevated the quantitative phytochemicals. The sensory attributes showed that *Dioscorea rotunda* was more accepted by the taste panelist in all the parameters tasted however, the inclusion of *Moringa oleifera* seed meal at both 5% and 10% inclusion improve the mouldability and the appearance for *Dioscorea cayenensis* and *Dioscorea bulbifera*.

**COMPETING INTERESTS**

Authors have declared that no competing interests exist.

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