PRINT ISSN 1119-8362
Electronic ISSN 1119-8362

Full-text Available Online at
https://www.ajol.info/index.php/jasem
http://ww.bioline.org.br/ja

J. Appl. Sci. Environ. Manage.
Vol. 24 (8) 1391-1396 August 2020

# Dietary Fibre and Micronutrient Potential of Underutilized Green Leafy Vegetable Sprinkles on Selected Foods

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**ABSTRACT**: Considering the rural poor in developing countries like Nigeria, diets that are deficient in dietary fibre and micronutrients are common. Food diversification or dietary modifications such as increased consumption of vegetables may solve the problem. This study assessed the dietary fibre and micronutrient levels of selected starchy foods (jollof rice and yam porridge) using three underutilized green leafy vegetables, namely, *Ebolo* (*Crassocephalum crepidiodes*), *Odu* (*Solanum nigrum* L), and *Yanrin* (*Launaea teracifolia* L) as sprinkles. Fresh samples of *Crassocephalum crepidioides*, *Solanum nigrum* L, and *Launaea teracifolia* were purchased from Ota market. The leafy parts of the vegetables were washed, cut, oven-dried at 90°C for 6 h and pulverized. Jollof rice and porridge were cooked and 2g each of dried ebolo, odu and yanrin were sprinkled on 100g of each food and stirred thoroughly. Total dietary fibre, as well as iron (Fe) and Zinc (Zn) content of the resultant diets, were determined using standard methods. The highest total dietary fibre of 8.45% was obtained in jollof rice sprinkled with *Yanrin*. Zn (31.75mg/kg) was highest in jollof rice sprinkled with *Yanrin*, and Fe (87.75mg/kg) in porridge sprinkled with *Ebolo*. The underutilized vegetables added more nutritional values to jollof rice and yam porridge as *Ebolo*, *Yanrin* and *Odu* were sprinkled on them.

**DOI:** https://dx.doi.org/10.4314/jasem.v24i8.13



**Dates:** Received: 30 May 2020; Revised: 03 July 2020; Accepted: 05 August 2020

**Keywords:** Underutilized vegetables, dietary fibre, micronutrient, zinc, iron

Vegetables generally play an important role in the human diet. Many varieties of vegetables are traditional or indigenous and they are characterized by a high nutritional value when compared with commercialized vegetables (Keatinge *et al.,* 2011). Previous studies have shown that underutilized vegetables are naturally nutrient-dense and could be sources of vitamins, protein and other phytonutrients (Hudges and Keatinge, 2012). Many vegetable species are high in either one or several micronutrients (Yang and Keding 2009). The underutilsed vegetables are abundant in rural areas but are usually neglected (Babayemi and Adepoju, 2020). Since this category of vegetables is naturally nutrient-dense, it may help to enhance a diverse and healthy diet among the rural poor in developing countries, if the neglected underutilized vegetables are adequately exploited. It may also help to solve the problem of dietary fibre and micronutrient deficiencies in starchy foods like rice and porridge. Studies have shown that people with high intakes of dietary fibre are likely to have a significantly lower risk of coronary heart disease, stroke, hypertension, diabetes, obesity, and certain gastrointestinal diseases (Aderson *et al*., 2009). During the stages of high iron demand, inadequate access to foods rich in absorbable iron may predispose individuals or certain groups to the highest probability of suffering iron deficiency (Abbaspour *et al*., 2014). Groups at risk of iron inadequacy include pregnant women, infants and young children, women with heavy menstrual bleeding, frequent blood donors, people with cancer, people who have gastrointestinal disorders or have had gastrointestinal surgery, and people with heart failure (National Institutes of Health, 2020a). Zinc plays a role in the catalytic activity of approximately 100 enzymes (National Institutes of Health, 2020b). Despite this health importance of Zn, some groups of people may still suffer a deficiency. Studies have shown that the inadequate dietary intake of absorbable Zn is the primary cause of zinc deficiency in most situations (Roohani *et al*., 2013). Vegetables are rich sources of micronutrients; and their abundance in underutilised or indigenous vegetables have been reported (Adeyeye et al., 2018). Currently, it appears there is a loss of the local knowledge of the values of indigenous vegetables (Dansi *et al*., 2012), resulting in a decline in their uses as food. Vegetables generally may not be available during the dry seasons; this may also contribute to a decline in their uses. There is, therefore, the need to study the potential of the underutilized green leafy vegetables in dry form, particularly as sources of

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dietary fibre and micronutrients. This may encourage their use during the dry season as well. Converting the vegetables to a dry and powdery form can be a valuable option to conserve their availability and nutrient value over time. Generally, the shelf-life of fresh vegetables is very short after harvest, and some forms of deterioration like uncontrolled browning, wilting and loss of nutritional value at ambient temperature and relative humidity may occur (Jiang *et al*., 2013); these challenges may be overcome when converted into dry and powdery form (Babayemi and Adepoju, 2020). The objective of the study was to improve the dietary fibre and micronutrient levels of selected starch foods (jollof rice and yam porridge) using three underutilised green leafy vegetables, namely, *Ebolo* (*Crassocephalum crepidiodes*), *Odu* (*Solanum nigrum* L) and *Yanrin* (*Launaea teracifolia* (L) as sprinkles. Specifically, the study aimed at assessing the effect of the vegetable supplementation on the micronutrient (Fe and Zn) and dietary fibre content of the starchy foods.

# MATERIALS AND METHODS

*Collection and preparation of the underutilized vegetables*: Following the procedures described in Babayemi and Adepoju (2020), fresh samples of *Ebolo* (*Crassocephalum crepidioides*), *Odu* (*Solanum nigrum* L), and *Yanrin* (*Launaea teracifolia*) were purchased from Ota Market in Ado-Odo/ Ota Local Government Area, Ogun State. The leafy parts of these vegetables were washed, cut and oven-dried at 90°C for 6 h. The dried leaves were pulverized, packaged in airtight sterile bottles, labeled and stored in a refrigerator until used. The sample codes are presented in Table 1.

**Table 1**. Sample codes

| Sample codes | Description |
|---|---|
| J | Jollof rice |
| P | Porridge |
| JE | Jollof rice and *Ebolo* |
| PE | Porridge and *Ebolo* |
| JY | Jollof rice and *Yanrin* |
| PY | Porridge and *Yanrin* |
| JO | Jollof rice and *Odu* |
| PO | Porridge and *Odu* |

*Cooking of jollof rice*: Following the method of Babayemi and Adepoju (2020), jollof rice was prepared by adding 0.3 kg of a mixture of ground pepper, tomatoes and onion into a pot containing 30 ml of groundnut oil. The whole content was stewed for about ten minutes. 0.3 kg of parboiled rice was poured into the stew after some quantity of water was added. Salt was added to taste. The whole content was covered and allowed to cook for about 20 minutes.

*Cooking of yam porridge*: 1.2 kg of peeled yam was washed and boiled in some quantity of water for about fifteen minutes; 0.3 kg of a mixture of ground pepper, tomatoes, onion and 30 ml of palm oil was added. Salt was added to taste. The whole content was allowed to cook for 20 minutes.

*Preparation of samples for mineral and dietary fibre analysis*: 2 g of each of the dried underutilized vegetables was thoroughly mixed with 100 g of each of the foods. From these, portions were taken for dietary fibre and mineral analysis.

*Mineral analysis*: Iron (Fe) and zinc (Zn) contents were determined using the standard procedure described by Miroslav and Vladimir (1998). A portion of each of the mixture of food and vegetable was dried to constant weight. 2 g of the dried sample contained in an acid-washed porcelain crucible was placed in a muffle furnace and ashed at 500°C for 4 h. After ashing, the sample was cooled. The ash was dissolved with 2.5 ml of concentrated $HNO_3$. This was quantitatively filtered into a 50 ml volumetric flask. The solution was made up to mark with distilled water. Analysis of Fe and Zn was carried out using Atomic Absorption Spectrophotometer (AAS).

*Determination of total dietary fibre*: Following the method described by Lee *et al*. (1992), 1g of the mixture of underutilized vegetable and food was weighed into a 50 ml centrifuge tube, followed by addition of 2 ml dimethyl sulphoxide and then capped. To obtain a homogenised sample, the mixture was stirred for about 2 min on a magnetic stirrer. The tube was placed in a beaker of boiling water on a hot plate with a stirrer, allowing it to mix for 1 hr, after which the tube was removed. Without cooling, 8 ml of sodium acetate buffer at pH 5.2 was pre-equilibrated at $50^0$C and vortex mixed. The tube with the content was allowed to cool at room temperature to between 30 $^0$C and 40 $^0$C. A α-amylase solution of 0.5 ml was added, followed by 0.1ml of pullulanase solution, and then the vortex mixed. The tube was capped and incubated for 16hr, after which 40ml of ethanol was added, thoroughly mixed, and left for 1hr at room temperature. The mixture was centrifuged at 1500 g for 10min. The supernatant was removed by decantation without disturbing the residue. The residue was washed twice using 50 ml 85% ethanol each time and mixed by inversion on a magnetic stirrer to suspend the residue and supernatant removed as before. The residue was then washed with 40 ml of acetone, stirred for 5 min and centrifuged at 1500 g for 10 min. The supernatant liquid was removed by aspiration. The tube with the residue was placed in a beaker of water on a hot plate at $65^0$C-$75^0$C with continuous stirring of the content till the residue appeared dry.

% Total Dietary Fibre (TDF) was calculated using the formula:

$$\%TDF = \frac{Weight\ of\ residue}{Weight\ of\ sample} \times 100$$

*Data analysis*: T-test was carried out to see if there is any significant difference between one parameter and the other using SPSS version 20.

## RESULTS AND DISCUSSION

*Dietary fibre*: The results of dietary fibre analysis are presented in Table 2 and Figure 1. The dietary fibre content of food sprinkled with the underutilised vegetables ranged from 6.63% to 8.47%. Jollof rice only and porridge only (as control) had the lowest dietary fibre with a mean of 2.92% and 3.16% respectively. Cheng (1993) reported 1.25% dietary fibre content of several varieties of polished rice, which is lower than 2.92% obtained in this study. Since jollof rice (which contained other ingredients like pepper, tomato and onion) was considered in this study, the higher dietary fibre content may, therefore, be expected. The result of this study is similar to the value (2.6 ± 0.3%) for jollof rice reported by Adegoke *et al*. (2006). The observed dietary fibre (3.16%) for porridge only is similar to the value (2.6 ± 0.3%) reported by Adegoke *et al*. (2006) for boiled yam; the slight increase for the value obtained in this study might arise from the ingredients (like pepper, tomato and onion) added to make the porridge. Comparing jollof rice only and porridge only, porridge had the highest dietary fibre. This may be expected since yam has higher dietary fibre than polished white rice (Cheng, 1993; Adegoke *et al*., 2006). In the jollof rice treatment group, jollof rice improved with *Yanrin* had the highest dietary fibre (8.45%); followed by the one sprinkled with *Odu* (8.41). For the porridge treatment group, the one sprinkled with *Ebolo* had the highest dietary fibre (6.72%); however, not significantly different ($P < 0.05$) from the one sprinkled with *Yanrin* (6.71%); therefore, similar to the jollof rice treatment group. This implies that the impact of *Yanrin* on the dietary fibre content of rice and porridge is higher than those of *Ebolo* and *Odu*. Ordinarily, *Yanrin* has a fibre content of 1.57%; *Ebolo*, 1.45%; and *Odu*, 1.44% (Adeyeye *et al*., 2018). This may account for the highest dietary fibre impact of *Yanrin* on jollof rice and porridge than the impact of the other two vegetables. Overall, it may be inferred that the underutilized vegetables increased the level of dietary fibre in the meals (Figure 1); this may be because vegetables are usually high in fibre. Dietary fibre possesses immense health benefits. Studies have shown that increasing fibre intake lowers blood pressure and serum cholesterol levels (Aderson *et al*., 2009).

**Table 2**: Total dietary fibre (%) of samples (analysed in triplicates)

| sample | Minimum | Maximum | Std. Dev. |
|---|---|---|---|
| J | 2.89 | 2.95 | 0.031 |
| JE | 8.25 | 8.28 | 0.015 |
| JY | 8.42 | 8.47 | 0.025 |
| JO | 8.39 | 8.43 | 0.020 |
| P | 3.15 | 3.18 | 0.015 |
| PE | 6.69 | 6.74 | 0.025 |
| PY | 6.68 | 6.73 | 0.025 |
| PO | 6.63 | 6.67 | 0.020 |

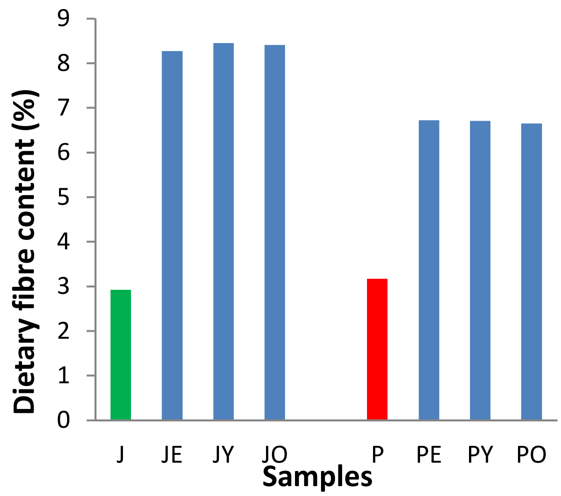


**Fig 1:** Comparison of the dietary fibre content of the different treatment groups

*Micronutrients content of the samples:* Table 3 shows the concentrations of micronutrients in the samples. Jollof rice only and porridge only served as the control and they had the lowest concentrations of the micronutrients: 8.25 mg/kg for Zn and 31.75 mg/kg for Fe in jollof rice only; and 8.75 mg/kg for Zn and 36.75 mg/kg for Fe in porridge only. This observation shows that Zn and Fe were higher in porridge than jollof rice. In the foods sprinkled with the underutilized vegetables, the concentrations of Zn ranged from 10.00 mg/kg to 31.75 mg/kg and Fe from 49.00 mg/kg to 87.75 mg/kg. In the jollof rice treatment group, Zn was highest in JY (31.75 mg/kg) and Fe in JE (67.25 mg/kg). In the porridge treatment group, Zn was highest in PO (11.50 mg/kg) and Fe in PE (87.75 mg/kg). The concentration of Zn in PY (10.00 mg/kg) was not significantly different from Zn in PO (11.50 mg/kg); therefore, making the results similar to that of jollof rice treatment group. This implies that the Zn is mostly contributed from *Yanrin* and Fe from *Ebolo*. However, there is a significant difference ($P < 0.05$) or extremely significant difference ($P < 0.001$) between the levels of Zn and Fe.

Comparing the three vegetables, previous studies (Adeyeye *et al*., 2018) have shown that *Ebolo* has the highest Fe content of 40.6 mg/kg; followed by *Odu* (38.2 mg/kg); and then *Yanrin* (34.7 mg/kg); while for Zn, *Ebolo* has the highest content of 1.52 mg/kg; *Odu*, 1.47 mg/kg; and *Yanrin*, 1.22 mg/kg. This trend may, therefore, be responsible for the highest Fe content impact of *Ebolo* on both the jollof rice and porridge. However, for Zn, the highest impact on porridge is from *Odu*. Tchientche *et al*. (2013) reported that *Odu* had the highest content of iron when compared with other underutilized vegetables such as amaranths, jute, mallow, etc, though their micronutrient analysis was on fresh vegetables, not on dried leaves sprinkled on food samples. Variation is expected in the mineral composition of similar plants; and this depends on the chemical composition of the soil where the plants grow (Azeez and Babayemi, 2020; Babayemi *et al*., 2017). Generally, there was an increase in the levels of Zn and Fe in the two selected foods improved with each of the three underutilized vegetables. That is, the micronutrients were significantly ($P > 0.05$) higher in the samples than in the control, implying that these three vegetables are high in Fe and Zn. The levels may even be higher than it is in some common vegetables. The iron content of some common vegetables reported in previous studies are tomato (0.54 mg/kg), cabbage (0.30 mg/kg), slippery cabbage (1.4 mg/kg) and sweet potato leaf (1.88 mg/kg) (AVRDC, 2008).

**Table 3**: Concentration (mg/kg) of micronutrients in the samples

| Sample Codes | Zn | Fe |
|---|---|---|
| J | 8.25±0.00 | 31.75±0.35 |
| JE | 13.75±0.00 | 67.25±0.20 |
| JY | 31.75±7.05 | 52.50±0.00 |
| JO | 13.00±1.20 | 49.00±0.30 |
| P | 8.75±0.00 | 36.75±0.23 |
| PE | 11.00±0.15 | 87.75±0.00 |
| PY | 10.00±0.08 | 49.00±0.00 |
| PO | 11.50±0.00 | 80.00±0.00 |

The nutritional importance of leafy vegetables rests so much on the high content of the macro- and micronutrients, especially calcium, magnesium, phosphorus and iron (Jaworska and Kmiecik, 1999). In general, vegetables contain significant amounts of beta-carotene, folic acid and dietary fibre; the mineral content of the leaves is known to be relatively high (21.8%) (Takebe *et al.,* 1995). The deficiency in Fe may result in some health disorder such as anaemia, functional impairments affecting cognitive development, immunity mechanisms, and work capacity (Abbaspour *et al*., 2014). Food diversification or dietary modifications such as increased consumption of vegetables may solve the problem of Zn and Fe deficiency (Roohani *et al*., 2013). Vegetables are dietary sources of nonheme iron (National Institutes of Health, 2020a). Some of the adverse health effects of Zn deficiency include growth retardation, loss of appetite, and impaired immune function (National Institutes of Health, 2020b). The most organs affected clinically by zinc deficiency are epidermal, gastrointestinal, central nervous, immune, skeletal, and reproductive systems (Roohani *et al*., 2013).

*Conclusion:* Indigenous vegetables add more nutritional values to jollof rice and yam porridge as *Ebolo, Yanrin* and *Odu* were sprinkled on them. The iron and zinc levels of these food samples increased when the three underutilized vegetables were sprinkled on them. The dietary fibre of the food samples also increased compared to the control. Food diversification or dietary modifications such as supplementation of starchy foods with vegetables may solve the problem of dietary fibre and micronutrients deficiency.

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