NUTRIENT AND ANTINUTRIENT PROFILES OF RAW AND FERMENTED TRIFOLIATE YAM (*DIOSCOREA DUMETORUM*) FLOUR

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ABSTRACT
Freshly harvested trifoliate yam was subjected to natural fermentation for 24, 48 and 72hours, dried and milled to produce trifoliate yam flour. The proximate, and antinutritional levels in the flour were determined and compared with those of raw (unfermented) trifoliate yam flour. The result of the proximate analysis revealed that there was significant increase in the protein (11.41 to 13.31%), ash (2.22 to 3.20%),crude fibre (2.03 to 2.36%) and crude fat (0.71 to 2.04%) contents while the carbohydrate content decreased significantly (77.55 to 71.16%) in the fermented flour. Antinutrients such as alkaloid, saponin and flavonoids reduced significantly in the fermented sample. The reduction was progressive throughout the 72 hours fermentation period.

Keywords: Trifoliate yam, proximate composition, antinutrients, fermentation.

INTRODUCTION

Trifoliate yam (*Dioscorea dumetorum*) is also known as African Bitter Yam, Cluster Yam, Esuri yam, Esuru, *Helmia dumetorum*, Igname sauvage, Ikamba, Inhame-bravo, Name Amargo, Name de Tres Hojas, Ono or three-leave yam. The trifoliate yam, (*Dioscorea dumetorum Pax),* belongs to the genus Dioscorea and family *Dioscoreaceae* (Bai and Ekanayake, 1998). The *Dioscorea dumetorum* varieties are of importance in a growing economy such as Nigerian (Malaurie, 1998). *Dioscorea dumetorum* originated in tropical Africa and occurs in both wild and cultivated forms but its cultivation is still restricted in West and Central Africa (King and Hackett, 1986). *Dioscorea dumetorum* tubers are clustered; that is why they are called cluster yam. It grows readily on various soils, the yield being 3-7 times that of other widely grown yam species (Treche and Guion 1980). Both planting and harvesting can be mechanized. The growth period is usually 8-10 months. Nutritionally, *Dioscorea dumetorum* is superior to the commonly consumed yams, having higher protein and mineral contents (Baquar and Oke 1976, 1977; Treche and Guion (1979). The amino acid profile of the *Disocorea dumetorum* has been reported to be quite balanced in essential amino acids with slight deficiency in sulphur containing amino acids and lysine as the most limiting (Alozie *et al*, 2009).

Treche and Guion (1980) has shown that the starch grains are smaller, more soluble, and more digestible than those of other yam species. This is because of its tiny polygonal or spherical granules with a type A x-ray diffraction structure that is similar to that of cereals (Robin, 1976). Generally, the tubers do not store well, a high proportion becoming hard and inedible within 4 weeks after lifting. Medoua *et al*, (2008) on his investigation on the Influence of fermentation on some quality characteristics of trifoliate yam (*Dioscorea dumetorum*) hardened tubers reported that total phenols, phytic acid, oxalates, trypsin inhibitors and alpha-amylase inhibitors decreased by significant levels ($P <= 0.05$) within 14 days of fermentation. *Dioscorea dumetorum* has not been as widely studied as other species. Increased study on *Dioscorea dumetorum* could add to the likelihood of exploitation of the species as an economic plant and bring about further work on its cultivation. The data obtained will be useful in designing new product formulations as well as efficient food process operations. Therefore, the objective of this work was to investigate the effect of fermentation on proximate composition and antinutrients content of Trifoliate yam flour.

MATERIALS AND METHODS

Experiment materials and Sample Preparation

Trifoliate yam tubers were obtained from yam programme of the National Root Crops Research Institute, Umudike. The tubers were washed and divided into 2 portions. One portion was peeled, washed and chipped with a chipping machine. The chips were then air dried. The second portion was peeled, washed and soaked in water, the traditional fermentation method of Oladele and Oshodi (2008) was used. The micro-organisms involved in the traditional fermentation were natural inoculants from the air. Samples were collected at 24, 48 and 72 hours interval and the samples were air dried. The dried yam chips were then milled into powder using a Thomas Wiley mill model ED-5 and stored in air tight containers before analysis.

Chemical Analysis

Moisture, crude protein, crude fat, crude fibre and ash of the samples were determined according to AOAC (1990) methods. The method adopted in the saponin determination was that described by Nahapetian and Bassiri, (1975). The method of Obadoni and Ochuko, (2001) was adopted in the alkaloid and phenol determination while the method of Boham and Kocipai (1994) was used in flavonoid determination.

Statistical analysis

Data collected were analysed by analysis of variance and the means separated by LSD to indicate the significant differences (p,0.05) using a SAS system 2008 version.

RESULTS AND DISCUSSION

The effect of fermentation on the proximate composition of *D. dumetorum* is shown in table 1. The crude protein contents of *D. dumetorum* (cultivated) ranged from 11.41% (raw flour) to 13.31% (72hrs fermented flour). The crude protein of the fermented flours increased significantly throughout the fermentation period, peak values of the protein were obtained after fermentation for 72hrs. The significant increase may be due to the fact that during fermentation, microflora enzymes hydrolyzed bonds among bound protein antinutrient and enzyme to release free amino acids for synthesis of new protein (El-Hag *et al*.,2002; Ahn,2005) as well as microbial biomass (Odetokun, 2000). A similar result was obtained for crushed maize by Abasiekong, (1991).

Fermentation increased the ash content from 2.22% to 3.20% in the trifoliate yam flour after 72 hours of fermentation. Therefore the present results showing a significant increase ($p<0.05$) in the ash content of the fermented trifoliate yam may be an indication of a significant increase in the levels of the minerals of the fermented tuber. The same trend was observed by Eka (1980) on the effect of fermentation on the nutrient status of locust bean where an increase of about 30% in ash content was recorded after fermentation, it also agrees with the observation of Amoo (2003) on the effect of fermentation on the nutrient and mineral content of *Bauhinia reticulate*.

Fermentation significantly increased the crude fibre composition of the tubers. The significant increase in the crude fibre content of fermented trifoliate yam falls within the range of 2.03 to 2.36%. The increase in fibre content of the fermented samples may be due to the activities of micro-organisms. The fermentation process involves the conversion of materials to the peculiar needs of the micro-organisms which include the bacterial cell wall. The bacterial cell wall is made up of peptidoglycan or murein, which is a polysaccharide like cellulose. As the micro-organisms were not separated from the biomass, the increase in fibre could be due to the peptidoglycan from the micro-organisms (Eze and Ibe, 2005). Carbohydrate content decreased on fermentation from 77.75% to 71.55% in *D. dumetorum*. This is obviously due to the fact that they were used up as the source of energy during fermentation.

Table 1: Effect of fermentation on the proximate composition of cultivated *D. dumetorum.*

Samples	Ash	Lipids	Moisture	Fibre	Protein	CHO	Energy
ROO	2.23c	0.71d	6.10d	2.03d	11.41d	77.55a	361.90a
OF24	2.65_b	0.90c	7.76c	2.18c	12.32c	74.21b	354.37c
OF48	2.80b	1.24b	7.88b	2.29b	12.83b	72.99c	354.38c
OF72	3.20_a	2.04a	7.94a	2.36a	13.31a	71.16d	356.18b
LSD	0.252	0.071	0.046	0.034	0.061	0.293	1.173

Means with different subscript on the same colum are significantly different (P<0.05)
ROO = Raw D. dumetorum, OF24 = D. dumetorum fermented for 24hrs, OF48 = D. dumetorum fermented for 48hrs, OF72 = D. dumetorum fermented for 72hrs

The effect of traditional fermentation process on alkaloids, saponins, flavonoids, phenols and tannins is presented in Table 2. The results showed that the concentrations of alkaloids, saponins and flavonoid decreased significantly ($p<0.05$) with the increase in the period of fermentation. The significant reduction in these antinutrients in the fermented trifoliate yam sample (Table 2) may be an indication that the micro-organisms had degraded them. After 72 hours of fermentation, the alkaloid content reduced from 3.08% to 0.71% while the saponin content reduced from 3.36% to 0.46% in the trifoliate yam tubers. Saponin has hemolytic effect on red blood cells (Nowacki, 1980). The flavonoid content also reduced significantly ($p<0.05$) on fermentation (0.66 – 0.31%), this reduction is not favourable because flavonoids are currently regarded as essential nutrients rather than as antinutrients. Some flavonoids like rutin are known to strengthen blood capillary and other connective tissues while others like quercetins help to block the sorbitol pathway that is linked with many health complications associated with diabetes (Alais and Guy, 1991).

The levels of tannins in the extracts ranged from 0.33% in the raw sample to 0.20% in the fermented sample. Fermentation for 24 hours did not cause any significant difference in the tannin content but further fermentation for 48hrs and 72hrs resulted to significant reduction of the tannin. Tannins are known to undergo hydrolysis by acids, bases or some hydrolytic enzymes. Therefore, the hydrolytic enzymes produced by the fermenting micro-organisms or acids produced during fermentation might be responsible for degradation of the tannin content. Tannins have been reported to be heat stable (Aderibigbe *et al*., 1997; Osagie, 1998; Reddy and Sathe, 2002) and are therefore not eliminated by heat during processing. Tannins are astringent, bitter plant polyphenols that either bind and precipitate or shrink proteins and various other organic compounds including amino acids and alkaloids. Generally if ingested in excessive quantities, tannins inhibit the absorption of minerals such as iron leading to anemia (Brune *et al*., 1989). This is because tannins are metal ion chelators, and tannin-chelated metal ions are not bioavailable.

Table 2: Effect of fermentation on the phytochemical composition of cultivated *D. dumetorum*

Sample	Alkaloid(%	Flavonoid(%	Saponin(%	Tannin(%	Phenol(%)
ROO	3.08^a	0.66^a	3.36^a	0.33^a	1.83^c
OF24	2.05^b	0.52^b	0.95^b	0.32^a	2.13^b
OF48	1.42^c	0.51^b	0.52^c	0.27^b	2.29^a
OF72	0.71^d	0.31^c	0.46^d	0.20^c	1.77^d
LSD	0.18	0.034	0.049	0.016	0.044

Means with different superscript on the same column are significantly different (P<0.05)
Where ROO = D. dumetorum, OF24 = D. dumetorum fermented for 24hrs, OF48 = D. dumetorum fermented for 48hrs, OF72 = D. dumetorum fermented for 72hrs.

CONCLUSION

The results obtained from this work indicated that fermentation improves the nutrient potentials of trifoliate yam by increasing some nutrients and reducing the level of antinutrient factors. Fermented trifoliate yam flour could be a potential food that could be used as *fufu* or incorporated into confectioneries.

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