

Classification of Some Wild Yam Species Tubers of Ivory Coast Forest Zone

Sahoré Drogha Alexis¹ *, Amani N'guessan Georges

^{1 2} Food Sciences and Technology Department, University Nangui Abrogoua
02 BP 801 Abidjan 02, Côte d'Ivoire

ABSTRACT

The tubers of some wild yam species (eight) found in the Ivory Coast forest were collected and their classification according to their nutrients and antinutritional factors was made by principal component analysis (PCA).

- The principal component analysis (PCA) of individuals, constituted by the yam species, according to Nutrients considered as the variables, showed two principal axes of correlation F1 and F2 (Fig. 1a). The percentages of these variables dispersion around the principal axes F1 and F2 (fig.1a) were equal to 72.86% and 20.24% respectively. The individuals projected on the principal axes F1 and F2 (fig.1b) grouped into four classes around the axes: Around the axis F1 (72.26%): The class gathering the tubers of wild yam species *D. minutiflora*; *D. will hirtiflora* and *D. bulbifera* bulbil (fig1b) which contained more **Moisture** (fig.1a) and the class gathering the tubers of wild yam species *D. burkilliana* *D. bulbifera* tuber; *D. dumetorum*; *D. praehensilis* and *D. mangelotiana* (fig1b) which had the highest **Energy Value** (fig1a). Around the axis F2 (20.24%): The class gathering the tubers of wild yam species *D. burkilliana* *D. bulbifera* tuber, *D. dumetorum* and *D. praehensilis* (fig1b) which contained more **Sugars** (fig1a) and the class gathering the tubers of wild yam species *D. minutiflora* *D. hirtiflora* *D. bulbifera* bulbil and *D. mangelotiana* (fig1b) which contained more **Ash** (fig1a).

- The principal component analysis(PCA) of individuals, constituted by wild yam species according to their Antinutritional factors considered as the variables, showed two principal axes of correlation F1 and F2 (fig. 2a). The percentages of variables dispersion around the principal axes F1 and F2 (fig. 2a) were equal to 35.88% and 31.99% respectively. The individuals projected on the principal axes F1 and F2 (fig. 2b) grouped into 3 classes around axes: Around the axis F1 (35.88%): The class gathering the tubers of wild yam species *D. mangelotiana*, *D. dumetorum*, *D. burkilliana*, *D. bulbifera* bulbil, *D. togoensis*, *D. bulbifera* tuber and *D. praehensilis* (fig2b) which contained more, **Tannins**, **Alkaloids** and **Hydrocyanic acid** (fig. 2a). Around the F2 axis (31.99%): The class gathering the tubers of wild yam species *D. togoensis* *D. dumetorum* *D. minutiflora* *D. mangelotiana* *D. praehensilis* and *D. bulbifera* bulbil (fig.2b) which contained more **Oxalic Acid** (fig2a) and the class gathering the tubers of wild yam species *D. togoensis*, *D. hirtiflora*, *D. minutiflora* and *D. dumetorum* (fig2b) and which contained more **Sapogenins** (fig2a).

Keywords: tuber, wild yam species, antinutritional factors, nutrients, individuals, variables, principal component analysis, distribution, classes.

Corresponding Author:

* Tel. (225) 08 52 78 20; Email: alexissahore@yahoo.fr

1. INTRODUCTION

The word yam indicated a set of plants of several species of the kind *Dioscorea* restarted on all the continents (Knuth, 1924; Miège, 1952; Degras, 1986; Hamon *et al*, 1995). Next to cultivated yam (Degras, 1986) and sometimes even celebrated through holidays by some peoples (Perrot, 1997), there were also the species of yam which grew to the wild state and which were still the object of picking (Hamon *et al*, 1995)

In Ivory Coast for example, they were the inhabitants of regions (south; west) where the culture of the yam remained marginal which consumed especially some species of these wild yams (Ildefonse, 1995). But yams generally and wild yam species in particular contained variable quantities of chemical substances: alkaloids, tannins, sapogénines, polyphenols, phytates, oxalates, etc.(Martin, 1972, Quigley, 1978).

If some of these substances gave only a bitter taste to tubers after cooking, the others as alkaloids were toxic and antinutritional (Coursey and Russull, 1969). This toxic matter, when they are ingested would provoke grave, even mortal symptoms (Coursey, 1983; Hladik *et al*, 1984; Webster *et al*, 1984). Before thus to consume them, these tubers of wild yam should be treated to reduce or destroy their toxic matter (Dumont *et al*, 1994).

The populations, which consumed such tubers, constituting nevertheless useful reserves for the periods of famine or food shortage, were conscious of it potential risks (Dégras, 1986). That was why they used traditional but often inappropriate processing, to eliminate these substances toxic of tubers (Dumont *et al*, 1994).

A classification of these tubers based on their chemical composition would allow knowing possibly which of these tubers of wild yam would be the least toxic thus more capable of the consumption.

Yams are used as well in the other purposes as the food, particularly, the wild yams which are used for their therapeutic properties and also for their toxic properties (Hamon *et al*, 1995).

It was the case in West Africa where the toxic properties of various species of wild yam were of all time exploited by hunters, fishermen and farmers (Miège, 1977). So, poisons having convulsive and paralysing effects or hemolytic are extracted from the species of wild *D. dumetorum* yam and *D. bulbifera* (Miège, 1977). These extracts would be alkaloids such as the dihydrodioscorin, the diosbulbin and sapogenins derived of saponins (Coursey, 1967; Miège, 1977).

The objective of our study was to make a classification of the tubers of the wild yam species collected in the Ivory Coast forest zone by using the method of the principal components analysis (PCA).

This statistical method of analysis could allow us to discriminate these species of wild yam according to their nutrients and their antinutritional factors.

Such study would find an eventual interest in a perspective of domestication of these yams with medicinal and nutritional uses, to introduce into cropping systems more efficient species carefully selected

2. MATERIAL AND METHODS

2.1 Vegetable material

The vegetable material is composed of various wild yam species tubers (yam species not cultivated, but collected in a wild state). These tubers of yam were harvested in July and August in the Ivory Coast forest zone. Particularly in the region of Memni, 80 km from Abidjan. Samples were identified by the Abidjan Cocody University Floral Institute. They were the tubers of the following wild yam species (to see Table I)

The wild yam species tubers were preserved in the laboratory one day after harvested. They were processed into flour that was conditioned in glass jars and stored in the refrigerator.

Table I: Some Wild yam species collected in the Ivory Coast South forest zone

Wild yam species	Some characteristics of tubers	Quantity of tubers collected
<i>Dioscorea praehensilis</i>	The tuber protected by thorny roots	4.58 kg)
<i>Dioscorea hirtiflora</i>	Cylindrical and small-sized tuber (70 - 200 g)	: 6.08 kg
<i>Discorea bulbifera</i> :	Small and spherical tubers (200 g). This plant produced plentiful polymorphs bulbils	5,93 kg (bulbil) 4,06kg (tubers)
<i>Dioscorea burkilliana</i>	The tuber is formed by three organs: lignified tray, fibrous peduncles and spherical starchy mass. Lignified tray having on its lower face many fibrous peduncles ending by the starchy mass constituting the real tuber (50 to 200 g)	6.79 kg
<i>Dioscorea togoensis</i>	The tuber is solid and low weight(200-300g)	4.50 kg
<i>Dioscorea mangelotiana</i>	Tuber of great mass and very broad. the old part and most important of the tuber is lignified, the newly formed part is starch-based	2.3 kg.
<i>Dioscorea dumetorum</i>	Globulous and small tubers (100-200g)	5.12 kg
<i>Dioscorea minutiflora</i>	The tuber presents a little developed ligneous pre-tuber from which are born fibrous and fluted tubers (20-60 cm) with a starchy neoformed extremity :	5.2 kg

2.2 Preparation of flour

1-2 kg, of each wild yam species tuber, was pre-pared peeled. The pulp was then immersed in water sulphite (0.1%) and cut into 1cm pieces. The pieces of pulp were then dried 24 hours in a ventilated oven at 45 ° C. then they were crushed and sieved, fine flour (250 µ) of yam obtained was used for some analyzes.

2.3 Chemical Analysis

2.3.1 Moisture content

5 g of the fresh yam pulp were placed in an oven at 105 ° C during 24 hours until constant weight and the amount of water evaporated is determined after weighing (AOAC, 1980).

2.3.2 Ash content

After determining moisture content, dry sample obtained was incinerated at 550 ° C in a muffle furnace. This temperature was maintained until obtaining ashes without organic particles. After cooling ashes in desiccators, they are weighed immediately (AOAC, 1980)

2.3.3 Proteins content

Crude proteins content was determined from dosage of total nitrogen by Kjeldahl method (BIPEA, 1976). One gram of sample (yam flour) is mineralized at 400 ° C for 2 hours in concentrated sulfuric acid (20 ml) in the presence of a catalyst (1g selenite of sodium + 1g copper sulfate + 20 G of potassium sulphate). 10 ml of mineralized added with 10 ml sodium hydroxide solution 40% was distilled. Ammoniacal distillate in 20 ml of boric acid was titrated with sulfuric acid (0.1 N) in the presence of a colored indicator mixed (methyl red and bromocresol green). With this method, all nitrogen compounds were assayed. The conversion of nitrogen to proteins was carried out by a conversion factor of total nitrogen in proteins which was $100/16 = 6.25$

2.3.4 Fat content

The lipids content was determined using the apparatus Soxhtec System HT 1043. The extraction solvent was diethyl ether (BIPEA, 1976). This dosage of lipids was based on the principle of solubilization of fat in apolar organic solvents. The fat contained in 3 g of the yam flour were entrained by 70 ml of diethyl ether at 119 ° C. Extraction was carried by flux and reflux during 65 min. Solvent was collected and then fats were recovered and weighed after removal of traces of the solvent in an oven at 130 ° C for 30 mi.

2.3.5 Total sugars content

Total sugars content (soluble sugars) was determined by the method of Luff Schoorl iodine (BIPEA, 1976). The sugars were extracted with water from 5 g of the yam flour and placed in the presence of Fehling's solution and potassium iodide (10 ml of KI solution 10% w / v). Iodine resulting from the reaction was titrated with thiosulfate (0.1 N). The table allowed the Luff Schoorl, with the volume of thiosulfate made to determine the sugars content of the sample

2.3.6 Total carbohydrates content

The sum of digestible and indigestible carbohydrates was evaluated by difference: 100 - (moisture content + fats content + proteins contents + ashes content). The knowledge of the total carbohydrates content was necessary for the application of thermal coefficients of Atwater and Rosa (1899) for the calculation of the energy value.

2.3.7 Starch content

To determine the starch content we proceed by estimation using 0.9 the conversion factor of the glucose in starch (J. O. L 248 /CEE n°900 (2008)

$\% \text{ Starch} = 0,9 \{(\% \text{ total carbohydrates}) - (\% \text{ total sugars} + \% \text{ Cellulose})\}$

2.3.8 Cellulose content

The method of weende (AFNOR. 1993) was used. A double hydrolyzes acid (200 ml of acid sulphuric 0.255 N) and alkaline (200 ml of 0.3 N sodium hydroxide) of the proteins and digestible carbohydrates contained in 3 g of the yam flour, is carried out, and then the hydrolysate is degreased with acetone.

The residue is dried and weighed. After calcination the weight of the ashes is subtracted

2.3.9 Energy value

The energy value was calculated by application of the thermal coefficients of Atwater and Rosa (1889) with 4 calories for 1g of proteins; 9, 3 calories for 1g of lipids and 3, 75 calories for 1g of carbohydrates. The energy value (callus / 100 g) = 4 x % proteins + 9, 3 x % lipids + 3, 75 x % carbohydrates.

2.3.10 Content of oxalic acid

Oxalic acid content was determined by titrimetric procedure. 10 g of the sample were macerated to hot (60 ° C) in 50 ml of boiled distilled water for 30 min shaking. The macerate was filtered on filter and the filtrate reduced to 200 ml in a graduated flask with boiled distilled water. 50 ml of this solution taken in a 250 ml flask were diluted with 50 ml of boiled water and titrated with a solution of sodium hydroxide (0.1 N) in the presence of phenolphthalein.

The result was expressed in millequivalents or g / 100 g of acid determined in this case oxalic acid (Rachid, 1978). Oxalic acid (HOOC-COOH) was an organic diacid, it releases 2 equivalents (H⁺) in solution to a molecular weight of M = 90 g. One milliequivalent corresponded to $90 / (2 \times 1000) = 0,045$ g of oxalic

2.3.11 Tannins content

The tannin content was determined by the method of acidified vanillin after soaked the sample in methanol (Burns, 1971). One gram (1g) of the sample was macerated in 50 ml of methanol during 28 hours. In 1 ml of this solution added the reagent Vanillin-HCl (5 ml) (reagent was used for the reference 100 % transmittance) and to read the UV spectrophotometer at 500 nm. The tannins content was determined by comparison to a solution of catechin.

2.3.12 Hydrocyanic acid content

The hydrocyanic acid content was determined by the method of alkaline titration (Holleman and Aten, 1956). The sample (27g) was macerated in water (200 ml) for 18 hours. The macerate is distilled by entrainment in water vapor and the distillate is collected in a solution NaOH (5%). After diluting 100 ml of the distillate to 2/5, cyanogenic ions of distillate were determined by a titrated solution of silver

nitrate (0.02 N) in presence of potassium iodide 8ml. It was necessary to plan a witness. Cyanogenic ions in aqueous solution complexed silver ions. AgNO₃ molecule reacted with two molecules of HCN representing 54 g of HCN for AgNO₃ solution with 1N. In the case of a solution of AgNO₃ (0.02 N) it was necessary $(54 \text{ g} \times 0.02)/1 = 1.08 \text{ g HCN}$. 1 ml of silver nitrate solution (0.02 N) was thus needed 1.08 g of hydrocyanic acid.

2.3.13 Alkaloids content

The alkaloids of the sample were put in solution by maceration in a mixture of diethyl ether and chloroform and extracted by HCl (J.O. 371 L 0250/CEE, 1998). 15g of the sample were macerated in a mixture of diethyl ether (100 ml) and chloroform (50 ml) overnight and the alkaloids put thus in solution were extracted by hydrochloric acid (0.3 N) and were precipitated by the silico-tungstic acid solution (10%). The precipitate was incinerated and the ashes were weighed. The alkaloids content of the essay was obtained by multiplying the weight of the ashes by a factor 0.2. Alkaloids content accounted for 20% weight of the ashes.

2.3.14 Sapogenins content

Usually the saponins by hydrolyzing gave the sapogenins. The principal sapogenins contained in yam were diosgenin. The extraction of sapogenins from (5g) sample was made by reflux boiling (30 min) in 50 ml of ethanol. The alcoholic extract was concentrated to syrup and hot hydrolyzed with 10 ml of sulfuric acid (4 N) for 2 hours. Sapogenins which precipitated were isolated by filtration. They were then dried and weighed (Asiedu, 1991)

3.4 Statistical analysis

The analysis of variance (ANOVA) at $p < 0.05$ means and standard deviations were carried out to compare the levels of nutrients and antinutritional factors in the tubers

The principal components analysis (PCA) were performed using the software Statsoft.99 ed-Test Newman - Keuls (NCSS, Kaysville, USA) to classify wild yam species tubers according to their different nutrients and factors antinutritional to determine the characteristic of each species of wild yam species studied.

3. RESULTS

3.1- Principal component analysis (PCA) of wild yam species tubers according to their nutrient composition

Table II indicated the nutrient composition of tubers. The principal component analysis (PCA), of the variables constituted by nutrients (Table II) according to the individuals constituted by wild yam species tubers (Table I), showed two principal axes F1 and F2 (fig.1).

The percentages of the variables dispersion around principal axes F1 and F2 (fig. 1a) were equal to 72.86% and 20.24%, respectively. The circle expressing correlations of the variables with respect to the axes was represented by the fig. 1a.

With the principal axis F1 (fig.1a) the variable moisture was correlated towards the positive values and the variables: total sugar, starch, energy value, lipids, proteins, cellulose and ash were correlated towards negative values.

With principal axis F2 (fig.1a) the variables: starch, total sugar and energy value were correlated towards positive values and the variables: moisture, lipids, proteins, cellulose and ash were correlated towards the negative values. The projection of individuals, consisting of wild yam species tubers (Table I), on principal axes F1 and F2, was represented in the figure 1b. It identified four groups of individuals around the axes. Around the principal axis F1 (fig. 1b) two classes emerged: the class of wild yam species *D. minutiflora*, and *D.hirtiflora* *D.bulbifera* bulbil which grouped together towards positive values of the principal axis F1 (fig. 1b) and the class of wild yam species *D. burkilliana*, *D dumetorum*, *D. bulbifera* tuber *D. praehensilis* and *D. mangelotiana* which grouped together towards negative values of the principal axis F1 (fig. 1b).

Around the principal axis F2 (fig.1b) two classes emerged: the class of wild yam species: *D. burkilliana*, *D. bulbifera* tuber, *D. Dumetorum* and *D. praehensilis* which grouped together towards the positive values of the principal axis F2 (fig.1b) and the class of wild yam species: *D. minutiflora*, *D. hirtiflora*, *D. bulbifera* bulbil and *D. mangelotiana* which grouped together towards negative values of the principal axis F2 (fig.1b)

3.2- Principal component analysis of wild yam tubers according to their composition of Antinutritional Factors

Table III indicated the antinutritional factors composition of tubers. The principal component analysis (PCA), of the variables constituted by antinutritional factors (Table III) according to the individuals constituted by wild yam species tubers (Table I), showed two principal axes F1 and F2 (fig. 2). The percentages of the variables dispersion around axes F1 and F2 (fig 2a) were equal to 35.88% and 31.99% respectively. The circle expressing correlations of the variables with respect to the axes was represented by the fig. 2a.

With the F1 axis (fig. 2a) the variable sapogenins was correlated towards the positive values and the variables: tannin, hydrocyanic acid, alkaloids and oxalic acid were correlated towards negative values.

With F2 axis (fig. 2a) the variables: tannin, hydrocyanic acid, oxalic acid and sapogenins were correlated towards positive values and the variable alkaloid was correlated towards the negative values. The projection of individuals, consisting of wild yam species tubers (Table I), on axes F1 and F2, was represented in fig. 2 b. It identified three groups of individuals around the axes. Around the F1 axis (fig. 2 b) emerged the class of wild yam species: *D. dumetorum*, *D.togoensis*, *D.bulbifera* bulbil; *D.Bulbifera* tuber; *D.burkilliana*; *D.praehensilis*; *D.minutiflora* and *D.mangenotiana*. Around the F2 axis (fig. 2 b) two classes emerged. The class of wild yam species: *D. dumetorum*; *D.togoensis*; *D.bulbifera* bulbil, *D.praehensilis*; *D.minutiflora* and *D.mangenotiana* and the class of wild yam species which grouped together towards positive values of the F2 axis (fig. 2b) *D. dumetorum*; *D.togoensis*; *D.minutiflora* and *D. hirtiflora*

4.DISCUSSION

4.1- Principal component analysis (PCA) of wild yam species tubers according to their nutrient composition

4.1.1- Observation on the variables (nutrients)

The ACP of wild yam tubers (Table I) according to their nutrients (Table II) revealed two principal axes F1 and F2 (fig.1a). Around these axes we noticed that the dispersion of variables (nutrients) was in a circle (fig.1a) where the variables which were situated in border of the circle were correlated between them. Thus the observation of this circle of correlation (fig1.a) showed variables: starch, sugars totals, value energetic, lipids, proteins, cellulose, ashes and moisture situated in border of the circle and closer to the principal axes F1 and F2 (fig.1a). These different variables were thus correlated between them and more or less correlated with the principal axes F1 and F2 (fig.1a).

The principal axis F1 (fig1a) is correlated towards its positive values with the variable water and towards its negative values with variables: fat, energy value, protein and total sugars.

The principal axis F2 (fig.1a) is correlated towards its positive values with the variable starch and towards its negative values with the variable ash.

From these observations we noticed that the principal axis F1 (fig.1a) expressed more variable moisture and the group of variables: energy, fat, starch and proteins. Variable water was negatively correlated with the variable energy value. According to Bradbury (1988) the energy value of a tuber was inversely proportional to its moisture content.

Concerning the principal axis F2 (Fig. 1), it expressed the variable sugars and the variable ash. These two variables were negatively correlated to each other.

4.1.2- Observation on the individuals (wild yam species tubers)

The distribution of individuals (Table II) around the axes F1 and F2 (fig.1b) revealed by the ACP identified different classes of regrouping.

The positioning of these classes with respect to principal axes F1 and F2 (fig.1b) and with respect to variables (fig.1a) allowed to discriminate tubers (Table I) around four characteristic variables (Table II

4.1.2.1- Around the principal axis F1 (fig.1b)

- One class which gathered towards the positive values of the principal axis F1 (Figure 1 b) the individuals *D. minutiflora*, *D. hirtiflora* and *D. bulbifera* bulbil

Observing the correlations of the variables with this principal axis F1 (fig.1a) and the distribution of individuals around that same principal axis F1 (fig.1b) we noticed that the tubers of this class had the highest levels of **moisture** (Table II).

- One class which gathered towards the negative values of principal axis F1 (fig.1b). the individuals *D. burkilliana*, *D. dumetorum*, *D. bulbifera* tuber, *D. praehensilis* and *D. mangelotiana* Observing the correlations of the variables with this principal axis F1 (fig.1a) and the distribution of the individuals around this same principal axis F1 (fig.1b), we noticed that the tubers of this class had the highest levels of **lipids, starch, proteins and the highest energy values** (Table II). The tubers of this class had the best nutritional potential.

4.1.2.2- Around the principal axis F2 (fig.1b)

- One class which gathered towards the positive values of the principal axis F2 (fig.1b) the individuals *D. burkilliana*, *D. bulbifera* tuber, *D. dumetorum*, *D. praehensilis*

Observing the correlations of the variables with this principal axis F2 (fig.1a) and the distribution of individuals around the same principal axis F2 (fig.1b), we noticed that the tubers of this class had the highest levels of **sugars** (Table II).

- One class which gathered towards the negative values of the principal axis F2 (fig.1b). the individuals *D. minutiflora*, *D. bulbifera* bulbil and *D. mangelotiana* *D. hirtiflora*, Observing the correlations of the variables with this principal axis F2 (fig.1a) and the distribution of individuals around the same principal axis F2 (fig.1b), we noticed that the tubers of this class had the highest levels of **ashes** (Table II).

4.2- Principal component analysis of wild yam tubers according to their composition of Antinutritional Factors

4.2.1- Observation on variables (Antinutritional Factors)

The ACP of the wild yam tubers (Table I) according to their antinutritional factors (Table III) revealed two principal axes F1 and F2 (fig. 2a). Around these axes we noticed that the dispersion of variables (Table III) around the principal axes F1 and F2 (fig. 2a) was in a circle of coordination (fig. 2a). We noticed that in this circle that the variables are not bordering (fig.1a) and were also close to each other. The variables are not correlated with one another (FIG. 2a). Although they are more or less close to the principal axes F1 and F2 (fig. 2a) so more or less correlated with these axes.

The principal axis F1 (fig. 2a) was correlated towards its negative values with the variables tannins, alkaloids and hydrocyanic acid. It was more correlated with the variable Tannins which was closer.

The principal axis F2 (fig. 2a) was correlated towards its positive values with variables: acid oxalic and sapogenins. It was more correlated with the variable oxalic acid which was closer. From these observations we could say that the principal axis F1 (fig. 2a) expressed more the variable Tannin. While the principal axis F2 (fig. 2a) expressed more the variable: oxalic acid

4.2.2- Observation on the individuals (wild yam species tubers)

The projection of individuals (Table I) around the principal axis F1 and F2 (FIG. 2b) and their position relative to the axes and variables (fig. 2a) revealed three classes of regrouping of these individuals.

4.2.2.1- Around the principal axis F1 (fig. 2b).

- One class which gathered the individuals *D.togoensis*, *D.bulbifera* bulbil, *D.mangenotiana* *D.Bulbifera* tuber, *D.burkilliana*, *D.praehensilis* and *D. dumetorum*.

The distribution of these individuals around the principal axis F1 (FIG. 2b) and the correlation of this axis with the variables (fig. 2a) allowed us to say that the wild yam species tubers (Table I) of this class had the highest contents of **tannins**, **alkaloids** and **hydrocyanic acid** (Table III)

The most toxic substances in the wild yam tubers were soluble alkaloids. During digestion they gave severe symptoms (FAO, 1971).

The hydrocyanic acid was a toxic recognized substance. It caused disorders of the thyroid preventing the iodine from settling in it. It so entrained incidences of goiters and stupidity (Bradbury, 1988).

Tannins were phenolic polymers. They developed according to their concentration in a food product a positive or negative organoleptic note when their astringency and their bitterness became excessive (Coursey, 1967).

4.2.2.2- Around the principal axis F2 (fig. 2b)

- One class which gathered the individuals *D. dumetorum*, *D. minutiflora*, *D.bulbifera* bulbil, *D.togoensis*, *D.mangenotiana* and *D. praehensilis*

The distribution of these individuals around the principal axis F2 (fig. 2b) and the correlation of this axis with the variables (fig. 2a) allowed us to say that the tubers of wild yam species (Table I) of this class had the highest **oxalic acid** contents (Table III)

The oxalic acid with some metals formed insoluble salts. During digestion, if it remained in the digestive tract as poorly soluble alkaline oxalates. The portion ingested is revealed toxic (Adrian *et al*, 1998)

- One class which gathered towards the positive values of the principal axis F2 (fig. 2b) the individuals *D. dumetorum*, *D.togoensis*, and *D.minutiflora* *D.hirtiflora*

The distribution of these individuals around the principal axis F2 (FIG. 2b) and the correlation of this axis with the variables (fig. 2a) allowed us to conclude that the wild yam species tubers (Table I) of this class had the highest **sapogenins** contents (Table III)

The sapogenins had a steroidal structure and were present as glycosides in aglycon designated by the terms saponins. They had a characteristic property that haemolysed red blood cell, that is to say, to liberate their hemoglobin, which explained the toxic effect of some of them and make them inedible (Coursey, 1973; Abe 1973; Asiedu, 1991).

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5. CONCLUSION

The discrimination by principal components analysis (PCA) of some wild yams species tubers studied according to their nutrients revealed four groups around the variables: 1) Moisture : 2) Energy value 3) Sugars; 4) Ash respectively

While the discrimination of these tubercles according to their antinutritional factors revealed three groups around the variables: 1) Tannins, hydrocyanic acid, alkaloids; 2) Oxalic acid; 3) Sapogenins respectively

The tuber of the wild yam specie *D dumetorum* was found in the three classes of regrouping. This tuber was therefore the most toxic.

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Tableau II: Composition of wild yam species tubers

Species	moisture % f.m	Proteins % d.m	Fat % d.m	Total Sugars %d.m	Starch % d.m	Total carbohydrate % d.m	Cellulose % d.m	Ash % d.m	Energy Ca/100g
<i>D.minutiflora</i>	84,95b	10,56d	2,95a	2,37b	67,53c	81,73b	4,30c	4,76d	376a
<i>D.hirtiflora</i>	81,89e	9,55bcd	3,35b	1,42a	67,40c	82,27b	5,98d	4,84d	377a
<i>D.bulbifera</i> bulbil	81,44e	8,82bc	3,99c	3,59c	57,15a	82,44b	7,67f	4,74d	381bc
<i>D.burkilliana</i>	71,59d	8,24b	3,26ab	2,34b	70,05d	83,77bc	3,64a	4,73d	377a
<i>D.bulbifera</i> tuber	69,80c	6,29a	3,53b	2,29b	73,01d	86,87c	3,71ab	3,31b	383d
<i>D.dumetorum</i>	69,65c	9,93cd	3,43b	3,77c	68,05c	83,36b	4,03bc	3,27b	384d
<i>D.praehensilis</i>	68,05a	9,48bcd	3,61b	3,81c	69,37d	84,51bc	3,62a	2,40a	389e
<i>D.mangenotiana</i>	66,24a	14,18e	4,61d	2,25b	58,83b	74,94a	7,33e	6,27c	380b

* The indicated values represented the average of three determinations (n = 3); ** in every column the Values affected by different letters were significantly different in p < 0. 05.

Tableau III: Composition of Wild Yam Species Tubers antinutritional factors

Species	Oxalic acid mg/100g dm	Tannins mg/100g dm	Hydrocyanic acid 10 ⁻² mg/100g dm	Alkaloids mg/100g dm	apogenins % dm
<i>D.dumetorum</i>	12.93e	560.10h	33.03e	167.70e	0.78b
<i>D.togoensis</i>	12.63e	456.03e	2.00a	214.80h	1.49c
<i>D.minutiflora</i>	10.03e	385.73b	2.00a	01.03a	0.90b
<i>D.Bulbifera</i> bulbil	9.33cd	470.03f	1.97a	165.63d	0.22a
<i>D.praehensilis</i>	9.03d	570.30h	4.00b	150.63c	0.05a
<i>D.mangenotiana</i>	8.33c	410.73c	20.03d	175.70f	0.26a
<i>D.Bulbifera</i> Tuber	6.83b	421.00d	10.03c	248.23i	0.08a
<i>D.hirtiflora</i>	6.50b	15.03a	7.00c	107.63b	1.34c
<i>D.burkilliana</i>	5.43a	489.23g	4.03b	187.03g	0.20a

* The indicated values represented the average of three determinations (n = 3); ** in every column the values affected by different letters were significantly different in p < 0. 05.