COOKING IN THE WATER EFFECT ON SOME WILD YAM SPECIES TUBER

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ABSTRACT

The tubers of some wild yam species (eight) found in the Ivory Coast forest were collected and effect of their cooking in the Water according to their nutrients and antinutritional factors was studied. After this hydrothermal processing of the wild yam tubers, the content of moisture, lipid, soluble sugar increased and the content of protein, total carbohydrate, cellulose, ash decreased. Nutrient contents varied differently. The analysis of variance realized showed that the cooking does not seem to have degraded significantly the nutrients excepted the remarkable increase of the rate of sugars. The effect of hydrothermal treatment has not significantly changed the nutritional value of wild yam tubers studied.
The antinutritional factors varied differently in the tubers after cooking in boiling water: the cyanogenic substance is partially destroyed; Alkaloids were soluble in water. The reduction of the sapogenins content after the hydrothermal treatment seemed remarkable oxalic acid was an organic acid which decomposed by heating. The antinutritional factors contents decreased significantly after cooking process.

KEYWORDS: wild yam, nutrients, antinutritional factors, cooking, Water, variance

INTRODUCTION

The yam was a tuber economically precious that only three areas of the world cultivated extensively: Western Africa, the Caribbean and Southeast Asia. World production of yam was 38 million tonnes per year. Excluding China as global production of yams for Asia and Oceania represented only 1.5%.
Ninety-six percent (96%) of world production came from West Africa, particularly in the area between the Ivory Coast and Cameroon. (Asiedu, 1991; FAO, 2002).
Next to cultivated yams there were also spontaneous yams. the yam species that grew in the wild and which were still the subject of gathering attended everywhere in Africa where they are also used in food as a cultivated species (Hamon *et al*., 1995), but these tubers contained sometimes lethal amounts

of toxic principles and indigestive.

Yam in general and its wild forms in particular contained varying amounts of chemical substances (alkaloids, tannins, sapogenins, polyphenols, phytates, oxalates, etc...). If some of these substances were only a bitter taste to the tubers after cooking, others such as the alkaloids were toxic and antinutrients (Coursey and Russull, 1969; Webster *et al*., 1984). These alkaloids, when they are ingested can cause serious symptoms, even mortals. Several authors announced cases of death per consecutive poisoning to the consumption of the tubers of the wild varieties of *D. dumetorum* (Coursey, 1983; Hladik *et al*., 1984). It is necessary that these wild tubers are treated to reduce or destroy the toxic substances for a better consumption (Dumont *et al*, 1994). The local populations which were conscious of the potential risks related to the consumption of such tubers which constituted nevertheless useful reserves during the time of famine or food shortage used often inappropriate techniques of traditional treatment to eliminate if it was necessary the nutritional anti substances of the tubers. It seemed important to know the chemical composition of these products. The objective of our study was to show the variation of reduction of the nutrients and the antinutritional factors in the tubers subjected to a treatment of cooking to water. It is a question for that of making cook with water the tubers of the species of wild yam and of comparing their composition before and after cooking with water.

MATERIAL AND METHODS

Material vegetable

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 D. *minutiflora, D. hirtiflora, D. bulbifera* bulbil, *D. burkilliana, D. bulbifera* tuber, *D. dumetorum, D. praehensilis, D. mangenotiana*. 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.

Preparation of flours

The flours preparation consisted of grinding and sifting the pulp of dehydrated yam (Asiedu, 1991). The collected tubers are freed of spines and roots, and then washed to eliminate the mud which covered them. After this operation two types of flours are prepared: the raw flour and the cooked flour.

Preparation of raw flour

One or two of each wild yam species tubers, was cleaned and 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 45ºC. Then they were crushed and sieved, fine flour (250 µ) of yam obtained was used for some analyzes.

Preparation cooked flour

One or two kilograms, of tubers of each species, were washed, cut into 5cm pieces and cooked in boiling water for 20 minutes. After cooling the cooked yam pieces are peeled and cut into 1 cm pieces. The pieces are dried and processed into flour as in the case of raw flour.

The flours obtained are packaged in jars and stored in a refrigerator until use for analysis

Chemical Analysis

Moisture content

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

2.3.2 Ash content

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

2.3.3 Proteins content

Crude protein content was determined from dosage of total nitrogen by Kjeldahl method (BIPEA, 1976). One gram of sample (yam flour) was mineralized at 400ºC for 2 hours in concentrated sulphuric acid (20 ml) in the presence of a catalyst (1g Selenite of sodium + 1g copper sulphate + 20 G of potassium sulphate). Ten milliliters of mineral solution added to 10 ml sodium hydroxide solution (40%) were distilled and the distillate collected in 20 ml of boric acid was titrated with sulphuric 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.

Lipid content

Lipid 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 solubilisation of fat in no polar organic solvent. The lipids contained in 3 g of the yam flour were entrained by 70 ml of diethyl ether at 119ºC. Extraction was carried by flux and reflux during 65 min. Solvent was collected and then lipids were recovered and weighed after removal of traces of the solvent in an oven at 130ºC for 30 minutes.

Soluble carbohydrate content

Soluble carbohydrate content (soluble sugars) was determined by the iodine method of Luff Schoorl (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 phosphate made to determine the soluble carbohydrate content of the sample

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 carbohydrate content was necessary for the application of thermal coefficients of Atwater and Rosa (1899). For the calculation of the energy value.

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). % Starch = 0, 9 {(% Total carbohydrate) – (% Soluble carbohydrates + % Cellulose)

Cellulose content

The method of Weende (AFNOR. NF V 03-040. 12. /1993) was used. Acid hydrolysis (200 ml of acid sulphuric 0.255 N) and alkaline hydrolysis (200 ml of 0.3N sodium hydroxide) of the proteins and digestible carbohydrates contained in 3 g of the yam flour were carried out, and then the hydrolysate was degreased with acetone. The residue was dried and weighed. After calcination the weight of the ashes was subtracted

Energy value

The energy value was calculated by application of the thermal coefficients of Atwater and Rosa (1899). 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.

Oxalic acid content

Oxalic acid content was determined by titrimetric procedure. 10 g of the sample were macerated to hot (60ºC) in 50 ml of boiled distilled water for 30 min shaking. The macerate was filtered on the filter and the filtrate reduced to 200 ml in a graduated flask with boiled distilled water. Fifty milliliters 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 x 1000) = 0,045 g of oxalic.

Tannins content

The tannin content was determined by the method of acidified vanillin after soaking 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 tannin content was determined by comparison to a solution of catechin.

Hydrocyanic acid content

The hydrocyanic acid content was determined by the method of alkalinity titration (Holleman and Aten, 1956). The sample (27g) was macerated in water (200 ml) for 18 hours. The macerate is distilled by internment in water vapour 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 the presence of potassium iodide 8 ml. It was necessary to plan a witness. Cyanogenic ions in aqueous solution complexed silver ions. $AgNO_3$ molecule reacted with two molecules of HCN representing 54 g of HCN for $AgNO_3$ solution with 1N in the case of a solution.

Alkaloid content

The alkaloids of the sample were put into solution by maceration in a mixture of diethyl ether and chloroform and extracted by HCl (J.O. 371 L 0250 / CEE, 1998). 15 g 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 with 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 alkaloid 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.

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 sulphuric acid (4 N) for 2 hours. Sapogenins which precipitated were isolated by filtration. They were then dried and weighed (Asiedu, 1991).

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.

RESULTS

Cooking in water Effect on the nutrient

The nutrient compositions of the tubers before and after cooking are compared in Table I. The moisture content of the cooked tubers ranged from 66.92% in *D. mangenotiana* to 85.90% in *D. minutiflora* with an average grade of 75.1%. It increased in the tuber after cooking from 74.20% to 75.19%. An increased of approximately 1%.

The carbohydrate content of the cooked tubers ranged from 75.40% dry matter in *D. mangenotiana* to 86.77% dry matter in *D. bulbifera* tuber with an average of 82.06% dry matter. It decreased on average from 82.47% dry matter to 82.06% dry matter in the tuber after cooking. A decreased of approximately 1%.

The protein content of the cooked tubers ranges from 6.15% d.m in *D. bulbifera tuber* to 13.70%% d.m in *D. mangenotiana* with an average content of 9.20% % d.m. It decreased in the tuber after cooking from 9.63% d.m to 9.20%. A decreased of 5%.

The lipid content of the cooked tubers ranged from 3.28% d.m in *D. minutiflora* to 4.89% d.m in *D. mangenotiana* with an average content of 4.00% % d.m. It increased in the tuber after cooking from 3.59 % d.m to 4.00% d.m. An increased of 11%.

The total sugar content of the cooked tubers ranged from 4.06% d.m in *D. burkilliana* to 6.64%d.m in D. bulbifera bulbil with an average content of 5.17% d.m. It increased in the tuber after cooking from 2.73 % d.m to 5.17% d.m. An increased of 90%.

The cellulose content of cooked tuber ranged from 3.41% d.m in *D. praehensilis* to 7.02% d.m in *D. mangenotiana* with an average content of 4.35% d.m. It decreased in the tuber after cooking from 5.03% d.m to 4.35% d.m. A decreased of 14%.

The ash content of cooked tubers ranged from 2.61% d.m in *D. praehensilis* ms to 6.01% d.m *in D.mangenotiana* with an average content of 4.09% d.m. It decreased in the tuber after cooking from 4.29 % d.m to 4.09%dm. A decreased of 5%. The energy value of cooked tubers ranged from 377 Cal / g 100 d.m in *D. minutiflora* to 389 Cal / g 100 d.m in *D. praehensilis* with an average of 384 Cal / g 100 d.m. It increased in the tuber after cooking from 381Cal / 100g d.m to 384 Cal / 100g d.m. An increased of approximately 1%.

The analysis of variance of nutrient composition showed no significant difference ($p < 0.05$) between the nutrient content of raw tubers and Cooked (the values assigned identical letters in Table I are not significantly different for certain species studied in the following cases: the water content of *D. bulbifera* bulbil; *D.praehensilis* and *D.mangenotiana* - The protein content of *D. hirtiflora*, *D. bulbifera* bulbil; *D. burkilliana, D. bulbifera* tuber; *D. praehensilis* and *D. mangenotiana* - The total carbohydrate content of *D. hirtiflora*, *D. bulbifera* bulbil, *D. burkilliana, D. bulbifera* tuber; *D. dumetorum* and *D. mangenotiana* - The cellulose content of *D. minutiflora* ; *D. burkilliana*; *D. bulbifera* tuber; *D. praehensilis* and *D. mangenotiana* - The ash content of *D. minutiflora*; *D. burkilliana, D. bulbifera* tuber and *D. dumetorum* - The energy value of *D. minutiflora, D. hirtiflora. D. burkilliana, D. bulbifera* tuber; *D. dumetorum; D. mangenotiana* and *D. praehensilis*

Cooking in water effect on antinutritional factors

The antinutritional factors compositions of tubers before and after cooking are compared in Table II. The hydrocyanic acid content of cooked tubers varied from 0.01 mg / kg d.m in *D. burkilliana, D. minutiflora* to 0.15 mg / kg d.m in *D. dumetorum,* with an average content of 0.044 mg / kg d.m. After cooking the hydrocyanic acid content decreased in the tuber from 0.093 to 0.044 mg / kg d.m. A decreased of 50%. Alkaloid content of cooked tubers ranged from 76.03 mg / 100 g d.m in *D. minutiflora* to 184.73 mg / 100 g d.m in *D. bulbifera* tuber, with an average content of 124.52 mg / 100 g d.m. After cooking, the alkaloid content decreased in the tuber from 168.71mg to 124.20 mg / 100 g d.m. A decrease of 30%. The sapogenins content of cooked tubers ranged from 0.01% d.m in *D. bulbifera* tuber and *D. mangenotiana* 0.86% d.m *in D. hirtiflora*, with an average content of 0.24% d.m. After cooking, the sapogenin content decreased in the tuber from 0.59 to 0.24% d.m. A decrease of 60%. The oxalic acid content of cooked tubers ranged from 3.93 mg / 100 g ms in *D. burkilliana* to 11.03 mg / 100 g ms *in D. togoensis*, with an average content of 7.37 mg / 100 g d.m. After cooking, the amount of oxalic acid decreased the tuber of 9.01 to 7.37 mg / 100 g d.m. A decrease of 20%.The tannin content of cooked tubers ranged from 255.63 mg / 100 g d.m in *D. hirtiflora* to 495.73 mg / 100

g d.m in *D. mangenotiana*, with an average content of 359.97 mg / 100 g d.m. After cooking, the tannin content decreased in the tuber from 453.80 mg to 359.97 mg / 100 g d.m. A decrease of 20%. The analysis of variance showed a significant difference between the levels of antinutritional factors raw tubers and Cooked respectively of each wild yam species studied (values assigned identical letters in Table II are not significantly different)

DISCUSSION

Cooking in water effect on the nutrients

After the hydrothermal processing of the wild yam tubers we noticed: That the moisture content slightly increased in a 1 % proportion approximately. This increase of the moisture content in tubers seems very low but cases of weak increase of the quantity of water in the tubers during the cooking, were observed by Favier *et al* (1971) in the roots of cassava ; Bell (1981) in tubers of yam and Harada *et al* (1985) in tubers of potato. The protein content in tubers decreased in a 5 % proportion, according to Bell (1981), protein contents in the cooked tubers of yam would be from 6 to 11 % lower than those of the tubers of raw yam. Our results thus seem to approach those of Bell (1981). The decrease of the protein content in tubers, during the cooking with water, would be due to a loss of the nitrogenous material by solubilisation (Trèche, 1989). The lipid content in tubers increased to 11 %. This increase noticed by the lipid content would can due to a distribution of lipid from the skin towards the pulp of yam. It would be also possible that this increase of lipid related to the mode of cooking in the boiling water of tubers with the skin which we used. The soluble sugar content in tubers varied. It has increased from 90% in proportion. This value is higher than the 50% obtained by Dadié *et al* (1998) for tubers of sweet potato. This behaviour tuber, usually in hydrothermal treatments could be explained by the hydrolysis that occurs in tubers transforming carbohydrates and starch in particular, soluble sugars (Trèche, 1989; Dadié *et al*, 1998). The total carbohydrate content was varied. It has slightly decreased in a proportion of 1%. This shows that the hydrothermal treatment does not seem too degraded carbohydrates. Cellulose content varied in the tubers. It decreased in a proportion of 14%. Holleman and Aten (1956) also observed such reaction of cellulose in cooked cassava roots, which might be due to enzymatic hydrolysis of cellulose during the cooking water.

Ash content varied in the tubers. The proportion of variation is down about 5%. Bell (1985) also found a slight decrease in ash content during the cooking water yam tubers. It would be due to a loss of mineral elements;

Energy value increased in a 1 % proportion. The weak increase of the energy could be related to the increase of the lipid content which is involved in its calculation. Nutrient contents varied differently. The analysis of variance realized showed that the cooking does not seem to have degraded significantly the nutrients accepted the remarkable increase of the rate of sugars. The effect of hydrothermal treatment has not significantly changed the nutritional value of wild yam tubers studied

Cooking in water effect on antinutritional factors

The antinutritional factors varied differently in the tubers after cooking in boiling water (Table II). Hydrocyanic acid is a volatile compound (boiling point = 26 ° C) which evaporates rapidly in air at temperatures higher than 28 ° C and is easily dissolved in water. The cooking in the water would eliminate the free cyanogenic substance. The cyanogenic substance is partially destroyed (50%) according to Esser (1986).

Alkaloids, with some exceptions, contained nitrogen in a heterocyclic ring included. They stretched to be protonated in aqueous solution, except in the case where the nitrogen atom of the molecule was adjacent to an electron with drawing group, so they were soluble in water in the form of free bases at high pH (Multon, 1991).

Sapogenins derived from the hydrolysis of saponins which were glycosides complex. The principal sapogenin of the yams would be the diosgenin which was a compound soluble in the organic solvents (Tsukamamoto and Ueno, 1936; Martin, 1969; Takeda, 1972; Asiedu, 1991; Richter, 1993). The reduction of the sapogenins content after the hydrothermal treatment seemed remarkable (60 %).

The oxalic acid was an organic diacid which decomposed by heating (Conia, 1987). The decrease of its content in the tubers could be attributed to the decomposition process. But the oxalic acid had a high affinity for calcium with which it formed a sparingly soluble salt. Tannins were compounds polyphenolic which had a little high points of boiling. They were water-soluble compounds but beyonded a certain molecular weight, they would be insoluble in water and entirely no absorbable (Conia, 1987). The variance analysis showed a significant reduction of the contents of factors antinutritional in the cooked tubers from 20 to 60% in proportion; the tubers of the class characterized by sapogenins could be best detoxicated after cooking the variable sapogenins being destroyed to 60% by the hydrothermal treatment whereas the other factors are destroyed only to 20 and 50%. Thus the tubers of the wild yam species which contain less sapogenins relatively would be detoxicated after the hydrothermal processing

CONCLUSION

The variance analysis shows that the compositions in nutrients of the wild yams did not seem varied significantly species with another. The tubers contain much water. The dry matter of the tubers has a large carbohydrate fraction and a remarkable content of proteins. The variance analysis shows a significant reduction of the antinutritional factors contents in the cooked tubers from 20 to 60% in proportion the antinutritional factors content is substantially reduced by cooking in boiling water. What supposed that a total cooking with boiling water could certainly detoxicated the tubers of these yams and to make them possibly edible

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Table I: Composition of wild yam species tuber (% dry matter)

Species	Sample nature	moisture % fm*	Proteins	Lipid	Solubles carbohydrate	Total carbohydrate	Cellulose	Cendre	Energie (cal/10 g
D. minutiflora	cooked	85,90i	8,84cde	3,28ab	4,54c	83,14b	4,28e	4,70e	377abc
	raw	84,95h	10,59g	2,95a	2,37ab	81,73b	4,30e	4,76e	376ab
D. hirtiflora	cooked	82,87g	10,00fg	3,93cd	4,09c	81,86b	4,10de	4,22d	383,53c
	raw	81,89f	9,55ef	3,35ab	1,42a	82,27b	5,98g	4,84e	377abc
D. bulbifera bulbil	cooked	82,14f	8,38bcf	4,53e	6,64d	82,89b	5,28f	4,22d	386d
	raw	80,44fg	8,82cde	3,99cd	3,59bc	82,44b	7,67i	4,74e	381e
D. burkilliana	cooked	73,06e	7,74b	3,83bd	4,06c	83,35b	3,39a	4,67e	379c
	raw	71,59d	8,24bc	3,26ab	2,34ab	83,77bc	3,64ab	4,73e	377abc
D. bulbifera tuber	cooked	71,01d	6,15a	3,84bd	4,74c	86,77cd	3,53ab	3,26c	385c
	raw	69,80c	6,29a	3,53bd	2,26a	86,87d	3,71abc	3,31c	383bc
D. dumetorum	cooked	70,85d	9,48e	3,69bd	6,41d	83,82bc	3,82bcd	3,00b	386abc
	raw	69,65c	9,93fg	3,43ac	3,77c	83,36b	4,03cde	3,27c	384abc
D. praehensilis	cooked	68,79b	9,29def	4,02d	6,71d	84,09bcd	3,41a	2,61a	389bc
	raw	68,05b	9,48ef	3,61cd	3,81c	84,51bcd	3,62ab	2,40a	389bc
D. mangenotiana	cooked	66,92a	13,70h	4,89e	4,21c	75,40a	7,02h	6,01f	383abc
	raw	66,24a	14,18h	4,61e	2,25a	74,94a	7,33h	6,27g	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

*fm: fresh matter

Table II: Composition of wild yam species tuber antinutritional factors

Species	samples nature	Oxalic acid (mg/100g ms)	Tanins (mg/100g ms)	Hydrocyanic acid (10^{-2}.mg/kgms	Alkaloid (mg/100g ms)	Sapogenins (% ms)
D. dumetorum	cooked	9,03f	493,60h	14,95h	127,63h	0,34c
	raw	12,93j	560,10i	33,03j	167,70m	0,78d
D. togoensis	cooked	11,03i	387,83e	0,99a	161,03k	0,40c
	raw	12,63j	456,03g	2,00b	214,80q	1,49e
D. minutiflora	cooked	8,43e	278,43b	1,00a	76,03a	0,24abc
	raw	10,03h	385,73e	2,00b	101,03c	0,90d
D. bulbifera bulbil	cooked	8,63e	356,63d	0,98a	125,87g	0,09ab
	raw	9,33g	470,03gh	1,97b	165,63l	0,22abc
D. mangenotiana	cooked	7,50d	495,73h	1,03a	105,43d	0,01a
	raw	9,03fg	570,30i	4,00c	150,63j	0,05ab
D. praehensilis	cooked	7,03d	319,03c	11,03g	121,37f	0,10ab
	raw	8,33e	410,73f	20,03i	175,70n	0,26bc
D. bulbifera tuber	cooked	5,03b	345,83d	8,03e	184,73o	0,01a
	raw	6,83d	421,00f	10,03f	248,23r	0,08b
D. hirtiflora	cooked	5,73c	255,63a	1,97b	80,73b	0,86d
	raw	6,50d	315,03c	7,00d	107,63e	1,34e
D. burkilliana	cooked	3,93a	307,03c	1,00a	137,83i	0,08abc
	raw	5,43bc	489,23h	4,03c	187,03p	0,20ab

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