

Chemical Evaluation and Nutritional Quality of Dried Kernels of *Odyendya gabonensis* (Pierre) Engl. (Simaroubaceae) Fruits from Gabon

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Abstract— The dried oleaginous kernels of *Odyendya gabonensis* fruits grown in Gabon, was investigated for its chemical characteristics and nutritive value. The analysis showed the following composition: moisture 6.21%, ash 2.05%, lipids 73.09% and crude protein 11.90%. The amino acid profile showed that essential amino acids are present in very interesting amounts, according to FAO standards except for methionine. The fatty acid profiles showed that stearic acid 41.60% and Oleic acid 50.21% were the principal fatty acids.

These data suggest that *Odyendya gabonensis* fruit dried kernel have a good nutritional value. The kernel could be extracted and proceeded for edible or industrial oil, and the ground dried kernel (meal) could be used as human food.

Index Terms— *Odyendya gabonensis*, oleaginous kernels, Fatty acids, Amino acids, non-timber forest products, Underutilized Crops, Gabon

I. INTRODUCTION

Odyendya gabonensis (Pierre) Engl. is the only species of genrea *Odyendya*, belongs to family of Simaroubaceae and it is also known under synonym of *Quassia gabonensis* Pierre (1896) [1], [2], [3], [4]. The trade name is *onzan*, *onzang*, or *mbanko* [5]. In Gabon, *O. gabonensis* is called under local specific linguistic names, as *Ozéndjé* (Mpongwè and close tongues), *Onzeng* or *Onzan* (Fang), *Musigiri* (Eschira and close tongues), *Musègèti* (Nzebi), *Musyègèti* (Punu) [1], [4]. The tree is also called *Ondjienji* by people of Franceville (Téké and close tongues).

Odyendya gabonensis is a medium-sized to fairly large tree, with height ranging from 25m to 40 m tall, and 60cm to 200 cm in diameter [5], [4]. According to same authors, the trunk is usually straight, deeply fluted over its entire height; outer bark grey to greyish green; leaves are red

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when young, arranged spirally, imparipinnately compound with 4–6 pairs of leaflets, glabrous; flowers are unisexual or bisexual; fruits are obovoid drupes up to 7 cm long, red when ripe, with oleaginous kernels.

The originate and geographic distribution of *O. gabonensis* are reported to be restricted in some central African countries, namely Cameroon, Equatorial Guinea, Gabon and Congo [2], [5].

The ecological conditions of favorable development of *O. gabonensis* are mainly rainforest (particularly primary and secondary forest), and sandy soils [2], [5]. Even locally common, it occurs with very weak abundance [6], [7], [4]. Its seeds are presumably dispersed by forest animals (Zoochory) [4]. In Haut-Ogooué province (South Eastern of Gabon), people plant this tree in their villages [8] and in urban home gardens [9].

In all countries of its occurrence, the growth of *O. gabonensis* is not yet studied, but the flowering month in Gabon is September [2], [5]. However, we have observed that some trees have a late or out season flowering time so that fruits can ripe from October to May.

Concerning the use of *O. gabonensis*, the tree *O. gabonensis* has less importance in wood international trade, because its wood is soft and not durable (due to its susceptibility to fungal, termites, powder-post beetles (*Lyctus*) and dry-wood borers), and log is too much fluted to be useful for rotary peeling. Therefore, its importance is for locally uses [5]. In the past time, Gabonese people used to make numerous tools with its wood, namely musical instruments, mallets to beat bark for house construction, spoons, and bells for hunting dogs [1]. Brink [5] reported that some authors considered the wood suitable for ship and boat building, furniture and cabinet work, frame moulding, light boxes and crates, interior trim, matches, toys and novelties, veneer and plywood, hardboard and particle board, wood-wool, and as pulpwood.

Aside the wood, the bark, leaves and fruits of *O. gabonensis* have specific uses, particularly in its various applications in food and traditional medicine.

From the bark, cytotoxic quassinoids have been isolated [5] with some potentially having a promising effectiveness for treatment against breast and ovarian cancers [10].

In field of body care, a mixture of the pounded leaves with palm oil, as well as maceration of the bark, are used against head lice [1], [11], [5]. Some diseases as stomach-ache, bronchitis and lung complaints are treated with decoction of the bark. The ground bark mixed with palm oil is applied to treat psoriasis [5].

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Flowers of *Odyendya gabonensis* are reported to be attractive for honeybees, and the fruits are eaten by porcupines, which reportedly makes the meat of these animals bitter (Brink, 2007).

Other authors reported consumption of **fruits** of *O. gabonensis* by Chimpanzees and Gorillas in Gabon [12].

According to Brink [5] a “flour” from fruit (crushed fruit **kernels**) was prepared, after a boiling time of 2 to 3 hours, and, was used for domestic consumption. To eliminate bitterness, the cooked fruits are placed in running water for one week, and then kept in a smokehouse to dry for one month. The dried kernels are crushed to obtain the flour. Owing to our observations and Raponda-Walker et al. [1] report, butter extracted from fruits can be eaten raw, or as a condiment in sauces. The butter of *O. gabonensis* can also be used in traditional medicine [1].

The actual cooking procedure we recorded from local people is that fallen ripe fruits are collected and broken to separate both periderm and mesoderm from endoderm (true kernel). The separated kernels are boiled in hot water for two hours. The cooked product is cut in small parts and stored in a vegetable shelter or flour bag in running water (river) still seven days. Instead of using running water, people can also use domestic containers filled with clean water that they replace each day still the bitterness is completely suppressed after seven days. The pieces of kernels are smoked and dried under sun during one week. The dried product can be crushed and used to consume various plats (dried fish and bush meat).

In Gabon, contrary to the African plum (*Dacryodes edulis* [G.Don] H.J.Lam) which is widely studied and appreciated and are sold regularly in all major urban markets for its nutritional value [13], [14], [15], the *Odyendya gabonensis* species has not yet been sufficiently studied. The literature data on chemical composition and nutritive value of fruit kernel seem nonexistent.

Within the context of sustainable development, the detailed study of the dried kernel of *O. gabonensis* from Gabon, in particular its composition, protein and oils characteristic, may lead to important economic and industrial incomes.

II. MATERIAL AND METHODS

A. Raw materials

Odyendya gabonensis fruits (ripen and fresh) were collected on May in Gabon, under a home garden tree in Franceville (1°36'4.74"S ; 3°36'34.54"E; Elev.301 m). The ripe fruits were thoroughly washed with distilled water, in laboratory, and split open with a sharp knife to remove the fresh kernel from the fruit. The fresh kernels were boiled in hot water for two hours, and dried to a constant weight, at 70°C during five days. Then the dried kernels obtained was ground. The ground material obtained as a paste was used to perform chemical analyzes.

B. General methods

The moisture content of the dried grounded kernel of *O. gabonensis* was determined gravimetrically after heating the material (500 mg) in an oven at 105°C for 24 h.

The ash content of the grounded kernel (3 g) was determined gravimetrically after dry mineralization at 600°C for 12 h [16].

Lipids from the seed kernel (3 g) were determined by using chloroform/methanol (2/1 v/v) mixture, as described by Folch, Lees and Stanley [17]. After the automatic phase of solvent removal, the extraction beakers (containing the extracted lipids) were dried in an oven at $103 \pm 2^\circ\text{C}$ before weighted.

The crude protein (N x 6.25) content was estimated from 100 mg of grounded kernel by the Kjeldahl procedure, by nitrogen determination after mineralization (with a 1000 Kjeltabs MQ tablet and a Digestion System 20, 1015 Digester, Tecator AB, Höganäs, Sweden) and distillation (by a Kjeltac Auto 1030 Analyser, Tecator AB, Höganäs, Sweden).

Carbohydrates (nitrogen free extract included fiber) content was estimated by difference that is by deducing the mean values of other parameters (moisture, ash, protein and lipids).

The composition in total amino acids of the paste of dried grounded kernel of *O. gabonensis* was given after hydrolysis under nitrogen with 6M HCl at 110°C during 24 h and an HPLC analysis (Biochrom 20 Plus amino acid analyser, Pharmacia, Cambridge, UK) [18], [19]. Norleucine was added as internal standard. The hydrolysates (30 μl) were injected on a column of cation exchange; the amino acids, separated by elution with suitable buffers of increasing pH, were detected with ninhydrin in a continuous flow photometric analytical system at 570 and at 440 nm (only for proline). Amino acids Standard Solution 0.05 mM (Fluka AG, Buchs, Switzerland) containing also norleucine was injected separately to calibrate the analyzer and to calculate the response factors used to calculate the amount of amino acid in the samples.

The composition in fatty acids of the paste of dried grounded kernel of *O. gabonensis* was determined with a GLC by the proportioning of fatty acids methyl esters of the lipids prepared by saponification-esterification, according to the IUPAC Method No.: 2.301 [20]. GC analyses were performed using a Hewlett-Packard 6890 series Gas Chromatograph System equipped with a HP-INNOWAX capillary column (30 m x 0.25 mm, film thickness 0.32 μm). Derivatized extracts (1 μl) in hexane were injected on-column. The oven temperature was programmed from 50 (isothermal for 1 min) to 150 °C at 30 °C min⁻¹ and from 150 °C to 240 °C (isothermal for 10 min) at 4 °C min⁻¹. Compounds were detected using a flame ionisation detector at 325 °C. Helium was used as carrier gas at a flow rate of 65 ml/min. Identification and quantification of fatty acid methyl esters was accomplished by comparing the retention times of the peaks with those of standards of Supelco 37 component FAME Mix 1ml (Supelco Inc., Bellefonte, PA, USA).

Statistical analysis: All analyses reported in this study were carried out in triplicates. Descriptive statistics were calculated and results expressed as Mean value \pm standard deviation (SD).

III. RESULTS AND DISCUSSION

A. Proximate composition

Table 1: Overall composition of the ground dried kernel of *O. gabonensis* (% on the basis of matter dry)

	Dried kernel of <i>O. gabonensis</i>
Moisture	6.21 ± 0.26
Ash	2.05 ± 0.12
Crude Protein	11.90 ± 0.31
Lipids (neutral and polar)	73.09 ± 4.32
Carbohydrates ^a (nitrogenous free extract including fiber)	6.75 ± 0.4

^acalculated by difference.

Data are the means of triplicate analysis ± SD

The overall chemical composition of the crushed dried kernel of *O. gabonensis* revealed (Table 1) the following composition: moisture (6.21%), ash (2.05%), protein (11.90%), lipid (73.09%) and carbohydrate (6.75%).

The moisture content (6.21%) obtained in the ground dried kernel of *O. gabonensis* was very lower, and so, can be stored for a long time.

The levels of ash (2.05%) in the ground dried kernel of *O. gabonensis* fruits were low. These values were comparable to values (2.55%) reported in literature for safou (*Dacryodes edulis*) [21], [22].

The crude protein content (11.90%) of the ground dried kernel of *O. gabonensis* was relatively high. This protein level will make significant contribution to diet in ameliorating protein malnutrition and would be a useful feed supplement. A meal with the paste of dried kernel of *O. gabonensis* and starches (cassava) could be a balanced ration. The total lipid content (obtained by using chloroform/methanol (2/1 v/v) mixture) of the paste of dried kernel of *O. gabonensis* was very high (73.09%). This high level suggests that this food could be considered as “natural margarine or butter” and, so, a good source of calories. *O. gabonensis* dried kernel showed a relatively high oil content than safou (*D. edulis*) fruits from Cameroun (40 to 65%), Nigeria (68.29%) and Gabon (70.17%) according to the results obtained by Kengué [23] Ibanga and Okon [24] and Ondo-Azi et al. [25], respectively; and also than *Irvingia gabonensis* (bush mango) from Nigeria (58 to 68%) obtained by Ekpe et al. [26] and Ogunsina et al. [27].

The carbohydrate content (6.75%) in crushed dried kernel of *O. gabonensis* was relatively low. However, this value was lower to those found by Ondo-Azi et al. [25] in safou fruits from Gabon (30.91%).

B. Composition in amino acids

B.1. Total amino acids composition

The composition in total amino acids (AA) of the ground dried kernel of *O. gabonensis* is presented in table 3. Paste of dried kernel of *O. gabonensis* contain, in relatively high concentration, all the known amino acids (except tryptophan which was not determined). Amino acids are the building blocks of protein, they are crucial in the synthesis of muscle growth and prevention of muscle catabolism as well as mental health.

Table 3: Amino acid composition of ground dried kernel of *O. gabonensis* (in g amino acid/100 g of dried kernel meal).

Amino acid	Dried kernel of <i>O. gabonensis</i>
Asp + Asn	1.14 ± 0.02
Thr	0.53 ± 0.02
Ser	0.73 ± 0.01
Glu + Gln	2.37 ± 0.01
Pro	0.54 ± 0.02
Gly	0.75 ± 0.01
Ala	0.56 ± 0.02
Cys – Cys	0.34 ± 0.02
Val	0.93 ± 0.01
Met	0.06 ± 0.02
Ile	0.69 ± 0.02
Leu	1.12 ± 0.02
Tyr	0.76 ± 0.01
Phe	0.44 ± 0.05
His	0.38 ± 0.01
Lys	0.63 ± 0.01
Arg	1.27 ± 0.01

The values represent the means of triplicate analysis ± SD

B.2. Protein quality evaluation

The quality of protein was estimated by calculating the chemical score (CS). It's based on comparison of the concentration ratio of the essential amino acid having the shortest supply a_i (restrictive amino acid) to the concentration of this amino acid in the standard a_s ($CS = (a_i/a_s) \times 100$). The FAO/WHO [28] reference pattern was used as protein standard. The amino acids are of importance for maintenance of the metabolism and are used by our body to manufacture structural proteins, hormones, enzymes, antibodies and other important molecules. Non-essential amino acids are synthesized in the body and essential amino acids have to be taken up from the diet.

The analysis indicates clearly in Table 4 that the dried kernel of *O. gabonensis* could be considered as a “complete protein”

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in which all the essential amino acids (Arginine, Valine, isoleucine, Histidine, leucine, threonine, lysine and phenylalanine) are present in very interesting amounts, according to FAO standards, excepted for methionine which is found at the most limiting concentration. Arginine (like histidine) is considered essential for children [29].

Table 4: Content of essential amino acids (EAA) in the ground dried kernel of *O. gabonensis* (in g amino acid/16 g N^a).

Essentials Amino acid	Dried kernel of <i>O. gabonensis</i>		FAO/WHO Standard
	g AA ^b /16 g N	% of FAO	g AA /16 g N
Thr	3.93	116	3.40
Val	6.87	196	3.50
Met	0.14	6	2.50
Ile	5.07	181	2.80
Leu	8.31	126	6.60
Phe	3.27	52	6.30
Lys	4.66	80	5.80
Arg	9.92	709	1.40
His	2.79	147	1.90
Chemical score	6%		100%
Limiting amino acid	Met		

^aCalculated from crude protein content

^bAmimo Acid

C. Composition in fatty acids

Table 5: Fatty acids composition (% of total FA content) of oils from ground dried kernel of *O. gabonensis*.

Fatty acids	Dried kernel of <i>O. gabonensis</i>
Palmitic (C16)	4,01 ± 0.12
Stearic (C18)	41.60 ± 0.24
Oleic (C18:1 n-9)	50.21 ± 2.10
Linoleic (C18:2 n-6)	1.42 ± 0.11
Linolenic (C18 :3 n-3)	0.71 ± 0.04
Arachidic (C20)	1.80 ± 0.01
Gadoleic (C20 :1)	0.23 ± 0.03
Saturated fatty acids	47.40
Monounsaturated fatty acids	50.44
Polyunsaturated fatty acids	2.13
n-3/n-6	0.5

The values represent the means of triplicate analysis ± SD

Fatty acid compositions of the oil extracted by chloroform/methanol (2/1 v/v) from the ground dried kernel

of *O. gabonensis* are given in Table 5. These results showed that the principal fatty acids in the oil from the dried kernel of *O. gabonensis* are oleic (18:1) 50.21% and stearic (18:0) 41.60% acids, respectively. For comparison, Safou oil contains 47% palmitic acid, 31% oleic acid, 17% linoleic acid and 2% stearic acid (Umoti et al., 1987). This composition (richness in oleic acid) reflects the interesting nutritional value of *O. gabonensis* dried kernel. *Oleic acid* consumption has been associated with decreased low-density lipoprotein (LDL) cholesterol, increased HDL cholesterol (the good cholesterol), reduced blood pressure, increased fat burning to help with weight loss, protected cells from free radical damage, prevented autoimmune and inflammatory diseases, decreased risk of breast cancer, could prevent type 2 diabetes, prevented ulcerative colitis and generated brain myelin [30], [31], [32].

Unfortunately, carob germ oil not contains a considerable amount of linolenic (18:3n-3) acid (~ 0.71%) to be considered as a very good nutritional oil [33], [34]. However, the quantity and quality of oil from dried kernel of *O. gabonensis* showed that it could be a source of edible and industrial oil to reduce dependence on popular vegetable oils.

IV. CONCLUSION

The dried oleaginous kernels of *Odyendya gabonensis* fruits grown in Gabon, was investigated for its chemical characteristics and nutritive value. The analysis data showed the following composition: moisture 6.21%, ash 2.05%, lipids (neutral and polar) 73.09% and crude proteins 11.90%. The amino acid profile showed that essential amino acids (Arginine, Valine, isoleucine, Histidine, leucine, threonine, lysine and phenylalanine) are present in very interesting amounts, according to FAO standards except for a low content of methionine. The protein level and quality showed that dried kernel will make significant contribution to diet in ameliorating protein malnutrition and would be a useful feed supplement. The fatty acid profiles showed a saturated fatty acid content of 47.40% and an unsaturated fatty acid content of 52.57%. Stearic acid 41.60% and Oleic acid 50.21% were the predominant fatty acids. The quantity and quality of oil from dried kernel of *O. gabonensis* showed that it could be a source of edible and industrial oil to reduce dependence on popular vegetable oils.

From the results presented, we can conclude that *Odyendya gabonensis* fruit dried kernel have good nutritional value. The fruit could be proceeded and the kernel could be extracted and proceeded for edible or industrial oil and the ground dried kernel could be used as as “healthy meal” in human food.

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