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COMPARATIVE STUDY OF THE NUTRIENTS IN THE *VOANDZEIA SUBTERRANEA* SEEDS (VAR OF NKAMBA AND DJAMBALA)

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ABSTRACT

The objective of the study is to compare the composition of nutrients on two cultivars of *voandzou* seeds. The seeds of *voandzou* we studied come from the locality of Nkamba South of the DR Congo and in the town of Djambala precisely in the North of Congo Brazzaville. Biochemical and physicochemical seeds characteristics were evaluated to determine the nutritional value of the seeds of this legume and its conservation. The results of the analysis indicated that content in humidity of both cultivars have revealed (12.08±0.19% for seeds of Nkamba against 10.85±0.07% for seeds of Djambala); ash content however shows (4.3±0.35% for seeds of Nkamba and 3.8±0.28% for seeds of Djambala); the seeds of *voandzou* lipid composition gives proportions of the order of 7.2±1.41% and 9.42±0.95% respectively for Nkamba and Djambala seeds.While the analysis on protein levels reveals (17.53±0.4% and 17.82±0.2% respectively for Nkamba and Djambala seeds) and the total carbohydrate contents (58.89±0.2% for seeds of Nkamba and 58.11±0.4% for seeds of Djambala). The order on the profile in fatty acid of both cultivars is similar and is as follows: C18:3 < C16:1 < C20:4 < C18:2 < C18:1 < C16:0.

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INTRODUCTION

Legumes were historically part of inexpensive meals around the world because they have an important role in the fight against malnutrition. It is therefore necessary that their consumption levels, that are already too low in a number of developing countries, should be increased (Borget. M, 1992). Plant proteins provide nearly 65% of the world's offer for protein for humans; 45-50% of grain and 10-15% of legumes (Mahé, S., Gausseres. N, and Tome. D, 1994). These legumes serve as unprocessed protein for rural residents and urban particularly those in poor countries of the world (Rachie. K.O. and Silvestre. P, 1977); and also as a good source of fiber, starch and other food. Its common name is the *voandzou*, and the scientific name is *Voandzeia subterranean* synonym of *Vigna subterranea*. The genre *Voandzeia* belongs to the fabaceae family. The *voandzou* is a form of peanuts of African origin (Borget, M, 1992) that grows in the ground; this type of peanut is often prevalent south of the Sahara (Ocran, V. K, Delimini. L. L., Asuboah. R. A and Asiedu. E. U 1998). In terms of production, the *voandzou* occupies the third place

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compared to some other peanuts (*hypogea d'arachis*) and the China cowpeas (*Vigna unguiculata*). In Africa, because of its low status, it is used as a dietary supplement, a snack or food but not for lucrative harvest (Linnemann, 1992). In traditional medicine, a decoction of the leaves and stems of *voandzou* prepared with Palm wine in association with other plants (e.g. bark of trunk) of *Hallea stipulosa*, *Anchomanes difformis*, and *Abrus recatorius* is used to treat skin rashes and severe skin diseases; Astite, epilepsy and joint pain (Kembelo Kibungu., 2004). In Niger, people consume the *voandzou* for its therapeutic virtues. The *voandzou* is used in the treatment of bleeding and for its aphrodisiac properties (Harouna et *al*., 2014). In Congo, the data on the nutritional value of the *voandzou* aren't yet well known whereas the potential of these seeds could prove very important in the fight against malnutrition. This study is aimed to enhance the seeds (*Voandzeia subterranea*) harvested in DR Congo in the locality of Nkamba and in the Plateaux region of the Congo Brazzaville, precisely in Djambala and to determine the biochemical composition of the seeds.

MATERIALS AND METHODS

Vegetable Material

Both seed cultivars of *Voandzeia subterranean* used here, present morphological differences. The *voandzou* of Nkamba is in the form of monocoque (fig 1 a) while that of Djambala is a polycoque (fig 1 b) as shown in the figures below.

Figure 1: Seeds of *voandzou* of Nkamba (a) and of Djambala (b)

Methods

Proximate composition: To determine the chemical composition of the seeds of *voandzou*, raw protein levels were evaluated by Pearson's common method (1976) using the (micro-Kjeldahl); moisture by the method (AOAC 1997). The level of the ash content was also determined by common methods (Pomeranz and Meloan, 1994). 2 g of dry matter was weighed in order to determine the ash content in the microwave flask at 550 ° C for 8 h until a white residue of constant weight was obtained. All carbohydrates were obtained by difference. Each determination was in a triplicate.

Extraction process by the Soxhlet: 15 g of Nkamba and Djambala *voandzou* seeds have been used to extract oil using 100 ml of n-hexane in a soxhlet Extractor (Moulinex SeBPREP'LINE model 850) at 90 °C for 6 h, as described in the standard method (AOAC, 1997). The solvent was evaporated to 50 °C at reduced pressure using a rotary evaporator model N-1 (Eyela, Tokyo Rikakikal co., Ltd. Japan) and oil was dried at 105°C to a constant mass under nitrogen in a drying oven.

Assessment of the oils of seeds of Nkamba and Djambala indices: Indices of oils are usually determined according to standard methods: index of acid (AOAC (12), the standard method 969.1), iodine content (AOAC (12), standard method 993.20), and saponification value (965.33 standard method of the AOAC (12)) and the peroxide content (920.160 method of the standard AOAC (12)).

Determination of fatty acids composition: Of fatty acid methyl esters (FAME) have been obtained by the transmethylation of the total aliquot of lipid (50 mg) with 1 ml of trifluoride boron in (8% w/v) methanol for 10 minutes in a water bath of jerk heating at 90 °C as described by Ackman (1998) earlierly to submit samples to the analysis of chromatography. The analysis of the fame was performed by gas chromatography in a Perichrom TM (Saulx-les-Chartreux, France) 2000 system, equipped with a detector of flame ionization (FID) and a melted silica capillary (25 m x 0.25 mm X 0.5µm, BPX70 SGE Australia Pty, Ltd.) The column temperature was maintained at 145°C for 20 minutes and then warmed to 145-210 °C outgoing at 5 °C the minute $^{-1}$ and taken at 210 °C for 15 minutes. Thefinished injection opening has been maintained to 230 °C and 260 °C sensor. The fatty acid was identified by comparison of their conservation time with the adequate marine source of Pufa-1 levels (Supelco, number 4-7033, Bellfonte, PA-USA), the animal 2 source Pufa (Supelco, number 4-7015-U, Bellefonte, PA-USA). Each measure was in a triplicate.

RESULTS AND DISCUSSION

Chemical composition: The *voandzou* of Nkamba seeds contain 7.2±1.41% in oil and 12.08±0.19% of water content with 4.3±0.35% in ash content 58.89±0.2% is relatively high in total carbohydrates of the seeds. The *voandzou* of Nkamba is rich in protein 17.53±0.4% (table 1). Regarding the *voandzou* of Djambala, the seeds contain 9.42±0.9% of the oil, slightly high value content compare to that of the seeds of Nkamba and 11.85±0.07% of water content, the difference is significant between the seeds of Nkamba and those of Djambala with 3.8±0.28% of the ash content. The rate of the total carbohydrates in seeds of Djambala is approximately the

same 58.11±0.4% than those of seeds of Nkamba. The protein content in seeds of Djambala is 17.82±0.25%, value close from Nkamba seeds. Compare to other seeds such as Bombax and Manga, the values in the *voandzou* of Nkamba and Djambala carbohydrates present rates slightly high compared to Bombax seeds and those of Manga (58.89 and 58.11% against 54.74 and 17.56%). The seeds of Bombax and Manga show rates higher in lipids (36.97 and 47.43% against 7.2 and 9.42%). Manga seeds have a higher protein 32.60% compared to the three species (Table 1).

Table 1. Proximal Composition of different seeds

Composition	Nkamba (%)	Djambala (%)	[a]Bombax (%)	[b]Manga (%)
Moisture	12.08±0.19	11.85±0.07	5.89±0.12	7.58±0.86
Ash	4.3±0.35	3.8±0.28	2.61±0.34	5.67±0.98
Lipid	7.2±1.41	9.42±0.9	36.97±0.03	47.43±1.60
Proteins (N_Tx6.25)	17.53±0.4	17.82±0.25	5.68±0.20	32.60±0.26
Carbohydrates	58.89±0.2	58.11±0.4	54.74±0.05	17.56±1.33

Values are mean± standard deviation of triplicate determinations; Carbohydrate obtained by calculation

Table 2. Index of different seed oil

Indices	Nkamba	Djambala	[a]Bombax	[b]Manga
Iodine values (Iv)	75.83±3.72	76.3±4	25.59±0.08	100.93±1.88
Peroxide values (Pv)	1.35±0.14	1.23±0.12	6.86±0.31	2.48±0.65
Acidity (oleic)	2.6±0.5	2.65±0.39	8.18±0.82	4.56±0.41
Saponification values (Sv)	115.6±6.2	106.59±8.4	162.32±0.15	258.06±3.51

Iv (mg/100 g); Pv (meq O_2/kg; Sv (mg KOH/100 g) Reported values [a,b]Dzondo et *al*. (2015). Values are mean± standard deviation of triplicate determinations

Indices values: Four physicochemical indices have been studied to characterize the oils of two cultivars of *voandzou*. These are: iodine index (Ii) determined by calculation, acid index (Ia), the peroxide (Ip) content and the value of the saponification index (Is). Iodine index obtained by calculation gives 75.83±3.72 for the voandzou of Nkamba and 76.3±4 for the *voandzou* of Djambala. Standards of codex alimentarius, (1993) give values between 2.2 and 7.26 for acid index, while the index of acidity (Ia) obtained is of 2.6±0.5 for the seeds of Nkamba and 2.65±0.39 of oleic acid for seeds of Djambala. The acidity index found is in compliance with the standards of the codex alimentarius, this value reveals a low acidity of the studied oil, *voandzou* oil would be a good oil for human consumption. As for peroxide index (Ip), it gives 1.37± 0.14 for Nkamba oil and 1.23±0.12 meq O_2/kg of oil for oil of Djambala. The low value of peroxide index indicates that the oil from the seeds of two cultivars of *Voandzeia subterranean* studied doesn't oxidize easily, because it is rich in monounsaturated and polyunsaturated fatty acids. Indeed, the presence of the unsaturation induce very little oxidation of the oil. According to codex alimentarius, the standard is understood between (5.2-7.2 meq O_2 /kg of oil) two other oils extracted from seeds of Bombax and Manga are also in compliance with the codex alimentarius standards. Regarding saponification index, the value of 115.6±6.2 mg KOH / 100 g oil for the *voandzou* of Nkamba and 106.59±8.4 mg KOH / 100 g oil for the *voandzou* of Djambala are in accordance with the Codex alimentarius standards (1993) between 189,7 and 195.2 mg KOH / 100g of oil. Because of the high index of saponification on Manga oil (Table 2), this oil could have industrial applications (Hilditch, 1949).

Composition in fatty acids: As shown in table 3, ten (10) compounds of acids fat are listed, of wich two saturated fatty acids (SFA), three monounsaturated fatty acids (MUFA) and five polyunsaturated fatty acids (PUFA) have been identified. Among them, Palmitic acid C16:0 (26.22-25.78%) respectively for Nkamba seeds and seeds of Djambala. This oil has a high proportion of Palmitic acid compared to other fatty acids. Stearic acid C18:0 (8.61- 8.75%). The Palmitic acid (SFA) is the most predominant. Among the monounsaturated fatty acids we have palmitoleic acid C16:1 (2.67 - 2.58%) for seeds of Nkamba and seeds of Djambala, oleic acid C18: (24.42 ω9 - 1.20 ω7%) for the seeds of Nkamba and (24.87ω9 - 1.71ω7%) for seeds of Djambala. These are the major MUFA found in two cultivars of voandzou, C18:2ω6 (22.67- 22.09%) linoleic acid was also identified for seeds of Nkamba and Djambala. Other PUFA have been identified, the C18:3 (2.60 ω6 - 1.68 ω3%) linolenic acid for seeds of Nkamba and (2.51 ω6 - 1.02 ω3%) for Djamba seeds. Arachidonic acid C20:4 was also identified (6.82 ω6 and 6.93 ω6%) respectively for seeds of Nkamba and Djambala. And finally, docosahexenoique (DHA) (3.11ω3 and 3.26 ω3%) acid for both cultivars. The summary order of the profile in fatty acid, expressed as a percentage of oil from the seeds of *voandzou* of Nkamba and those of Djambala gives a similar order C18:3 < C16:1 < C20:4 < C18:2 < C18:1 < C16:0. However, there is a big difference in compositions of fatty acids between these results and those reported by Dzondo et al, 2015. This could be explained by the fact that the seeds do not come from the same locality, climatic conditions and treatments after harvest. Two cultivars of *voandzou* oil is liquid at room temperature.

Comparison with a few known oils: When we compare the oil of seeds of *voandzou* of the Nkamba and Djambala to other conventional oils, we found that Palmitic acid content was higher in oil of Bombax (54.89±0.08) followed by Nkamba and Djambala oils respectively (26.22±1.18 and 25.78±1.34) and the oil of Manga (12.43±1.52) (table 3). *voandzou* seed oil (Nkamba and Djambala) is very rich in oleic and linoleic acids intake; respectively (25.63% and 22.67%) for Nkamba and (26.58% and 22.09%) for Djamabala. Manga oil is the one that has a higher percentage in the oleic acid (53.18%) and (29.32%) in linoleic acid. Regarding Bombax oil, it is oil that has the low rate in oleic acid (8.27%) and (6.09%) in linoleic acid compared to the other three oils. When we consider the content in linoleic acid, oil of seeds of Bombax (6.09%) is far from the oil of Nkamba *voandzou* as well as Djamabala (22.67 and 22.09%) and oil of Manga (29.32%).

Table 3. Composition of fatty acids

Fatty acids	Nkamba (%)	Djambala (%)	[a]Bombax (%)	[b]Manga (%)
C16 : 0	26.22±1.18	25.78±1.34	54.89±0.08	12.43±1.52
C16 : 1	2.67±0.15	2.56±0.58	0.00	0.00
C18 : 0	8.61±0.04	8.75±0.98	3.19±0.21	1.52±0.66
C18 : 1ω 9	24.42±2.29	24.87±2.55	7.54±0.78	53.18±2.94
C18 : 1ω7	1.21±0.06	1.71±0.63	0.73±0.21	0.00
C18 : 2ω 6	22.67±1.4	22.09±2.02	6.09±0.99	29.32±3.02
C18 : 3ω6	2.60±0.32	2.51±0.09	2.17±0.66	0.00
C18 : 3ω3	1.68±0.67	1.02±0.52	0.00	0.00
C20 : 4ω6	6.82±0.76	6.93±0.89	0.89±0.31	0.00
C22 :6ω3	3.11±0.94	3.26±0.8	8.87±0.95	0.00
∑SFA	34.83±0.81	34.53±0.25	58.08±1.23	13.95±1.56
∑MUFA	25.63±1.61	26.58±1.32	8.27±0.40	53.85±1.00
∑PUFA	36.88±0.39	35.81±0.72	18.02±0.31	29.32±3.02
PUFA/SFA	1.06±0.3	1.04±0.33	0.31±0.65	2.10±1.25
MUFA/SFA	0.74±0.5	0.77±0.71	0.14±0.02	3.86±0.2

The low C 18:3 content, can allow the oil from seeds of *voandzou* to be used for frying

Conclusion

Voandzou seeds have a good nutritional value according to the chemical composition. ω3 (DHA) and ω6 oil levels, like the ones in fish oil, are very significant from the point of view of food. The oil is light yellow and fluid at room temperature. It could not be used for frying, because the levels of linoleic acid are above 3%. The advantage of this oil is that it contains a high fatty acid ω 3 andω 6 which is very good for health. It is very essential for adults and even children at an early age. The seeds of both *voandzou* cultivars studied are a rich and rare starchy biomass protein and relatively mono and Bi-unsatured acid lipid fat in particular.

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