

## Bromatological analysis of *Hevea brasiliensis* seeds collected from industrial plantations in Kpoo with a view to their inclusion in the diet of grasscutter (*Thryonomys swinderianus*, Temminck, 1827) at the IRVAG, Republic of Guinea

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### Abstract

The objective of this study was to conduct a bromatological analysis of samples from 10 varieties of rubber tree seeds collected from industrial plantations in Kpoo. A total of 10 clones were collected from 10 different sites. Of the 10 clones, 2 show similarities. These include: IRCA109 and IRCA119. The actual harvesting began in the plantations at 13:13 and ended at 17:07. 1 kg of seeds per clone was collected, named and classified according to the collection area. The collected and packaged clones were analysed at the ENVAL laboratory in Ivory Coast. The analyses carried out involved determining the levels of total cyanides, protein, energy value, total carbohydrates, ash, total fat, moisture and volatile matter in the samples.

The results of the sample analyses revealed that ECH: AVRO 5 2037/SITE: KH30 contains less than 0.517 mg CN/kg of cyanide, followed by samples ECH: PB 254/SITE: KH12 at 0.770 mg CN/kg and ECH: BPM 24/SITE: KH 12 at 0.808 mg CN/kg. The sample ECH: RRIC 100/SITE: KH 37 contains the highest cyanide levels at 5.043 mg CN/kg.

Given the abundance of these raw materials and their relatively low cost in Guinea, the use of these oilseed cakes in grasscutter (*Thryonomys swinderianus*, Temminck, 1827) feed is expected to reduce the country's reliance on imported supplementary feed and lower feed costs in the production of grasscutter.

**Keywords:** Bromatological Analysis; *Hevea Brasiliensis* Seeds; Kpoo; Grasscutter

### 1. Introduction

Aulacodiculture is an important means of combating poverty and improving the living conditions of rural households in Africa [1–2].

Since the emergence of this form of farming, the grasscutter has been the subject of studies and trials aimed at its development in many African countries [3–5].

The grasscutter's staple diet remains primarily natural forage. This includes, amongst others: *Panicum maximum*, *Andropogon gayanus*, *Paspalum vaginatum*, *Pennisetum purpureum*, *Echinochloa pyramidalis*, *Echinochloa stagnina*, *Brachiaria ruziziensis*, *Hyparrhenia diplandra*, *Cynodon dactylon*, *Hyparrhenia rufa*, maize stalks, millet and sorghum stalks, etc. It should be noted that as the nutritional value of these forages is low, farmers always resort to feed

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supplements. One of the main obstacles to the development of the livestock sector is the feeding of herds, particularly during the dry season. The forage from natural grazing lands, which forms the bulk of herbivores' diet, is affected both quantitatively and qualitatively by rainfall patterns and seasonal changes [6]. Thus, in the field of aulacodiculture, the growth and reproduction of grasscutter in captivity require a healthy and balanced diet. To meet its requirements for protein and energy, the grasscutter in captivity needs a dietary supplement. Supplementary feeds are crucial for grasscutter kept in captivity, as they improve health, growth and, above all, reproduction, enabling breeders to maximise their income by reducing the intervals between spawning through balanced rations (often 15–25% supplementary ingredients), and preventing energy deficiencies linked to excessive supplementation (50% is inappropriate and risky). A good diet, combining green fodder and supplements, is the key to productive and sustainable aulacodiculture. Efforts have been made and have led to the incorporation of feed supplements such as palm kernel cake, maize, etc. into the grasscutter diet in order to use this species more rationally for the purpose of feeding the population.

Many areas of research remain unexplored and are essential for meeting the requirements of farmed grasscutter [7]. One potential solution to improve the productivity of farmed grasscutter herds is the formulation of a healthy and balanced diet incorporating nutrient-rich feed supplements [8]. In Guinea, aulacodiculture has been practised since 2001. It plays a variety of roles in terms of food security, the economy, finance, health, the environment, society and science [9–10]. Nowadays, there is growing interest in aulacodiculture in urban and peri-urban areas, where one of the major problems is the difficulty in collecting green fodder to feed the grasscutter. Added to this is the high cost and unavailability of raw materials for animal feed, such as maize and palm kernel cake, which are limiting factors for the development of this industry. It is therefore necessary to investigate other local resources for catfish production in Guinea. Much research has been carried out on forage resources, agricultural by-products and agro-industrial by-products used in the feeding of grasscutter. Despite these efforts, many areas of investigation remain unexplored. It is with this in mind that the Institute for Research and Extension in Aulacodiculture in Guinea (IRVAG) carried out a study on rubber tree seeds. The aim of this study was to conduct a bromatological analysis of samples from 10 varieties of rubber tree seeds collected from industrial plantations in Kpoo.

## 2. Materials and methods

### 2.1. Materials

#### 2.1.1. Biological material

The biological material used in this study consisted mainly of rubber tree seeds.

Botanical description of the rubber tree (*Hevea brasiliensis* Muell. Arg.)

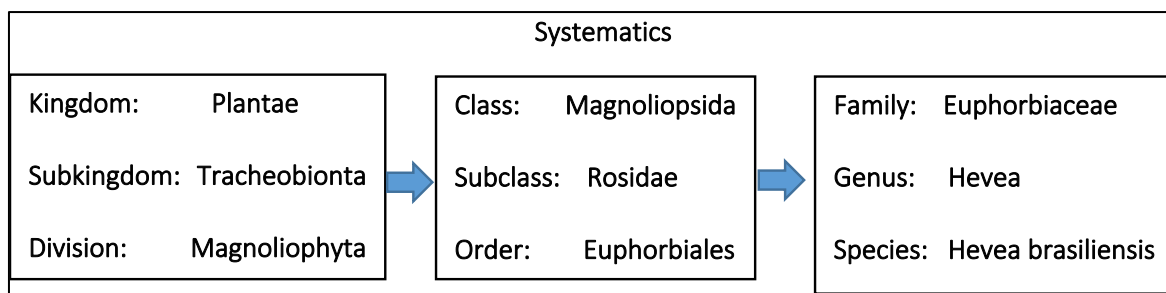
Compagnon (1986) describes the rubber tree as a large forest tree with a circumference at breast height of up to 5 m on well-drained soils in its natural habitat in the Amazon [11].

In most cases, rubber trees in plantations are grafted trees, which do not reach the same size as those in the Amazon rainforest. They have a straight, cylindrical trunk, a height of nearly 25 m and a circumference of around 1 m towards the end of their economic life, which lasts approximately 35 years (Figure 1) [12].

The growth of the rubber tree's aerial system is characterised by its rhythmic nature [13]. Leaves form in tiers at the top of each growth unit.



**Figure 1** An industrial rubber plantation in Kpoo, SOGUIPAH/Diécké



**Figure 2** Rubber tree fruits (Source: field photographs, 2022)



**Figure 3** Capsules, field photo

#### Seed production

*Hevea brasiliensis* Muell. Arg. begins to bear fruit when it is four years old (1); it reaches full productivity at the age of eight. Each fruit contains 3 to 5 seeds; when ripe, it bursts open, scattering the seeds onto the ground.

A first, and largest, harvest can be taken in September–October, and a second, smaller one in January–February.

Each tree, at full yield, produces 700 to 800 seeds (2). This number decreases with altitude; at 300 m, there are only about a hundred, at 600 m above 800 m, there are none at all.

An adult rubber tree yields an average of 1.25 kg of seeds (7.33), but a tree from which latex has been extracted produces fewer.

#### Characteristics of the seeds

The seeds are enclosed in a thin, hard shell, 0.1 mm thick. They range in length from 2 cm to 2.5 cm. The weight of the seeds (3) varies between 1.85 and 5.17 g; naturally, this depends greatly on their freshness. The weight of the extractable matter varies depending on whether the whole seed or just the kernel is processed. The kernel accounts for approximately 50% of the total weight of the seed (14); when fresh, it contains 35% moisture (4); this content then decreases as the seed ages and can fall to as low as 6%. On average, processing the kernel yields 44% oil, 50% cake and 6% miscellaneous waste (2, 66, 74).

These figures show that from the whole seed, barely 20% oil is obtained.

Seed harvesting and storage: Collection.

There is no practical mechanical method. One method, involving spreading mats made of bamboo or palm leaves (5) beneath the trees, has been criticised as being too costly.

Collection can practically only be done by hand. It becomes arduous and costly in plantations covered in vegetation or in mountainous regions. As male labour is too expensive, it is mainly women and children who are employed. Gathering can be done once or twice a week at harvest time, as a short period on the ground does not cause any deterioration.

### *2.1.2. Introduction to the Institute for Research and Extension in Aulacodiculture in Guinea*

The Institute for Research and Extension in Aulacodiculture in Guinea (IRVAG) is located in the Republic of Guinea. It was established on 23 February 2000 by Decree No. 645/MESRS/CAB/DRH and inaugurated on 22 June 2001 under the supervision of the Ministry of Higher Education, Scientific Research and Innovation (MESRI). It is attached to the Directorate-General for Scientific Research (DGRS)

Location: Moata district, 20 km from the capital of N'Zérékoré Prefecture on the N'Zérékoré-Lola national road.

### *2.1.3. Overview of the area where rubber seed samples are collected (SOGUIPAH)*

Brief description of Yomou Prefecture

Yomou Prefecture, where SOGUIPAH's operations are based, is situated in the southern part of the N'Zérékoré region. It comprises six sub-prefectures, including Péla, Banié, Beetha, Bowé, Diécké and Bignamou. The sub-prefectures of Diécké and Bignamou account for the bulk of palm and rubber tree cultivation activities. In Diécké, the districts of Diécké-centre, Soopa, Baala, Danié, Naapa, Koimpa and Saoro benefit from SOGUIPAH's initiatives, whilst in Bignamou the districts most affected are: Kpoo, Nawé, Gbanzou, Ballan, Galakpaye and Gbamou.

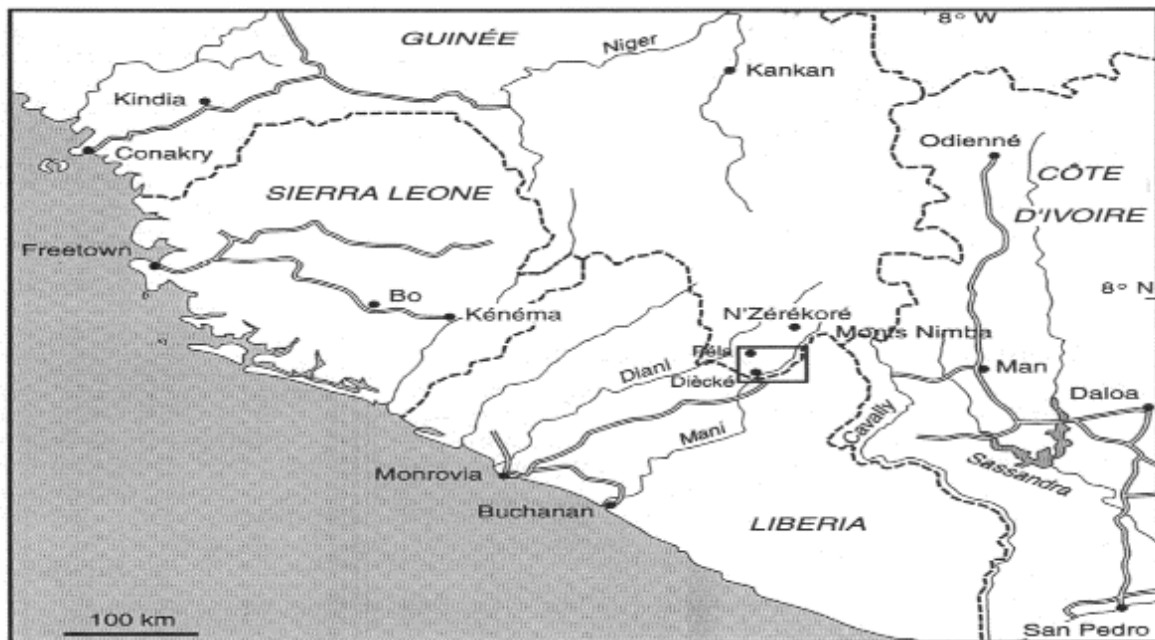
Introduction to SOGUIPAH

Located in the sub-prefecture of Diécké, SOGUIPAH (Guinean Oil Palm and Rubber Company) was established in 1987 by Presidential Decree No. 043/PRG/87. Although it began its operational activities in 1988, its official year of foundation is 1987, and it was converted into a public limited company (SA) in 2022. Its aim is to promote the economic and social development of the Forest Region of Guinea through the creation, development, production and management of oil palm and rubber plantations in Guinea, the cultivation of oil palms and rubber trees, as well as the processing and marketing of related products, by-products and derivatives. It owns an oil mill, a soap factory and a coagulum (rubber) processing plant. The operational centre is located in Diécké and the head office in Conakry.

Industrial plantations, mainly of oil palms and rubber trees, have been established in the traditional areas of Gbeinson and Niékoré, covering vast tracts of land in the sub-prefectures of Diécké and Bignamou, as part of the SOGUIPAH project. These plantations, situated alongside family farms, are aimed at the mass production of palm oil and rubber. In these areas, industrial plantations cover an area of nearly 4,600 hectares. Kpoo, one of the districts in the sub-prefecture of Bignamou, is an area where industrial plantations have been established, forming part of the sites affected by SOGUIPAH's activities.



**Figure 4** Location of SOGUIPAH in Guinea: source – African Development Bank report (ADF-BD-IF-2008-123)

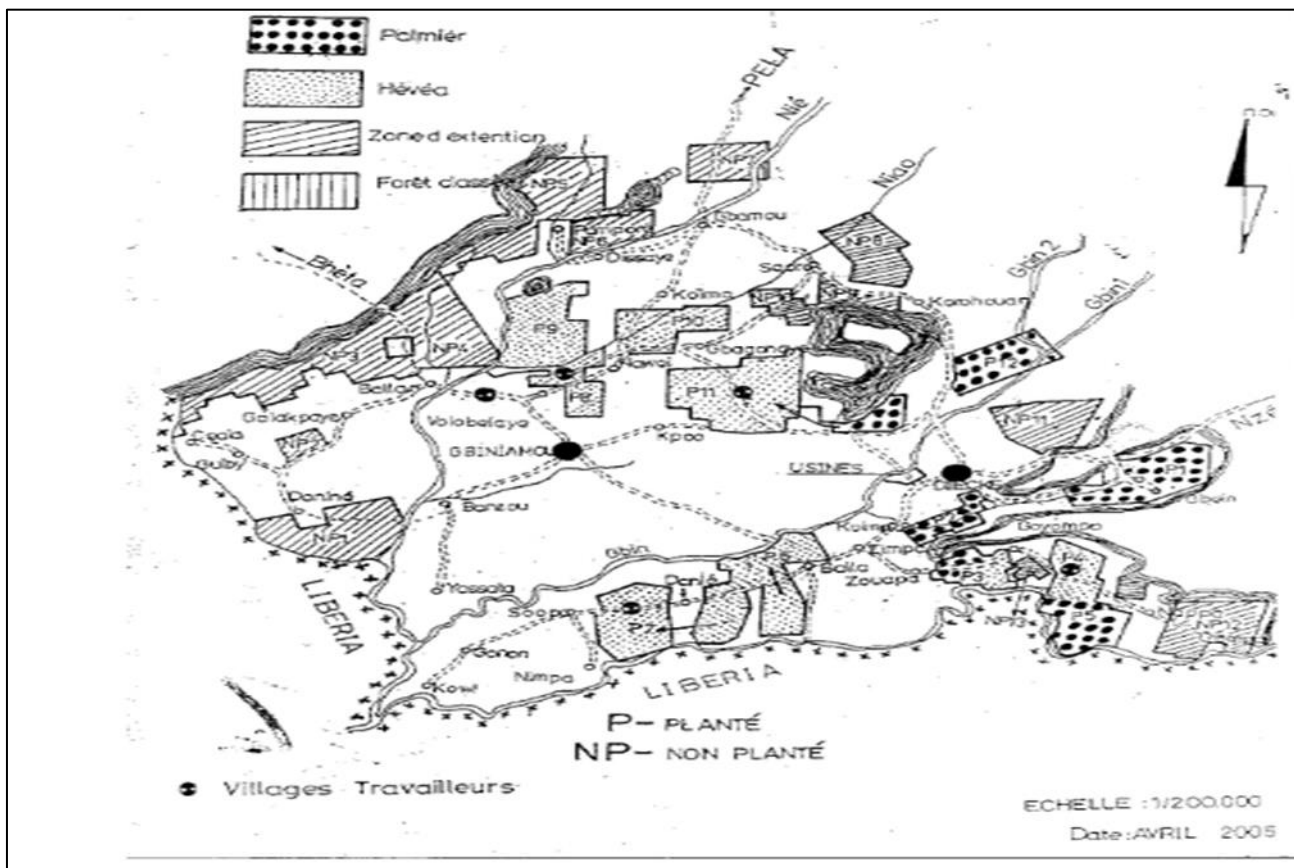


**Figure 5** Location of the SOGUIPAH project in Guinea: source, SOGUIPAH's activities in the Guinean forest region [14].

According to technicians at the industrial plantations (IPs), some of these varieties are being trialled—such as RRIM 805 and IRCA 317—to assess their actual rubber content (ARC), whilst others are being tested in the field, depending on their intended production purpose. There are numerous areas of Hevea plantations in the village of Kpôo, whilst those located in the village of Nawè are, in some places, being tested in the JBG (grafting nursery) or tree nursery, which is based at the central nursery in the district of Bignamou (see Fig. 6).

- There is a map of the plantations, which are estimated to cover approximately 12,000 ha of rubber plantations in the SOGUIPAH area and 20,000 ha not yet under cultivation.

- According to current statistics, there are 2,425 rubber and palm tree growers in the Gbeinson area and 811 growers in the Niékoé area. There are 3,678.98 hectares of plantation land in Gbeinson and 1,286.57 hectares in Niékoré, representing 4.95%. In terms of rubber cultivation specifically:
  - 3,678.75 hectares of private or unaffiliated plantations
  - 1,201 hectares of family or affiliated plantations
  - 2,592.75 hectares of industrial plantations



**Figure 6** SOGUIPAH concession and plantations, layout plan, April 2005 (source: SOGUIPAH)

**Table 1** List of collected clones

N°	Sample name	Sample collection site	N°	Sample name	Sample collection site
	Clone			Clone	
1	PB235	KH11	6	IRCA119	KH12
2	PB260	KH14	7	PB254	KH12
3	GT1	KH13	8	RIM 712	KH36
4	AVROS2037	KH30	9	RRIC 100	KH37
5	BPM24	KH12	10	IRCA109	KH12

Table 1 shows that a total of 10 clones were collected from 10 different sites. Of these 10 clones, 2 show similarities. These include: IRCA109 and IRCA119.

#### 2.1.4. Working Method

#### 2.1.5. Collection of rubber tree seeds

The collection activities began by making contact with the authorities responsible for industrial plantations. To ensure administrative coverage and benefit from scientific and technical support, we contacted the authorities responsible for managing industrial plantations in the SOGUIPAH area (Kpoo area). These meetings enabled us not only to obtain information on the number of clones in the area and the locations of the various rubber tree species.

A guide was provided to assist us in selecting the clones. Over the course of a day, we collected samples from 10 industrial plantations. The actual collection began at 13:13 and ended at 17:07. The aim was to collect 1 kg of seeds per clone from each plantation, and to name and classify them according to the collection area. The clones collected in this way were labelled and placed in empty onion sacks, chosen for their mesh to help keep them cool.

#### 2.1.6. Methods for analysing rubber tree seeds

The collected and processed clones were analysed at the ENVAL laboratory in Ivory Coast.

##### Fat content determination ISO 734: 2015

A test sample of the product is extracted in a suitable apparatus using technical hexane or, failing that, petroleum ether. The extraction solvent is removed and the resulting extract is weighed. Weigh, to the nearest 0.001 g, approximately 10 g of the test sample. Transfer the test sample into the extraction cartridge and seal it with filter paper, wrapping the test sample in this paper. Weigh, to the nearest 1 mg, the flask of the extraction apparatus containing one or two grains of pumice stone. Place the cartridge containing the test sample into the extraction apparatus. Pour the required quantity of solvent into the flask. Fit the flask to the extraction apparatus on the electric heating bath. Adjust the heating so that the reflux rate is at least three drops per second (moderate, non-boiling). After extraction for 4 hours, allow to cool. Remove the cartridge from the extraction apparatus and place it in a draught to remove most of the residual solvent. Empty the cartridge into the micro-mill and grind as finely as possible. Return the mixture to the cartridge and place it in the extraction apparatus.

Extract again for 2 hours, using the same flask containing the first extract. The solution obtained in the extraction flask must be clear. Remove the solvent and weigh the extract.

Remove the last traces of solvent by heating the flask for approximately 20 minutes in an electric oven set to 103 °C.

Heat for a second time for approximately 10 minutes under the same conditions. Allow to cool and weigh. The difference between the two weighings must not exceed 10 mg. If this is not the case, repeat the heating for approximately 10 minutes, cool and weigh, until the difference between two successive weighings is no more than 10 mg. Record the final mass of the flask.

##### Determination of moisture and volatile matter content ISO 665:2020

The water and volatile matter content of a test sample is determined either on the material received (pure seed and impurities) or, if necessary, on the pure seed alone, by drying at 103 °C ± 2 °C in an oven at atmospheric pressure until a practically constant mass is reached.

Place the container holding the test sample, without its lid, in the oven set at 103 °C ± 2 °C. Close the oven. After 3 hours, counting from the moment the temperature returns to 103 °C, open the oven. Immediately close the container by replacing its lid and place it in the desiccator. As soon as the container has cooled to laboratory temperature, weigh it to the nearest 0.001 g. Return the container, without its lid, to the oven. After 1 hour, repeat the process of closing the container, allowing it to cool and weighing it. If the difference between the two weighings is less than or equal to 0.005 g (for a test sample of 5 g), consider the determination complete. Otherwise, subject the test sample to successive 1-hour periods in the oven until the difference between two successive weighings is less than or equal to 0.005g.

Carry out two determinations on the same test sample.

##### Determination of total ash – ISO 1125:2015

Weigh 5 g of the sample to the nearest 1 mg in a pre-calcined and tared combustion crucible. Place the crucible on the hotplate and heat gradually until the material is carbonised.

Place the crucible in a muffle furnace set at  $525 \pm 25$  °C. Continue the incineration until a grey, spongy ash is obtained. If, despite the precautions taken, carbonization remains incomplete, moisten the ash with a hydrogen peroxide solution and return to the furnace as before.

Remove the crucible from the furnace, allow it to cool in a desiccator and weigh it quickly to the nearest 0.5 mg. Return the crucible to the furnace for one hour and repeat the procedures described above until two successive weighings yield results differing by no more than 2 mg.

#### Determination of proteins ISO 5983-1: 2005

Organic nitrogen-containing compounds (proteins and nucleic acids in certain matrices) are decomposed by heating in the presence of sulphuric acid and a catalyst. This catalyst contains potassium sulphate ( $K_2SO_4$ ), which raises the boiling point of the sulphuric acid, and copper sulphate ( $CuSO_4$ ), which acts as a reaction catalyst. The nitrogen yields ammonium sulphate in quantitative terms: this is the mineralisation stage.

The ammonia is then displaced from its salt by sodium hydroxide, distilled by steam distillation and collected in a known quantity of boric acid. This is the distillation stage. The quantity of nitrogen thus collected is titrated with hydrochloric acid. This is the titration stage.

#### Titration of total cyanides

The determination of cyanides is carried out in two stages. The first stage involves distilling the sample to eliminate interferences and break down most of the cyanide complexes. Use an undried sample portion. The percentage of water must be determined on another portion of the sample. – Pour 70 ml of 0.05 M NaOH into the bubbler.

Weigh 0.50 g of sample and add 100 ml of water and 0.5 ml of 1 M NaOH. Leave to shake overnight on a mechanical shaker at approximately 120 oscillations per minute. Decant into the flask and add water to bring the volume in the flask to 200 ml. Carry out the distillation and transfer the contents of the bubbler to a 100 ml graduated cylinder and make up to 99 ml with the 0.05 M NaOH solution.

Transfer to a plastic bottle and add 1 ml of the 10 % (w/v)  $CdCl_2$  solution and shake. If the solution turns yellow, add the 10 % (w/v)  $CdCl_2$  solution millilitre by millilitre to precipitate the sulphides. Do not add more than 10 ml of the cadmium chloride solution. Note the final volume if more than 1 ml of the  $CdCl_2$  solution has been added. – Allow the distillation system to cool, rinse the condenser and wash the rest of the distillation system.

In the second step, the extracted cyanides are determined using specific cyanide electrodes in accordance with the manufacturer's specifications.

#### Total carbohydrates

Carbohydrates are calculated as follows:  $100 - (\text{Water} + \text{Protein} + \text{Fat} + \text{Ash} + \text{Fibre} + \text{Alcohol})$

#### Energy value

This is calculated as follows:  $= \text{Protein} \times 4 + \text{Carbohydrates} \times 4 + \text{Fat} \times 9 + \text{Alcohol} \times 7$  (kcal) Data processing.

## 2.2. Data processing

Microsoft Excel was used to process the collected data. It was used to enter the collected data, perform calculations and create histograms, diagrams and tables. The analyses focused mainly on the methods used to determine the various proportions (%) of the physico-chemical parameters of rubber tree seeds, namely the levels of total cyanides, moisture and volatile matter, protein, energy value, total carbohydrates, ash and total fat in ten (10) varieties of rubber tree seeds.

### 3. Results and discussion

#### 3.1. Samples collected from industrial plantations in Kpoo

10 clones were collected from 10 different sites.

**Table 2** Code and storage conditions of the collected seeds

N°	Customer code	Nature	Storage conditions	Temperature (°C)
1	ECH: PB 235/ SITE KH11	HEVEA SEED	Ambient air 25	25
2	ECH: PB 260/SITE: KH14	HEVEA SEED	Ambient air 25	25
3	ECH: GT1/SITE : KH13	HEVEA SEED	Ambient air 25	25
4	ECH: AVRO 5 2037/SITE: KH30	HEVEA SEED	Ambient air 25	25
5	ECH: BPM 24/ SITE: KH 12	HEVEA SEED	Ambient air 25	25
6	ECH: IRCA 119/ SITE: KH 12	HEVEA SEED	Ambient air 25	25
7	ECH: PB 254/ SITE: KH12	HEVEA SEED	Ambient air 25	25
8	ECH: RIM 712/ SITE: KH 36	HEVEA SEED	Ambient air 25	25
9	ECH: RRIC 100/ SITE: KH 37	HEVEA SEED	Ambient air 25	25
10	ECH: IRCA 109/ SITE: KH12	HEVEA SEED	Ambient air 25	25

Table 2 shows that 10 rubber tree seed clones were collected and packaged at a temperature of 25°C.

#### 3.2. Results of sample analyses

The analyses carried out involved determining the levels of total cyanides, protein, energy content, total carbohydrates, ash, total fat, moisture and volatile matter in the samples.

**Table 3** Results of sample analyses ECH: PB 235/SITE KH11 and ECH: PB 260/SITE: KH14

N°	PARAMETRES	DATE OF EXECUTION	METHOD	UNIT	REFERENCES, SAMPLES AND RESULTS	
					ECH: PB 235/ SITE KH11	ECH: PB 260/SITE: KH14
1	Total cyanides*	26/09/2022	NF T 90-107:2002	mgCN/kg	1,823	1,323
2	Moisture and volatile matter	27/09/2022	ISO 665:2020	%	30,03	32,01
3	Protein*	27/09/2022	ISO 5983-1: 2005	%	9,2	7,8
4	Energy value*	28/09/2022	Internal method (calculation)	Kcal/100g	355,76	327,71
5	Total carbohydrates*	28/09/2022	Internal method (calculation)	%	43,11	46,97
6	Ash*	27/09/2022	ISO 1125: 2015	%	1,38	1,15
7	Total fat *	28/09/2022	ISO 734:2015 (Cotton seed)	%	16,28	12,07

The results of the analyses in Table 3 show a high cyanide concentration of 1.823 mg CN/kg in sample PB 235/SITE KH11, compared with 1.323 mg CN/kg in sample ECH: PB 260/SITE: KH14.

**Table 4** Results of the sample analyses ECH: GT1/SITE: KH13 and ECH: AVRO 5 2037/SITE: KH30

N°	PARAMETRES	DATE OF EXECUTION	METHOD	UNIT	REFERENCES, SAMPLES AND RESULTS	
					ECH: GT1/SITE: KH13	ECH: AVRO 5 2037/SITE: KH30
1	Total cyanides*	26/09/2022	NF T 90-107:2002	mgCN/kg	1,232	0,517
2	Moisture and volatile matter	27/09/2022	ISO 665:2020	%	28,44	27,55
3	Protein*	27/09/2022	ISO 5983-1: 2005	%	8,4	8,1
4	Energy value*	28/09/2022	Internal method (calculation)	Kcal/100g	369,65	369,02
5	Total carbohydrates*	28/09/2022	Internal method (calculation)	%	44,66	46,22
6	Ash*	27/09/2022	ISO 1125: 2015	%	1,01	1,27
7	Total fat *	28/09/2022	ISO 734:2015 (Cotton seed)	%	17,49	16,86

In Table 4, the analysis of sample ECH: AVRO 5 2037/SITE: KH30 shows a very low cyanide concentration of 0.517 mg CN/kg.

However, in sample ECH: PB 260/SITE: KH14, a cyanide level of 1.232 mg CN/kg was found. However, the results of the analysis of the other parameters reveal approximately the same values for both samples (Moisture and volatile matter, Protein\*, Energy value\*, Total carbohydrates\*, Ash\* and Total fat\*).

**Table 5** Results of the sample analyses ECH: BPM 24/ SITE: KH 12 and ECH: IRCA 119/ SITE: KH 12

N°	PARAMETRES	DATE OF EXECUTION	METHOD	UNIT	REFERENCES, SAMPLES AND RESULTS	
					ECH: BPM 24/ SITE: KH 12	ECH: IRCA 119/ SITE: KH 12
1	Total cyanides*	26/09/2022	NF T 90-107:2002	mgCN/kg	0,808	2,213
2	Moisture and volatile matter	27/09/2022	ISO 665:2020	%	29,46	34,52
3	Protein*	27/09/2022	ISO 5983-1: 2005	%	8,3	9,4
4	Energy value*	28/09/2022	Internal method (calculation)	Kcal/100g	353,28	315,84
5	Total carbohydrates*	28/09/2022	Internal method (calculation)	%	45,64	43,1

6	Ash*	27/09/2022	ISO 1125: 2015	%	1,32	1,22
7	Total fat *	28/09/2022	ISO 734:2015 (Cotton seed)	%	15,28	11,76

The results of the analyses in Table 5 show a high cyanide concentration of 2.213 mg CN/kg in sample PB 235/SITE KH11, compared with 0.808 mg CN/kg in sample ECH: BPM 24/SITE: KH 12

**Table 6** Results of sample analyses ECH: PB 254/ SITE: KH12 and ECH: RIM 712/ SITE: KH 36

N°	PARAMETRES	DATE OF EXECUTION	METHOD	UNIT	REFERENCES, SAMPLES AND RESULTS	
					ECH: PB 254/ SITE: KH12	ECH: RIM 712/ SITE: KH 36
1	Total cyanides*	26/09/2022	NF T 90-107:2002	mgCN/kg	0,770	2,447
2	Moisture and volatile matter	27/09/2022	ISO 665:2020	%	22,28	31,77
3	Protein*	27/09/2022	ISO 5983-1: 2005	%	9,9	7,7
4	Energy value*	28/09/2022	Internal method (calculation)	Kcal/100g	390,52	344,21
5	Total carbohydrates*	28/09/2022	Internal method (calculation)	%	49,48	44,13
6	Ash*	27/09/2022	ISO 1125: 2015	%	1,34	1,19
7	Total fat *	28/09/2022	ISO 734:2015 (Cotton seed)	%	17,00	15,21

In Table 6, analysis of sample ECH: PB 254/ SITE: KH12 reveals a very low cyanide concentration of 0.770 mg CN/kg. In contrast, a cyanide concentration of 2.447 mg CN/kg was found in sample ECH: RIM 712/ SITE: KH 36

**Table 7** Results of sample analyses ECH: RRIC 100/ SITE: KH 37 and ECH: IRCA 109/ SITE: KH12

N°	PARAMETRES	DATE OF EXECUTION	METHOD	UNIT	REFERENCES, SAMPLES AND RESULTS	
					ECH: RRIC 100/ SITE: KH 37	ECH: IRCA 109/ SITE: KH12
1	Total cyanides*	26/09/2022	NF T 90-107:2002	mgCN/kg	5,043	1,570
2	Moisture and volatile matter	27/09/2022	ISO 665:2020	%	43,50	25,45
3	Protein*	27/09/2022	ISO 5983-1: 2005	%	7,0	8,4

4	Energy value*	28/09/2022	Internal method (calculation)	Kcal/100g	270,07	368,69
5	Total carbohydrates*	28/09/2022	Internal method (calculation)	%	38,4	49,91
6	Ash*	27/09/2022	ISO 1125: 2015	%	1,27	1,19
7	Total fat *	28/09/2022	ISO 734:2015 (Cotton seed)	%	9,83	15,05

In Table 7, the results of the analysis of samples ECH: RRIC 100/ SITE: KH 37 and ECH: IRCA 109/ SITE: KH12 show cyanide concentrations of 5.043 mg CN/kg (high) and 1.570 mg CN/kg (lower), respectively.

### 3.3. Summary of the table analysis

An analysis of Tables 3, 4, 5, 6 and 7 shows that the sample ECH: AVRO 5 2037/SITE: KH30 contains the lowest level of cyanide at 0.517 mg CN/kg, followed by the samples ECH: PB 254/SITE: KH12 at 0.770 mg CN/kg and ECH: BPM 24/ SITE: KH 12 at 0.808 mg CN/kg. The sample ECH: RRIC 100/ SITE: KH 37 contains the highest cyanide concentration at 5.043 mg CN/kg.

#### 4. Conclusion

The work carried out as part of the analysis of rubber tree seeds involved determining the levels of total cyanides, protein, energy value, total carbohydrates, ash, total fat, moisture and volatile matter in the samples. The samples analysed were collected from industrial plantations in Kpoo. A total of 10 clones were collected from 10 different sites. Of the 10 clones, 2 show similarities. These include: IRCA109 and IRCA119. 1 kg of seeds per clone was collected, named and classified according to the collection area. The collected and packaged clones were analysed at the ENVAL laboratory in Ivory Coast. The analyses carried out involved determining the levels of total cyanides, protein, energy value, total carbohydrates, ash, total fat, moisture and volatile matter in the samples.

The results of the sample analyses revealed that ECH: AVRO 5 2037/SITE: KH30 contains less than 0.517 mg CN/kg of cyanide, followed by samples ECH: PB 254/SITE: KH12 at 0.770 mg CN/kg and ECH: BPM 24/SITE: KH 12 at 0.808 mg CN/kg. The sample ECH: RRIC 100/SITE: KH 37 contains the highest cyanide content at 5.043 mg CN/kg.

The next stage of this work should focus on the detoxification of rubber seed kernel cake. This is because the detoxified rubber seed kernel cake could be incorporated into the diet without any adverse effect on the growth of grasscutter at IRVAG.

However, further studies are needed to improve the nutritional quality of the seeds, to determine the optimal rates of incorporation according to the physiological stages of the grasscutter, and to assess the socio-economic impact of the adoption of these technological innovations by grasscutter farmers. Nevertheless, given the abundance of these raw materials and their relatively affordable prices in Guinea, the use of these oilseed cakes in grasscutter feed should lead to a reduction in the country's dependence on imported supplementary feed and a decrease in feed costs within the production cost of an grasscutter.

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#### Compliance with ethical standards

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##### *Declaration of Conflicts of Interest*

The authors declare that they have no conflicts of interest related to the publication of this article.

##### *Author's Contribution*

The first author collected, processed, and wrote this article. The other authors read and edited the manuscript. All authors have read and approved the final version of the manuscript.

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#### References

- [1] D. RÉMOND, Major challenges and solutions for livestock farming, Special Issue, 32 (2) (2019) 147–158, <https://productions-animales.org/issue/view/284> (29 August 2023)
- [2] D. BOURZAT, D. ROUILLE, V. BRIOUDES, Analysis report on PVS Guinea discrepancies, World Organisation for Animal Health (OIE). 12 rue de Prony F-75017 Paris, France, (17–25 September 2012) 6p.
- [3] S. B AYSSIWEDE, A. DIENG, M. R. B. HOUINATO, C. A. A. M. CHRYSOSTOME, J. L. HORNICK and A. MISSOHOU, Traditional or indigenous chicken farming in Senegal and sub-Saharan Africa: current situation and constraints, *Ann. med. vet.*, 157 (2013) 103–119
- [4] MK. ETTIAN, SCB. POMALEGNI, GA. ABOH and GA MENSAH, Correlation between age, weight gain and linear morphometric measurements in grasscutters fattened with dietary supple
- [5] MK. ETTIAN, the effect of three levels of dietary supplements on weight gain, linear growth and reproductive performance in grasscutters (*Thryonomys swinderianus*, Temminck, 1827) reared in a natural environment in the Grand-Lahou Department of Ivory Coast. PhD thesis, Nangui Abrogoua University, (2016) 220 pp.
- [6] MK. ETTIAN, S. BABATOUNDE, K. FOUA-BI, GA MENSAH and A FANTODJI, Effect of diet on reproductive parameters in grasscutters (*Thryonomys swinderianus*) reared in captivity in the Grand-Lahou Department of

Ivory Coast. Bulletin of Agronomic Research of Benin, 68 (2010) 1–11. ISSN: 1025–2355, Website: <http://www.slire.net>

- [7] Fantodji, A. and Mensah, G.A. 2000. Role and economic impact of intensive game farming in Benin and Ivory Coast. In: Proceedings of the International Seminar on Intensive Game Farming for Food in Africa. Libreville (Gabon), 23–24 May 2000. DGEG/VSF/ADIE/CARPE/EU Project. pp. 25–42
- [8] Ettian Mian Kouadio, Faculty of Science and Nature (SN), University of Abobo-Adjamé (UAA), 08 BP 109 Abidjan 08. Ivory Coast. Mobile: (225) 02 731 174. Email: [mk\\_ettian@yahoo.fr](mailto:mk_ettian@yahoo.fr)
- [9] K. G. M. BOUAFU, A. K. BROU, K. G. KOUAME, S. KATI-COULIBALLY, Banana products and by-products in animal feed. Int. J. Biol. Chem. Sci., 6 (4) (2012) 1810–1818
- [10] ERCKD. MENSAH, OBA ROMEILIA MARLENE, D-G. MENSAH, SCB. POMALEGNI, GA MENSAH, E. AKPO PASTEUR JUST and A. IBRAHIMY, Sustainability and financing of grasscutter (*Thryonomys swinderianus*) farms in Benin. International Journal of Biology and Chemical Sciences, 5 (5) (2011) 1842–1859. Website: <http://ajol.info/index.php/ijbcs>
- [11] Compagnon P., (1986). Natural rubber: Biology, Cultivation and Production. Ed. G.P.Maisonneuve & Larose, Paris, 595 pp.
- [12] Atsin G.J.O., Soumahin E.F., Mahyao A., Okoma K.M., Kouakou T.H. AND Obouayeba S., 2017. Incidence of latex harvesting technologies on agronomic and physiological parameters and profitability of some rapid metabolic class clones of rubber tree (*Hevea brasiliensis*) in southwestern Ivory Coast. Int. J. Biol. Chem. Sci. 11(5): 2209–2224.[13] - Hallé, F and Martin, R. (1968) Study of rhythmic growth in the rubber tree (*Hevea brasiliensis* Mull. Arg.). Adansonia, Series 2, 8, 475-503.
- [13] Abd Karim, Y., Modelling the rubber tree system. <https://doi.org/10.25560/49915> Ahoba, A., 1985. Study of the quality of rubberwood in relation to wind breakage for the research and definition of early selection criteria. Master's thesis in Wood Science, Mechanics option, defended in Nancy on September 9. 2017
- [14] Bidou Jean-Étienne. Slash-and-burn farming, industrial crops and the environment: the work of SOGUIPAH in the forested regions of Guinea. In: Environmental management practices in tropical countries. 6th Conference on Tropical Geography organised by the National Geography Committee. 'Tropical Areas and their Development' Commission. Talence, 6–8 September 1995. Bordeaux: University Press of Bordeaux, 1997. pp. 161–173. (Tropical spaces, 15) [www.persee.fr/doc/etrop\\_1147-3991\\_1997\\_act\\_15\\_6\\_976](http://www.persee.fr/doc/etrop_1147-3991_1997_act_15_6_976)