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Research Article

Study of the effect of intercropping on the physicochemical characteristics of castor bean, soybean, cowpea and common bean seeds after cultured in two agroecological zones of Cameroon

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Abstract

In order to promote the culture of castor bean, soybean, cowpea and d u bean in Cameroon while preserving food safety, the effect of the combination of the crop characteristics physicochemical seeds of this plant are studied in Laboratory after the cultivation of castor in combination with these three field grain legumes in Sudano-Guinean zone of Adamaoua and in the Eastern Bimodal Forest at Cameroon in 2015 and 2016. The physical characteristics such as length, width, thickness, seed mass and weight of one thousand seeds and chemical properties are the s of castor seeds (the moisture content, the content of castor bean, the mass density, the consumer acid, iodine, and saponification of esters) and Leguminous (the protein content, the sugar content and the ash content) are evaluated. The results show that the physico-chemical properties of castor seeds and legumes do not vary, regardless of the study zone, thus showing that these seeds can be grown in different zones without losing their characteristics. Castor bean contents of the grain is varied from 45.27 ± 1.04 to 47.84 ± 1.02 g / 100g DM; the iodine value of 67.12 ± 1.12 to 71.12 ± 1.21 gI_2 / 100g; saponification number of 171.45 ± 1.23 to 172.97 ± 0.97 mg KOH / g; the acid number of 2.9±0.0 1 to 3.7±0.01 mg KOH/g and the index of ester 168.22±1.33 to 169.27±1.19 mg KOH/g. In Legumes studied the Protein content ranged from 11.13 ± 1.1g /100g DM in common bean to 32.39 ± 0.7 g / 100g DM in soybean, the sugar content of 31.74 ± 0.9 g /100g DM in common bean at 65.44±1.1g /100g DM in cowpea and ash content ranged from 1.53±0.7 in common bean to 4.23±0.2 in soybean.

Keywords: Castor bean, soybean, cowpea, cropping system, physico-chemical properties, Sudano-Guinean zone, Sudano-Sahelian zone, Cameroon.

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1. Introduction

The world is in the midst of an energy disruption whose main cause is the population explosion, creating a strong anthropic pressure on natural resources. The development of industries using fossil fuels promotes the emission of greenhouse gases, which are at the root of global warming and the destruction of the ozone layer [1,2]. Global industrial powers are actively seeking to limit emissions of these greenhouse gases and reduce energy dependence on increasingly expensive petroleum [3,4]. The use of plant species to produce fuels is being considered to address soaring petroleum prices and fossil-fuel dependence. However, good agricultural production must first be food to keep the prices of food products accessible to all and avoid the hunger riots that Cameroon and Haiti have experienced in 2008 [5]. In this respect, it is therefore imperative to find a means of producing biofuels without reducing agricultural production intended for food [6,7]. The study should focus mainly on inedible plants capable of producing biofuels [8]. Food security remains a priority especially as the population of our planet could double in the year 2050 [7,9].

Castor bean (oleaginous plants with biofuel potential), appears as an alternative likely to solve these energy problems, because its cultivation can be done in intercropping with food crops [13]. In this respect, the cultivation of castor bean in combination with three legumes (soybean, cowpea and bean) which are among the major legumes grown in the Sudano-Guinean region of Adamaoua-Cameroon and the Bimodal Forest of East Cameroon in because of their high protein content would help popularize castor farming. The intercropping cropping is the cultivation of two or more plants simultaneously on the same plot [10]. This culture system is used by farmers to increase the diversity of their products and the stability of their annual production through the efficient use of land and other resources (light, fertilizer) [11]. However, a better knowledge of food and their physico-chemical properties helps to ensure the food and cultural security of populations. Indeed, the spontaneous food plants and industrial they find themselves increasingly on markets and in the daily diet of families; this reflects the interest that people and industries are brought to these plants. The evaluation and monitoring of nutrient inputs and properties of plants from food and biofuel plants is very important for their farms [12]. The general objective of this work is to study the influence of cultural intercropping on the physicochemical characteristics of castor bean seeds, soybean, cowpea and common bean.

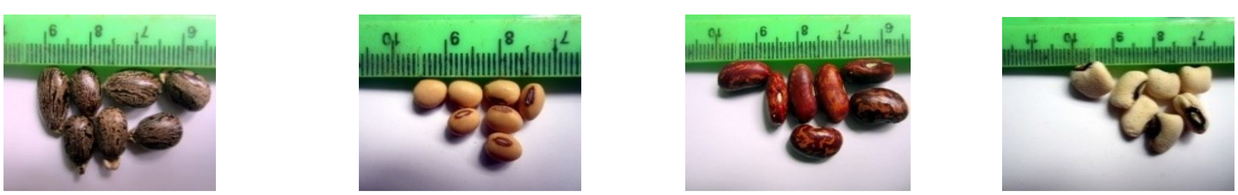
2. Materials and methods

2.1. Description of the experimental sites

The field study took place in the years 2015 and 2016 in two agroecological zones of Cameroon: the Sudano-Guinean zone of the region of Adamaoua-Cameroon and the zone of the Bimodal Forest of East Cameroon. In the Sudano-Guinean zone, the study was conducted in the locality of Bini-Dang in the experimental farm of the Biodiversity Laboratory and Development of arable University of Ngaoundere Cameroon, located at 7 ° 24 '671' latitude Nord, 13 ° 34 ' 238' " longitude Est and an altitude 1155.8 m. The Sudano-Guinean climate is characterized by two seasons of the same length the rainy season that lasts mid-March to mid-September and the dry season from mid-September to mid-March. Rainfall is unimodal, with an average between 1500 mm. The temperature varies on average between 22 ° and 24 ° C. In the Forest Bimodal, the study was conducted in the village of Birpondo if killed 4 ° 60'9 " of latitude N ord, 13 ° 3 ' 4' 'of longitude Est to 668 m altitude. The climate of this zone is of the classical Guinean equatorial type with four seasons, including two dry seasons and two rainy seasons which are distributed as follows: a big rainy season from September to November; a small dry season from July to mid-August; big rainy season from August to November; a great dry season of November of Mars; a small rainy season from April to June. The Bimodal Forest zone is characterized by low temperatures from 23 to 25 °C average per year and regular rainfall, on average 1500 to 2000 mm of rainfall per year.

2.2. Biological material

The accession Ndoutourou castor is used for this study. This accession of castor is used because of its high yield of seeds [14]. Its seeds are brown with black lines [15]. Summers will laugh Goinia denied soybean, Lori cowpea and GLP 190 of the common bean are used for this work (Figure 10). These varieties have a short life cycle and high yield seeds [16]. Common bean seeds are purchased from an agricultural inputs store located in the local Ngaoundéré market, while castor seeds, cowpea seeds and soybean are supplied by IRAD's research centre in Garoua. It should be noted that the use of short-cycle food crops has an advantage for the farmer in that the farmer can have several harvests a year if he practices a means of culture in the off -season.The analysis of soilsshown that there is difference between the both soils from Bini-Dang and Birpondo localities on studied parameters. Soil from Bipondois more acid (pH = 3.7) and richer in phosphorus (0.67 mg/100g of MD) than that from Bini-Dang. Soil from Adamawa Cameroon is richer in nitrogen (1.68 mg/100g of MD) than that from East Cameroon region.[41]



Castor bean seeds (Ndoutourou accession) | Soybean seeds variety (Goiania) | Common bean seeds variety (GLP 190) | Cowpea seeds variety (Lori)

Figure 1 : Plant seeds studied

2.3. Physical properties of seeds

Physical characteristics such as the length, width, thickness, seed mass and the weight of seeds miles are evaluated.

2.4. Weight of thousand grain century

It is one of the components of agronomic performance and seeds. The weight of a thousand grains makes it possible to determine the average weight of grains by weighing a thousand seeds. This is the weight of 1000 whole grains in grams [17].

2.5. Chemical properties of castor seeds

Analyses of physicochemical properties are carried out in the Food Chemistry Laboratory of the National School of Agro-Industrial Sciences (ENSAI) at the University of Ngaoundere.

2.5.1. Water contents of castor seeds

AFNOR [18] method is used to determine the water content of castor seeds. The water content is the mass loss after complete desiccation.

2.5.2. Extraction of oil from castor bean seeds

To extract the oil, the seeds of the different accessions are reduced to pulp by grinding with a Moulinex. The extraction method used is that described by the International Union of Pure and Applied Chemistry[20].

2.5.3. Evaluation of the mass density

The specific gravity D, expressed in g/ml, is defined as the mass of castor bean occupying a given volume. Indeed, using a densitometer a volume of 2.25 ml is measured by introducing water. We will weigh 2.10g bean by filling the densitometer. The mass density is determined by the following ratio:

$$D = m / v \ (g / ml)$$

D: mass density of fat (g / ml);
m: mass of fat (g); **v**: volume (ml).

2.5.4. Acid index (I_A)

The acid index of a fat is the number of milligrams of potassium hydroxide needed to neutralize the free fatty acids present in 1g of material [20]. The determination of the index is made according to the method using a coloured indicator Phenolphthalein of the International Union of Pure and Applied Chemistry [20].

2.5.5. Iodine index (I_i)

The iodine number is the number of grams of iodine set per 100g of lipids. It measures the degree of introduction of a bean. The iodine value is determined by the Wijs method of reagent [20].

The iodine index is calculated by the relation:

$$Ii = 12.69 \times T \ (Vo - V1) / m$$

Vo: volume of 0.1 thiosulphate solution N used for the blank test;
V_1: volume of the thiosulphate solution used for the sample;
T: the exact title of thiosulphate solution;
m: mass in g of the test sample.

2.5.6. Saponification index (I_S)

The saponification number is the number of milligrams of KOH needed to saponify 1g of fat [20]. It gives an idea about the molecular weight of the fatty acids in the bean. The saponification number is determined according to the method using a coloured indicator: phenolphthalein [20]. The formula for measuring the saponification index is as follows:

$$I_S = N \times 56.1 \ (Vo - V_1) / m$$

With 56.1: molecular weight of KOH; **N**: normality of the HCl solution, **m**: mass in g of the test sample, **Vo**: volume of HCl used for the blank test, **V_1**: volume of HCl used for the test sample.

Ester Index: (I_E)

The ester number is the mass of potash, expressed in milligrams (mg), necessary to saponify the esters contained in one gram (1g) fat. It was determined by the difference between the saponification number [I_S] and the acid number [I_A] and is as follows:

$$I_E = I_S - I_A$$

2.5.7 Determination of total nitrogen and crude protein contents

Total nitrogen is determined after mineralization of the samples according to Kjeldahl's method; [19], and assay according to the colorimetric technique of Devani *et al* [21].

The analysis of crude protein in foodstuffs is to measure the total nitrogen according to Kjeldahl and multiplying the nitrogen content by a conventional factor (Ntot x 6.25) metering the nitrogen content in the foodstuff according to Kjeldahl.

2.5.8 Determination of sugar content

The spectrophotometer assay of sugars and their derivatives are made by the method of Dubois *et al* [22].

2.5.9 Determination of total ash content

Total ash is quantified by the method described in AFNOR [18].

2.5.10 Methods of statistical analysis of the results

The results are statistically analysed using the Statgraphic plus version program 5.0 who performs the analysis of variance. Duncan's test was used to assess the difference between the average salary and the correlation test is used to study the relationship between various parameters.

3. Results and discussion

3.1. Physicochemical characteristics of seeds

3.1.1. Physical characteristics of castor seeds

Table 1 shows the physical characteristics of castor bean. It appears that the cropping systems, the study zone and the year of experiment did not significantly influence ($p > 0.05$) the weight, length, width and thickness of the castor.

In this study the weight of castor seeds varies from 0, 54±0.01 at 0.55± 0.02g; the length of 0.54±0.01 at 0.55±0.02cm ; the width from 0.63±0.02 to 0.64 ± 0.02 cm; thickness 0.30± 0.02 to 0.32±0.03 cm and the weight of a thousand seeds 524.21±0.01 to 525.1±0.01g.

The Sudano-Guinean Zone of Adamaoua Cameroon and the year 2015 records the highest values on these parameters. The lowest values are obtained in the East Cameroon Bimodal Forest Zone and in 2016. From these results we can say that there is a correlation between the weight length and width of the castor.

The results of the physical properties of the seeds of castor bean (length, width, thickness and weight) are generally similar in both ecological zones, but little wind varied according to the year of testing. Castor would be stable in both zones. This is a positive observation for castor improving the physical characteristics of seeds through selection in that there will be no need to develop specific genotype for a given environment. These results obtained the physical characteristics of castor bean are consistent with the work of Tchuenteu *et al* [14], who reports that the physical characteristics of castor bean do not vary by study zone.

Table 1: Physical characteristics of castor bean based on cropping systems

Settings	AEZ	C	C/S	C/Cw	C/Cm
Length (cm)	ZFB	1.2±0.01[a]	1.21±0.01[a]	1.22±0.01[a]	1.23±0.02[a]
	ZSG	1.2 ±0.03[a]	1.21±0.02[a]	1.22±0.01[a]	1.23±0.01[a]
Width (cm)	ZFB	0.63±0.02[a]	0.63±0.03[a]	0.63±0.02[a]	0.64±0.01[a]
	ZSG	0.63±0.02[a]	0.63±0.02[a]	0.63±0.01[a]	0.64±0.02[a]
Thickness (cm)	ZFB	0.30±0.01[a]	0.31±0.01[a]	0.31± 0.03[a]	0.32±0.01[a]
	ZSG	0.30±0.02[a]	0.31±0.02[a]	0.31±0.03[a]	0.31±0.03[a]
Weight of the seed (g)	ZFB	0.54±0.01[a]	0.54±0.03[a]	0.54±0.02[a]	0.54±0.04[a]
	ZSG	0.54±0.01[a]	0.54 ± 0.01[a]	0.54±0.01[a]	0.55±0.02[a]
PDMG (g)	ZFB	525.1±0.02[a]	525.1 ± 0.02[a]	525.1±0.02[a]	525.1±0.01[a]
	ZSG	524.2±0.01[a]	524.2 ± 0.01[a]	524.2±0.01[a]	524.2± 0.01[a]

C: monocrop castor bean; **C/S:** intercropping castor bean-soybean; **C/Cw:** intercropping castor bean-cowpea; **C/Cm:** intercropping castor bean-common bean; **ZSG:** Sudano-Guinean Zone; **ZFB:** Bimodal Forest Zone; **AEZ:** Agroecologique zone. Values of bands followed by the same letter are not significantly different

3.1.2. Physical characteristics of soybean, cowpea and common bean seeds

Table 2 presents the characteristics physical soybean, cowpea and common bean. It appears that the cropping systems, the study zone and the year of experiment did not significantly influence ($p > 0.05$) the weight, length, width and thickness of seeds.

In this study the weight of Legume seeds ranged from 0.51±0.01 to 0.63±0.02g; the length of 1.2±0.01 at 1.5±0.02 cm; the width of 0.61±0.01 to 0.93±0.01 cm; thickness 0.30±0.01 to 0.32±0.01 cm and the weight of millet seeds of 543.3±0.01 to 625.1±0.01g. The Sudano-Guinean Zone of Adamaoua Cameroon and the year 2015 records the highest values on these parameters. The lowest values are obtained in the East Cameroon Bimodal Forest Zone and in 2016.

From these results we can say that there is a positive correlation between the weight the length and width of Leguminous seeds.

Table 2: **Physical characteristics of soybean, cowpea and common bean seeds based on cropping systems**

Settings	AEZ	S	C/S	Cw	C/Cw	Cm	C/Cm
Length (cm)	ZFB	1.2±0.01[a]	1.21±0.01[a]	1.22 ± 0.01[a]	1.23 ± 0.02[a]	1.5 ± 0.04 [a]	1.5 ± 0.02[a]
	ZSG	1.2 ±0.03[a]	1.21±0.02[a]	1.22 ± 0.01[a]	1.23 ± 0.01[a]	1.5 ± 0.01 [a]	1.5 ± 0.01[a]
Width (cm)	ZFB	0.61±0.01[a]	0.61±0.03 [a]	0.63 ± 0.02[a]	0.64 ± 0.01[a]	0.92 ± 0.02[a]	0.93 ± 0.01[a]
	ZSG	0.61±0.01[a]	0.61±0.02 [a]	0.63 ± 0.01[a]	0.64 ± 0.02[a]	0.91 ± 0.01[a]	0.92 ± 0.02[a]
Thickness (cm)	ZFB	0.30±0.01[a]	0.31±0.01[a]	0.31 ± 0.03[a]	0.32 ± 0.01[a]	0.32 ± 0.02[a]	0.32 ± 0.01[a]
	ZSG	0.30±0.02[a]	0.31±0.02[a]	0.31 ± 0.03[a]	0.31 ± 0.03[a]	0.32 ± 0.03[a]	0.32 ± 0.02[a]
Weight of the seed (g)	ZFB	0.52±0.01[a]	0.52±0.03[a]	0.54 ± 0.02[a]	0.54 ± 0.04[a]	0.63 ± 0.01[a]	0.63 ± 0.01[a]
	ZSG	0.51±0.01[a]	0.52±0.01[a]	0.54 ± 0.01[a]	0.55 ± 0.02[a]	0.62 ± 0.01[a]	0.63 ± 0.02[a]
WTS (g)	ZFB	543.5±0.01[a]	543.5±0.01[a]	548.8±0.02[a]	548.9±0.01[a]	624.4±0.01[a]	625.1±0.01[a]
	ZSG	543,3±0.02[a]	543.4±0.01[a]	547.7±0.01[a]	547.7±0.02[a]	624.2±0.01[a]	624.2±0.01[a]

S: Soybean; **Cw:** Cowpea; **Cm:** Common bean; **C/S:** intercropping castor bean-soybean; **C/Cw:** intercropping castor bean-cowpea; **C/Cm:** intercropping castor bean-common bean; **WTS:** the weight of thousand seeds.

The values of the lines followed by the same letter are not significantly different ($p < 0.05$).

3.3. Physico-chemical analyses of castor bean seeds

3.3.1. Water content and oil content

Changes in water content and oil content of castor bean are recorded in the table 2. This table shows that the water content and oil content of castor seeds do not vary significantly (p> 0.05) depending on the cropping system, the study zone and the year of experimentation. However, these parameters have the highest values (4.67±0.03g/100g MF and 47.84±1.02g/100g MS) were observed in intercropping with common bean in the Sudano-Guinean zone of Adamaoua Cameroun in 2015. While the lowest values (4.44 ± 0.02g/100g MF and 45.27 ± 1.04 g / 100g MS) were observed in castor monocropping in the Bimodal forest zone of eastern Cameroon in 2016. Oil content castor obtained in this work corroborates that reported in the literature. Indeed, [14,23,24] report that castor bean contains 35 to 55 % of oil. The work of [25] has also shown that castor bean is rich in oil content of 40 %. Also the low values obtained on the water content of castor bean are in this work suggested that castor bean seeds have good provisions for their conservation. For humidity levels below 10 % are unfavourable for microbial growth [25,23].

3.3.2. Mass density of castor bean

Table 2 also shows the quantity of castor bean. It can be seen from this table that this density does not vary significantly (P> 0.05) as a function of the culture systems of the study zone and the year of experimentation. These values 0.96 g/ml are close to those reported by many authors: [14,23,27]. Compared with other vegetable oil, castor bean appears to be denser with sunflowers, palms; soybean, peanuts, cotton and colza bean to having a density of 0.92 to 0.94 g/ml [27,28].

In the case of castor bean, the density or the mass density East used as a means identification or control. A food bean has a density between 0.90 and 0.94g/ml, water 1g/ml. Comparing the density of a species to that of the water makes it possible to make predictions as to whether the species is floating or not. When it is a liquid, that liquid in question is not miscible with water.

3.3.3. Index of iodine, acid, saponification and esters of castor bean

The iodine (Ii), acid, saponification and ester levels of castor bean are reported in Table 3. It appears from this table that there is no difference significative (p> 0.05) between cultivation systems, the study zone and year of experimentation on the relevant indices. However, on these parameters, the highest index values in castor bean were observed in intercropping with common bean in the Sudano-Guinean zone of Adamaoua Cameroon in 2015. While the lowest values are observed in monoculture of castor bean in the Bimodal forest zone of eastern Cameroon in 2016. Our results corroborate several other previous studies. Indeed [14,23,25] showed that the iodine value of castor bean varies between 82 and 88. The work carried on vegetable castor bean has also shown that the iodine value coconut varied from 10 to more than 180 and 80 to 130, for rapeseed, sunflowers, soybean, castor and corn [27,29].

The iodine value is indicative of the degree of introduction of castor bean. According to Lambert *et al*[29], knowledge of the iodine value (amount of iodine can react on double bonds fatty acids) allows an initial judgement on the ability to burning castor bean. The higher this index, the lighter the bean becomes and the liquid becomes flowing; Combustion can cause problems. Jayed *et al* [30] showed that the iodine value is an indicator of the oxidation stability of biodiesel. In fact, the more double bonds there are, the more the fuel is unstable, that is, susceptible, to degrade and oxidize [31,32]. There is no American Society for Testing and Materials (ASTM) standard for iodine value, but European standards mention it and set the maximum limit of 120g of iodine per 100g of fat for fuel). With reference to these values, our results have iodine indices fewer than 120; shown so that castor bean head was p ê be used as fuel in the engines.

Our results in the acid index are close to those reported in some literature [14,23,26] who showed values of the acid value of castor bean from 1 to 3. The determination of the acid number allows us to appreciate the degree alteration by hydrolysis of the oil [33]. In addition, [34] reports that the acid value of an edible bean is less than or equal to 2 mg KOH / g fat. Our values obtained are above this value indicates that castor bean is not food. This is in accordance with the studies of Alloune et *al*[42] on comparative study of two local bean plants for biodiesel production in Algeria, reveals that cultured castor bean in Algeria is not edible.

The saponification value of a material is the number of milligrams of potash (KOH) needed to saponify 1g of fat [20]. Our values on this index corroborate those of [14,23,26], which reveals that the saponification of castor varies from 179 to 185 according to the study site and castor accessions. In addition, Eke *et al*[35], in the analysis of locally produced soap using castor bean mixed with Shea butter of palm kernel bean in Nigeria report that saponification index ranging from 173.3 to 248.2 mg KOH/g can be used for the manufacture of soap. Our results located in this range thus showing that this castor bean studied can be used for the manufacture of soap.

Generally, the castor saponification value obtained in this study is less laughing to other vegetable oil [36], in England revealed that for plants below the saponification index is: 174 mg KOH/g for rapeseed colza bean, 189 mg KOH/g for sunflower oil, (230-254 mg KOH /g) for palm kernel bean, (192-200 mg KOH/g) for cocoa butter, (189-

198 mg KOH/g) for cottonseed bean, (187-196 mg KOH/g) for peanut bean, (184-196 mg KOH/g) for olive bean,(187-185mg KOH /g)for corn bean and (189-195 mg KOH/g) for soybean bean.

Table 3: Chemical characteristics of castor bean based on culture systems and years of experimentation

Crop system		C	C/S	C/Cw	C/Cm
Years			**2015**		
Water content (g/100g FM)	ZFB	4.50±0.05 ^{a}	4.52±0.05 ^{a}	4.52±0.03 ^{a}	4.53±0.04 ^{a}
	ZSG	4.63±0.03^{a}	4.64±0.02 ^{a}	4.65 ± 0.01 ^{a}	4.67±0.03 ^{a}
Oil content (g/100g DM)	ZFB	45.65±1.22^{a}	45.45±1.04^{a}	45.47±1.03^{a}	45.54±1.04^{a}
	ZSG	45.58±1.03^{a}	47.63±0.92^{a}	47.78±1.01^{a}	47.84±1.02^{a}
Density (g/ml)	ZFB	0.95±0.02^{a}	0.95±0.01^{a}	0.95±0.01^{a}	0.95±0.01^{a}
	ZSG	0.94±0.01^{a}	0.95±0.01^{a}	0.95±0.02^{a}	0.95±0.01^{a}
I_i (gI_2/100g)	ZFB	67.17±1.03^{a}	67.16±1.03^{a}	67.18±1.08^{a}	68.27±1.04^{a}
	ZSG	70.24±1.02^{a}	70.48±1.27^{a}	70.76±1.12^{a}	71.12±1.21^{a}
I_S (mgKoH/g)	ZFB	170.24±1.19^{a}	171.45±1.27^{a}	171.72±1.32^{a}	171.53±1.22^{a}
	ZSG	171.45±1.27^{a}	172.58±1.77^{a}	172.65±1.25^{a}	172.97±1.32^{a}
I_A (mgKOH/g)	ZFB	3.2±0.01^{a}	3.2±0.01^{a}	3.3±0.01^{a}	3.3±0.02^{a}
	ZSG	3.2±0.02^{a}	3.3±0.02^{a}	3.5±0.02^{a}	3.7±0.01^{a}
I_E	ZFB	167.04±1.21^{a}	168.25±1.42^{a}	168.42 ±0.47^{a}	168.23±1.57^{a}
	ZSG	168.25±1.17^{a}	169.28±0.44^{a}	169.15±1.32^{a}	169.27±1.19^{a}
Years			**2016**		
Water content (g / 100g FM)	ZFB	4.44 ±0.02 ^{a}	4.45 ±0.03 ^{a}	4.47± 0.04^{a}	4.48±0.05^{a}
	ZSG	4.52±0.03^{a}	4.53±0.02^{a}	4.54± 0.05^{a}	4.55± 0.02^{a}
Oil content (g / 100g DM)	ZFB	45.34±1.04^{a}	45.44±1.04^{a}	45.48±1.04^{a}	45.65±1.04^{a}
	ZSG	45.27±1.04^{a}	45.53± 0.07^{a}	45.54±0.92^{a}	45.77±1.05^{a}
Density (g / ml)	ZFB	0.94±0.01^{a}	0.95±0.02^{a}	0.95±0.01^{a}	0.95±0.02^{a}
	ZSG	0.94±0.01^{a}	0.95±0.01^{a}	0.95±0.02^{a}	0.95±0.01^{a}
I_i (gI_2 / 100g)	ZFB	68.14±1.07^{a}	68.12±1.18^{a}	68.12±1.04^{a}	69.25±1.05^{a}
	ZSG	67.12±1.12^{a}	67.28±1.14^{a}	67.32±1.05^{a}	68.33±1.03^{a}
I_S (mg KOH / g)	ZFB	171.45±1.23^{a}	172.95±1.05^{a}	172.97±1.74^{a}	172.97±0.97^{a}
	ZSG	3.22±0.02^{a}	3.33±0.02^{a}	3.50±0.02^{a}	3.77±0.01^{a}
I_A (mg KOH / g)	ZFB	2.92±0.01^{a}	3.20±0.02^{a}	3.33±0.01^{a}	3.33±0.01^{a}
	ZSG	2.90±0.02^{a}	3.41±0.01^{a}	3.43±0.01^{a}	3.50±0.01^{a}
I_E (mg KOH / g)	ZFB	170.07 ±0.72 ^{a}	169.77±1.22^{a}	169.67±1.27^{a}	168.15±1.33^{a}
	ZSG	168.22±1.33^{a}	167.76±1.21^{a}	167.77±1.33^{a}	167.78±0.78 ^{a}

C: Monocrop castor bean; **C/S:** intercropping castor bean-soybean; **C/Cw:** intercropping castor bean-cowpea; **C/Cm:** intercropping castor bean-common bean; **ZSG:** Sudano-Guinean Zone; **ZFB:** Bimodal Forest Zone; **AEZ:** Agroecologique zone. Values of bands followed by the same letter are not significantly different; **DM:** dry matter; **FM:** fresh matter

3.4. Chemical analyses of Legumes seeds

3.4.1. Protein, Sugar and sash from cowpea and common bean

Table 4 presents the chemical analyses of the seeds of soybean cowpea and common bean. It appears from this table that there is no difference significantly ($p > 0.05$) between cultivation systems, the study zone and year of experimentation on protein sash content in Legumes are studied. However the sugar content varies significantly ($p < 0.05$) according to the study zone and year of experimentation. Of these parameters, the highest values among Legumes are studied observed in cultural intercropping with castor bean, in the zone of the Bimodale forest of East Cameroon in 2015. While the lowest values are observed in monoculture in the Sudano-Guinean zone of Adamaoua Cameroon in 2016. Protein content in Leguminosae studied ranged from 11.13±1.1g/100g DM in common bean to 32.39±0.7g/100g DM in soybean, sugars content of 31.74 ± 0.9 g / 100g DM in common bean at 65.44±1.1g/100g DM in cowpea and ash content ranged from 1.53±0.7 in bean to 4.23±0.2 in soybean (Table 2).

The results obtained on the chemical analyse of soy bean, cowpea and common bean are similar to those of Zitari Sana [37] are studying the nutritional values of certain food resources used in food animals, and reports that the soya protein content is 51.52 g/100g of dry matter (DM), the sugar content 6.25g/100g DM and the ash rates 12.40. Moreover, Zelter et al [38] found that the soy protein content varies between 47.3 and 49.1 g/100g DM, that of sugar between 7.3 and 6 g/100g DM and the rate of ash s between 5.7 and 7.3. As per Mille[39] is a protein content of cowpea which varies between 23.65 to 29.98 g/100g DM, those of are sugars between 3.28 to 6.03 g/100g DM and a rate ash to 3,62. The results obtained on the chemical analyse of bean and cowpea seeds corroborate those of Atuahene-Amankwa [40] Which show that the protein content of common bean and cowpea generally varies from 21.1 to 23.1 g / 100g DM, that of sugars between 59 and 64.4 g/100g MS and ash s between 2.4 and 3.2 %.

It was observed in this study that the two study zones (zones of the Eastern Bimodal Forest and Sudan-Guinean of Adamaoua Cameroon) as well as the year of experimentation have a significant influence ($p < 0.05$). Chemical properties of soya bean seeds, the cowpea and the bean. This is explained by the fact that these two zones have different climatic and edaphic characteristics. In effect, the floor of the site Bini-Dang Adamawa Cameroon. Is richer in nitrogen than that of locality Birpondo, East Cameroon.

It was observed in this study that the two study zones (zones of the Eastern Bimodal Forest and Sudan-Guinean of Adamaoua Cameroon) as well as the year of experimentation have a significant influence ($p < 0.05$).

The sugar content of soybean seeds, the cowpea and the bean. It also could be justified by the property s different physicochemical soil study sites and climate conditions vary by study zones and the year of experimentation.

The analysis of the physicochemical properties of soybean, cowpea and common bean reveals that the chemical properties of the seeds of plants studied do not vary whatever the study zone. This is an advantage for the use of these seeds in several zones of study.

These results reveal the importance of legumes in the diet. Their consumption may be important for the protein-energy balance of the ration. The example of soybean, cowpea and common bean analysed shows the protein fraction between 11.13 and 32.39 g/100g DM. These vegetables are also sources of minerals with ash levels between 1.5 and 4. This study promotes the integration of these legumes in agrarian systems. Protein sources (soy, cowpea and bean) are rich in protein. These raw materials can be vulgaris in poultry feeding and partially substitute certain foods such as meat.

Table 4: **Chemical characteristics of soybean, of cowpea and of common bean based on culture and years of experimentation systems**

Settings	AEZ	S	C/S	Cw	C/Cw	Cm	C/Cm
Years of study				**2015**			
Protein content (g/100g DM)	ZFB	31.16±0.9[a]	32.39±0.7[a]	12.26±0.2[a]	12.95±0.3[a]	19.94±0.2[a]	20.76 ±0.3[a]
	ZSG	26.49±0.9[a]	27.76±0.1[a]	17.02±0.5[a]	17.13±0.2[a]	11.13±1.1[a]	11.27±1.1[a]
Sugar content (g/100g DM)	ZFB	48.52±1.1[a]	49.18±1.1[a]	65.45±1.2[a]	67.48±1.2[a]	40.87±0.5[a]	41.74±0.7[a]
	ZSG	47.59±0.7[a]	48.18±0.4[a]	63.62±1.1[a]	65.44±1.2[a]	38.81±0.8[a]	39.26±1.1[a]
Ash rate	ZFB	4.2 ± 0.3[a]	4.23±0.1[a]	3.57± 0.2[a]	3.88 ±0.2[a]	2.27±0.3[a]	2.33 ±0.2[a]
	ZSG	4±0.2[a]	4.17±0.2[a]	3.39±0.4[a]	3.55±0.3 [a]	2 ± 0.5[a]	2.12± 0.1[a]
Years of study				**2016**			
Protein content (g/100g DM)	ZFB	27.03±0.7[a]	29.98±0.1[a]	11.3 ±0.9 [a]	11.57±0.8 [a]	17.71±0.5[a]	18.51±0.2[a]
	ZSG	26.49±0.9[a]	27.76±0.1[a]	11.13±1.1 [a]	11.27±1.1 [a]	17.02±0.5[a]	17.13±0.2[a]
Sugar content (g/100g DM)	ZFB	48.55±0.9[a]	48.93±0.8[a]	60.25±1.1 [a]	61.62±1.1 [a]	33.77±0.7[a]	35.18±1.2 [a]
	ZSG	43.78±0.5[a]	44.78±1.1[a]	57.49±1.2 [a]	59.89±1.2 [a]	31.74±0.9[a]	32.26±1.1[a]
Ash rate	ZFB	4.14± 0.1[a]	4.21± 0.2[a]	3.44±0.1 [a]	3.75±0.2[a]	1.8 ± 0.8[a]	1.82±0.1[a]
	ZSG	3.72± 0.7[a]	3.88± 0.3[a]	3.35±0.2 [a]	3.7 ± 0.1[a]	1.53± 0.7[a]	1.7±0.2[a]

S: Soybean; **Cw:** Cowpea; **Cm:** Common bean; **C/S:** intercropping castor bean-soybean; **C/Cw:** intercropping castor bean-cowpea; **C/Cm:** intercropping castor bean-common bean; **DM:** dry matter.
The values of the lines followed by the same letter are not significantly different ($p < 0.05$).

4. Conclusion

This work, which aims to promote castor culture in Cameroon by preserving food security, has led to a better understanding the effect of the cultural intercropping of the physicochemical characteristics of castor bean, soybean, cowpea and common bean seeds after the cultivation in the field of these plants in cultural intercropping in the Sudano-Guinean zone of Adamaoua and in the Forest Eastern bimodal in Cameroon in 2015 and 2016.

Our results reveal slow that the physico-chemical properties of castor seeds and legumes do not vary, regardless of the study zone thus showing that these seeds can be grown in different zones without losing their characteristics.

The oil contents of castor bean ranges from 45.27 ± 1.04 to 47.84 ± 1.02 g / 100 g MS; the iodine number of 67.12 ± 1.12 to 71.12±1.21 g/100g; the saponification number of 171.45 ± 1.23 at 172.97 ± 0.97 mg KOH / g; the acid number of 2.9 ± 0.01 to 3.7 ± 0.01 mg KOH / g and the ester number of 168.22 ± 1.33 to 169.27 ± 1.19 mg KOH.

In Leguminous plants studied, the protein content varies from 11.13 ± 1.1 g / 100 g DM in common bean to 32.39 ± 0.7 g / 100 g DM in soybean, the sugar content of 31.74 ± 0, 9 g / 100g DM in bean at 65.44 ± 1.1g / 100g DM in cowpea and the ash rate varies from 1.53 ± 0.7 in bean at 4.23 ± 0.2 in soybean. By growing castor bean in intercropping with legumes, Cameroonian farmers are not only helping to promote the production of biofuels, all while maintaining food security.

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