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The proximate and phytochemical composition of *Sesamum indicum* Linn and *Ceratotheca sesamoides* Endl at different stages of growth

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ABSTRACT
Sesamum indicum Linn. and *Ceratotheca sesamoides* Endl., both of family Pedaliaceae which were commonly harvested in substitute of one another now belong to the group of neglected and underutilized indigenous vegetables of the tropics. There is no known record of their chemical composition in line with their growth. In the light of this, the proximate and phytochemical composition of these closely related plants were studied in order to bring to limelight the potentials of these increasingly neglected vegetables. Significant differences were observed in the percentage proximate and phytochemical analyses of the two species at different stages of growth. Comparative studies also revealed a higher percentage proximate in *S. indicum* (9.57% crude fibre, 9.53% moisture) than *C. sesamoides* (8.67% crude fibre, 9.17% moisture*)* while the phytochemicals were significantly more in the *S. indicum* (138.33mg/100g Tannins) than *C. sesamoides* (127mg/100g Tannins). The values for the two species were at par for saponins at 330mg/100ml, while the other phytochemicals present had slightly higher values in *C. sesamoides* for flavonoids, alkaloids and phenols at 1315 mg/100g, 843 mg/100g and 46.3 mg/100g respectively. In this study, proximate, mineral and phytochemical constituents showed a decline as the leaves approached reproductive stage of flowering and fruiting. It was noted in the two species studied that *S. indicum* started flowering after 8 weeks of growth and *C. sesamoides*, between the 9th and the 10th week. The proximate and the phytochemical values of the plants strongly support their use as vegetables and suggestive of medicinal values hence should not be neglected.
Key words: Proximate analysis, Phytochemicals, *Sesamum indicum* and *Ceratotheca sesamoides*

INTRODUCTION

Various studies on traditional leafy vegetables in Africa have documented their importance in providing affordable and nutritious delicacies for local consumption, generating income through trading while maintaining the stability of the ecosystems (Chweya and Eyzaguirre, 1999). The World Health Organization (1992) reported that chronic under-nutrition affects over 200 million people (42%) of the population in Sub-Sahara Africa. Indigenous leafy vegetables represent inexpensive but high quality nutritional sources, for the less privileged segment of the population especially where malnutrition is wide spread. Leafy vegetables are rich sources of carotene, ascorbic acid, riboflavin, folic acid and minerals like calcium, iron and phosphorous (Nnamani *et al.,* 2007). George (2003) stated that though the bulk weight is water, leafy vegetables represent a veritable natural pharmacy of minerals, vitamins and phytochemicals. He concluded that the potassium content of leafy vegetables is good in the control of diuretic and hypertensive complications as it lowers arterial blood pressure. The fibre content of vegetables contribute to the feeling of satisfaction and prevents constipation (Noonan, 1999), while the proteins in vegetables are superior to those found in fruits (George, 2003).

Ceratotheca sesamoides and *Sesamum indicum* belong to Pedaliaceae family and are used only as vegetables but also as medicinal plants. The oil derived from their seeds and leaves have been reported to have medicinal properties. The cultivation of indigenous vegetables has contributed greatly to the socio-economic life of the people in Africa. Recent surveys carried out by the National Institute in Cameroon and Uganda provided evidence that indigenous vegetables offer a significant opportunity for the poor people to earn a living as producers and traders do not need large investment. They are important commodities for poor households because their prices are relatively cheap and affordable when compared with other food items.

Given the demand for a continuous and uniform supply of medicinal plants like other agricultural plants and the accelerating depletion of forest resources, increasing the number of plant species in cultivation would appear to be an important strategy for meeting a growing demand (Uniyal *et al*., 2000). Though indigenous vegetables have been reported for their medicinal properties and values by various workers, traditional medical practitioners believe that cultivated plants do not have the same power of potency as plant materials collected from the wild (Cunningham, 1994). This opinion may be due to the fact that cultivated plants are likely to be somewhat different in their properties from those gathered from their natural habitats. It should also be taken to cognisance that certain values in plants can be deliberately enhanced by cultivation (Palevitch, 1991; Uniyal *et al.,* 2000).

Cultivation of medicinal plants is beneficial as it may prevent counterfeiting, adulteration and accidental substitution. It provides regular supply of drug plants and with proper monitoring; both the drying and storage can be more effectively regulated. However, factors such as drought, floods, excessive rain, wind, insects, fungal and bacterial infestations and production costs are some of the factors that could negate plant cultivation. In addition, factors such as season of production, time of the day and the location have been noticed to influence the amount of secondary metabolites and also the degree of efficiency of drug plants. There are no details of the constitutional make up of both *C. sesamoides* and *S. indicum* in relation

to their collection. The present study is therefore aimed at ascertaining the disparities in the proximate and phytochemical composition of *C. sesamoides* and *S. indicum* at different stages of growth.

MATERIALS AND METHODS

Collections and Cultivation

Seeds of *Ceratotheca sesamoides* and *Sesamum indicum* were purchased from the market while some were collected in the wild. The cultivation was carried out on a back yard garden at the University of Ibadan, Oyo state, located in the Southern Guinea Savanna ecological zone of Nigeria. Two seeds were grown per stand in each plot at a spacing of 50 cm between and within rows. At 3 weeks after planting, 8 g of NPK 20-10-10 was applied per plant, an equivalent of 100 g of N/ha, 50 kg K/ha recommended for the crop (Bakare, 1987; Fasakin,2004). A broad spectrum fungicides (KAPTAF 75SD) and an insecticides (Karat 2.5EC) were also applied as foliar spray respectively against seedling damping off and leaf eating insect larvae. The plots were hoe-weeded, supplemented with hand pulling within the rows to ensure uncontaminated healthy growth of the plants. Also, the plants were watered in the absence of rain.

Harvesting, Authentication and Drying

The leaves were harvested at different stages of maturity (6, 8 and 10 weeks). The plants were later authenticated at the Forest Herbarium Ibadan (FHI) and assigned voucher numbers; FHI 109575 for *C. sesamoides* and FHI 109576 for *S. indicum*. Consequently, duplicates of the two plants were deposited at the University of Ibadan Herbarium. Drying of these plants was carried out at room temperature for 2 weeks and ground into powder using mortar and pestle. Thereafter, the each of the plant samples were stored in bottles and labelled.

Analyses

Proximate and phytochemical composition tests were carried out for the three stages of growth and estimated as percentages and mg/g respectively by standard methods as described by AOAC (1991) and Trease & Evans (1991).

All the data collected were subjected to statistical analysis of variance and comparison of means, using Statistical Analysis System. Differences between means were assessed for significance at ≤ 0.05 by Duncan's multiple range tests.

RESULTS

Table 1a shows the proximate values of *C. sesamoides* at the three stages of growth. Protein and Ash contents (12.85%, 8.55%) were found to be significantly highest during the 8th week of growth than in the 6th and 10th week with 11.85%, 7.80% and 12.80%, 8.10% respectively. The highest level of crude fibre (9.10%) was obtained in the 10th week followed by 8th week of growth with 8.60% while the 6th week had the least value of 8.30%. The fat content ranged from two to three percent in the entire period of study.

Table 1b shows the phytochemicals in *Ceratotheca sesamoides* at the three stages of growth. The presence of flavonoids (1400mg/100g) and phenols (48.0GAE/100g) were observed to be at significantly highest levels in the 8th week as compared to the 6th and 10th week (1265 mg/100g and 45 GAE/100g for flavonoids and 1280 mg/100g and 46 GAE/100g for phenols). Saponins (345mg/100g) and alkaloids (855mg/100g) at the 10th week exceeded those of the values obtained from the analyses carried out on both the 8th week (325mg/100g, 850mg/100g) and 6th week (320mg/100g, 825mg/100g) respectively.

Table 1a: Percentage proximate composition of *Ceratotheca sesamoides* at different stages of growth

Age of plant	Moisture Content	Protein	Ether Extract (Fat)	Ash	Crude Fibre	Carbohydrates (By Difference)
6th week	9.30 ±0.10	11.85 ±0.05	2.85 ±0.05	7.80 ±0.00	8.30 ±0.10	59.90 ±0.10
8th week	9.05 ±0.05	12.85 ±0.05	3.10 ±0.10	8.55 ±0.05	8.60 ±0.10	57.85 ±0.25
10th week	9.15 ±0.05	12.80 ±0.10	2.80 ±0.00	8.10 ±0.10	9.10 ±0.10	58.05 ±0.05
LSD $_{(0.05)}$	0.32	0.32	0.29	0.29	0.45	0.71
	ns	*	ns	*	*	ns

LSD $_{(0.05)}$: Least significant difference at P=0.05, *: Significant, ns: not significant

Table 1b: Phytochemical values in *Ceratotheca sesamoides* at three stages of growth.

Age of plant	Flavonoids (mg/100g)	Saponins (mg/100g)	Alkaloids (mg/100g)	Tannins (mg/100g)	Phenols (Gallic Acid Equivalent (GAE) /100g
6th week	1265.00±0.00	320.00±0.00	825.00±0.00	130.00±0.00	45.00±0.00
8th week	1400.00±0.00	325.00±0.00	850.00±0.00	127.50±2.50	48.00±0.00
10th week	1280.00±0.00	345.00±0.00	855.00±0.00	125.00±0.00	46.00±0.00
LSD (0.05)	0.00	0.00	0.00	6.49	0.00
	*	*	*	ns	*

LSD (0.05): Least significant difference at P=0.05, *: Significant, ns: not significant

Table 2a shows the percentage composition of the leaves of *S. indicum* at various stages of growth. Compounds such as Proteins, Fat and Ash contents were found to be significantly different with the 8th week having the highest values for Fat (3.20 %) and Ash content (8.75%) in comparison with the 6th week which had 2.80% Proteins and 8.10% Ash while the 10th week consisted of 2.80% Fat and 7.75% Ash. The highest level of significance for protein (12.95%) was discovered in the leaves harvested after the 10th week of growth and closely followed by the 8th week of growth and with 12.50% protein while the 6th week had the least value of protein (12.20%).

Table 2b summarizes the phytochemicals in *S. indicum* at the three stages of growth. Values obtained for flavonoids, saponins and phenols were significantly different at the various stages of growth. The 8th week of growth had flavonoids content of 1350mg/100g and phenols (47.50mg/ml). Though saponin had the same value (340mg/100g) for the 8th and 10th weeks, the 6th week recorded the lowest values for most of the phytochemicals.

Table 2a: Percentage proximate analysis of *Sesamum indicum* at three stages of growth.

Age of plant	Moisture Content	Protein	Ether Extract (Fat)	Ash	Crude Fibre	Carbohydrates (By Difference)
6th week	9.50±0.00	12.20±0.10	2.80±0.00	8.10±0.10	9.45±0.05	57.95±0.05
8th week	9.50±0.10	12.50±0.10	3.20±0.10	8.75±0.05	9.55±0.15	56.50±0.00
10th week	9.60±0.10	12.95±0.15	2.80±0.10	7.75±0.15	9.70±0.10	57.20±0.40
LSD (0.05)	0.37	0.54	0.37	0.49	0.49	1.05
	ns	*	*	*	ns	ns

LSD (0.05): Least significant difference at P=0.05, *: Significant, ns: not significant.

Table 2b: Phytochemicals present in *Sesamum indicum* at three stages of growth.

Age of plant	Flavonoids (mg/100g)	Saponins (mg/100g)	Alkaloids (mg/100g)	Tannins (mg/100g)	Phenols (GAE/100g)
6th week	1250.00±0.00	312.50±2.50	830.00±5.00	140.00±5.00	42.50±0.00
8th week	1350.00±0.00	340.00±0.00	840.00±0.00	145.00±0.00	47.50±0.00
10th week	1270.00±0.00	340.00±0.00	845.00±0.00	130.00±0.00	45.00±0.00
LSD (0.05)	0.00	6.45	12.99	12.99	0.00
	*	*	ns	ns	*

LSD (0.05): Least significant difference at P=0.05, *: Significant, ns: not significant

Table 3a shows the results of the means of percentage chemical composition for both *C. sesamoides* and *S. indicum.* The moisture contents (9.53%), proteins (12.55%), Ash (8.20%) and crude fibre (9.57%) were higher in *S. indicum* as compared to *C. sesamoides* while carbohydrates were more in the later species. Significant differences were observed in the moisture content, crude fibre and carbohydrates. However, there were no significant differences in the protein, fat and ash contents of the two species.

Table 3b revealed that there were no significant differences in the flavonoids, saponins, alkaloids and phenols contents of both plant species. The tannin content (138.33±3.07mg/100g) of *S. indicum* is significantly higher than *C. sesamoides* tannin content of 127.50±1.12mg/100g.

Table 3a: Mean percentage chemical composition of *Ceratotheca sesamoides* and *Sesamum indicum*.

Name of plant	Moisture Content	Protein	Ether Extract (Fat)	Ash	Crude Fibre	Carbohydrates (By Difference)
C. sesamoides	9.17±0.06	12.50±0.21	2.92±0.07	8.15±0.04	8.67±0.15	58.60±0.42
S. indicum	9.53±0.04	12.55±0.15	2.93±0.09	8.20±0.09	9.57±0.07	57.22±0.28
LSD $_{(0.05)}$	0.16	0.57	0.25	0.53	0.37	1.13
	*	ns	ns	ns	*	*

LSD $_{(0.05)}$: Least significant difference at P=0.05, *: Significant, ns: not significant

Table 3b: Comparative means of phytochemicals in *Ceratotheca sesamoides* and *Sesamum indicum*

Botanical name	Flavonoids (mg/100g)	Saponins (mg/100g)	Alkaloids (mg/100g)	Tannins (mg/100g)	Phenols (GAE/100g)
Ceratotheca sesamoides	1315.00±27.02	330.00±4.83	843.33±5.87	127.50±1.12	46.33±0.56
Sesamum indicum	1290.00±19.32	330.83±5.83	838.33±3.07	138.33±3.07	45.00±0.91
LSD $_{(0.05)}$	74.01	16.88	14.76	7.29	2.38
	ns	ns	ns	*	ns

LSD $_{(0.05)}$: Least significant difference at P=0.05, *: Significant, ns: not significant

DISCUSSION

The knowledge of plant composition is fundamental to the understanding of modes and mechanisms of action of medicinal plant particularly the neglected indigenous ones. In this study, proximate, mineral and phytochemical analyses showed a decline as the leaves approached reproductive stage (flowering and fruiting). This was noted in the two species studied as *S. indicum* started flowering after 8 weeks of growth and *C. sesamoides*, between the 9th and the 10th week.

Phytochemicals are chemicals that may have protective or disease preventive properties and are found generally in plants. In this study, phytochemicals screened did not only show the presence of secondary metabolites in *Sesamum indicum* and *Ceratotheca sesamoides* but also established significant differences at various stages of their growth.

The high flavonoids found in the two species studied might not be unconnected to their use in local medicine in treating cancer and heart diseases as reported by Shittu *et al.* (2007a) and Ahmed *et al.* (2009). Flavonoids are known for their anti-oxidants activity in-vitro and consumers and manufacturers have become interested in foods containing these secondary metabolites because of their medicinal properties, especially their putative role in inhibiting cancer and cardiovascular diseases. Although, physiological evidence is not yet established, the beneficial effects of fruits and vegetables have sometimes been attributed to flavonoid compounds. The high level of flavonoids displayed by both species makes them potential anti-oxidants as it is reported by Shittu *et al.* (2007b). Beneficial effects derived from high intake of fruits and vegetables on various metabolic disease conditions such as diabetes mellitus, obesity, heart diseases and cancer may not always be due to impact of their well characterized antioxidants. As observed in the present study that apart from flavonoids, secondary metabolites such as alkaloids, tannins, saponins and phenols were found to be significantly high. Phenols are strong antioxidants which prevent oxidative damage of biomolecules such as DNA, lipids, proteins, which play a role in chronic diseases such as cancer and cardiovascular diseases. Plant phenols may interfere with all stages of the cancer process, potentially resulting in a reduction of cancer risk (Hollman, 2001).

Alkaloids are commonly found to have protective properties due to their ability to intercalate with DNA of the microorganisms though their roles remain unclear. Saponins have been shown to possess cholesterol lowering properties. *Sesamum indicum* and *Ceratotheca sesamoides* with their high saponins and crude fibre could be used as fat burner. This anti- obesity factor has also been reported in the seeds of *Sesamum spp (*Shittu *et al*., 2006, 2007c and Ahmed *et al.,* 2009).

Steroids have also been reported in the seeds of *Sesamum spp.* and *C. sesamoides.* Steroids presence are of importance as they are of interest in pharmacy due to their relationship with such compounds as sex hormones which might not be unconnected to the reported use of *Sesamum spp*. as potential medication for male infertility (Shittu *et al.*, 2007d; Ogunlesi *et al.,* 2010). In general, the presence of the phytochemicals could account for the much tested medicinal properties of the leaves in various disease conditions.

Comparing the means of the compositions of the two species; moisture, crude fibre and tannins were significantly higher in *S. indicum*. Though on the contrary, *C. sesamoides* had better carbohydrate content. Earlier study by Fasakin (2004) on two cultivars of *Ceratotheca sesamoides* showed variation in the proximate composition at various growth rates. The result above is also confirmed in *Moringa oleifera* leaves where it was observed that chemical composition was influenced by the age at harvest (Bamishaiye *et al.,* 2011). They reported that these chemicals increased with the age of the plants and decreased as

the species approached reproductive stage. The decline in these components with age could be attributed to their remobilization from the leaves to the reproductive organs during flowering and fruiting (Hewitt and Marrush, 1986).
This study has established that the growth ages of *Ceratotheca sesamoides* and *Sesamum indicum* affect the level of their proximate contents and the phytochemical composition. This work will serve to guide the users of the plant at various stages of harvesting. Besides, the presence of their healthy and beneficial substances should encourage their consumption and not be neglected.

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