Evaluation of the Phytochemical and Proximate Composition of Fruit of False Yam (*Icacina senegalensis*) and African Star Apple (*Chrysophyllum albidum*)

ABSTRACT

The biochemical composition of the seed, fruit-pulp and fruit-skin of false yam and African star apple was carried out in this study using standard techniques. The result of the mean phytochemical composition of *Icacina senegalensis* and *Chrysophyllum albidum* fruits revealed higher composition of tannin in the pulp, seed of *I. senegalensis*, while alkaloid and flavonoid was higher in composition in the pulp (24.22±0.141mg/100g and 16.53±0.021mg/100g), seed (25.35±0.021mg/100g and 18.27±0.014mg/100g)and bark (24.62±0.085mg/100g and 16.94±0.035mg/100g) of *Chrysophyllum albidum.* The results were significantly different at $p<0.05$. The result of the percentage proximate composition of *Icacina senegalensis* and *Chrysophyllum albidum* fruits revealed higher percentage composition of carbohydrate in the pulp (51.52±0.127% and 57.02±0.141%), seed (52.42±0.085% and 56.1±0.198%) and bark (54.89±0.092% and 58.02±0.113%) of *I. senegalensis* and *C. albidum*. The result revealed high percentage composition of fat in the pulp (26.33±0.028% and 9.63±0.028%), seed (25.69±0.014% and 10.24±0.035%) and bark (23.14±0.028% and 9.28±0.071%) of *I. senegalensis* and *C. albidum* respectively. Moisture content was also high in the pulp (12.37±0.014% and 8.35±0.042%), seed (11.45±0.021% and 7.36±0.042%) and bark (11.13±0.014% and 5.23±0.028%) of *I. senegalensis* and *C. albidum* respectively. The result of the mean mineral composition of *Icacina senegalensis* and *Chrysophyllum albidum* fruits revealed high composition of calcium in the pulp, seed and bark of *I. senegalensis* and *C. albidum* respectively. The also result revealed high composition of magnesium in the pulp, seed and bark of *I. senegalensis* and *C. albidum.* The results from this work suggest that *Icacina senegalensis* and *Chrysophyllum albidum* may find their use in food/feed formulation/supplementation as well as nutraceutical/medicinal and industrial uses.

Keywords: Biochemical, False yam, African star apple, Seed, Pulp, Fruit-Skin, Mineral, Proximate, *Icacina senegalensis*, *Chrysophylum albidum.*

1. INTRODUCTION

The value of medicinal plants is based on various chemical constituents that bring about a concise physiological activity on the human body [1]. Phytochemicals are thus non-nutritive plant chemical compound that has protective and disease preventing properties. It is also the subject of plant chemistry which was raised in recently as a distinctive discipline that lies in between natural product of organic chemistry and plant biochemistry and both being closely related [2]. Phytochemistry is associated with the huge variety of organic components (Primary and Secondary metabolites), that are developed in detail and amassed by plants and also deals with the complex structures of the plant chemicals of these substances, their biological synthesis, turn-over, metabolic pathways, their distributions in nature and their biological roles [2]. It is necessary to note that the products of primary metabolism e.g. Protein, sugar, fats etc are usually harmless except for some rare toxic protein and therefore of little interest to those investigating drug activity in plants [3]. Unless a drug has been implicated to cause some harm, it is unlikely to do any good [4], secondary metabolites such as alkaloid are usually biologically active in man and animals [5]. There have been diverse speculations concerning the role of many of those secondary constituents in the life of the plant but with a few exceptions.

Icacina senegalensis is a shrubby perennial plant, variable in form, which sends up glabrous or pubescent erect leafy shoots from a large, underground fleshy tuber [6]. The aerial stems are light green and may reach about 1m in height [7]. *Icacina senegalensis* is a savannah shrub, native to west and central Africa, this wild species produces three types of food at the same time; a fruit that is eaten as a snack, a seed that is used as a staple, and a tuberous root that is enjoyed as emergency food when other crops have failed and communities are threatened with famine [8]. *Icacina senegalensis* is a drought-resistant plant in west and central Africa which produces a huge tuber that has high in starch content, but also is also made up of phytochemical constituent such as terpenes [9]. The bright-red coloured fruits of the *Icacina senegalensis* are uniquely tasty with a plume-like flavor and children love it. They are better eaten fresh but can sometimes be eaten dried as well. *Icacina senegalensis* fruits ripens towards the end of dry season when other food producing wild plants have generally run out of produce, this makes it an especially important food store for the hungry who otherwise have very little food options during this time [7].

Chrysophyllum albidum (Linn), also known as African star apple, belongs to the family Sapotaceae, and is majorly a forest tree species. It also naturally occurs in diverse ecosystems in countries like Uganda, Nigeria and Niger Republic [10]. The fruit comes in dry season when there's no rain fall (December-April) and has tremendous economic potential, especially owing to the opinion that jams gotten from the pulp of this fruit could be used in place of raspberry jams and jellies; also oil extracted from the seed has been used for diverse purposes [11]. In Nigeria, *C. albidum* is known as ''agbalumo'' in South Western Nigeria and "udara" or "udala" in South Eastern Nigeria. Its huge reserve of natural antioxidants have been observed to promote health by acting as antioxidant and hindering oxidative stress in diseases such as diabetics, cancer and coronary heart diseases. It was reported that the pulp of this fruit contains reasonable amount of ascorbic acid, vitamins, iron and food flavors, fat, carbohydrate and mineral elements [12]. The fruit-peel has been proven to be an enormous source of fiber and mineral while the seed shell pericarp has been reported to be a significant source of carbohydrate and minerals. The fruits are not only consumed fresh but also used to make smoothie, stewed fruit, marmalade, syrup and various types of soft drinks [13].

Proximate and nutrient analysis of edible fruits and vegetables plays an important role in knowing their nutritional significance. In spite of the wide application of *I. senegalensis* and *C.albidum* and their great potential as good sources of fiber and carbohydrate, information on the fiber fractions and sugar contents of their edible parts seems to be scanty in the available literature and has not been fully investigated. This study was designed to evaluate the nutritional and phytochemical contents of the edible parts (seed, fruit pulp and fruit-skin) of *I. senegalensis* and *C. albidum* fruits. The results of this study may provide useful information on their nutritional potential and contribution to nutrient intake of the nation. It may also create public awareness of its utilization when in season. The aim of this study was to evaluate the phytochemical and nutritional composition of the seed, fruit pulp and fruit-skin of *Icacina senegalensis* and *Chrysophyllum albidum* fruits.

2. MATERIALS AND METHODS

2.1. Experimental Site

This research was carried out at Central laboratory Service Unit in National Root Crops Research Institute, Umudike, Abia State.

2.1.1. Sample Collection

Icacina senegalensis (false yam) and *Chrysophyllum albidum* (African star apple) fruits were purchased from Eke-Awka market in Awka South L.G.A., Anambra State, Nigeria. The plant samples were authenticated by Mr. Iroka Finian a Taxonomist from the Department of Botany, Nnamdi Azikiwe University, Awka.

2.1.2. Sample Preparation

The fruits were examined to be free from diseases. Only healthy plant parts were used. Extraneous materials were also removed from the plant materials. They were cut into pieces using a kitchen knife and were air dried for 21days. The dried fruits were separately ground into powder using a Panasonic electric blender.

2.2. Phytochemical Screening

Preliminary phytochemical tests were carried out first on the samples to establish the presence or otherwise of the chemical constituents using standard procedures by Trease and Evans [14]. The determination of the quantitative phytochemical composition of *Icacina senegalensis* and *Chrysophyllum albidum* fruits was carried out using the gravimetric method described by Harbone [2] and the Folin Dennis spectrophotometric method described by Pearson [15].

2.3. Proximate and Mineral Analysis

Proximate composition was carried out according to the method Association of Analytical Official Chemistry [16]. More so, the sample for the determination of mineral elements was subjected to acid digestion and subsequently the different elements were determined using appropriate methods as described by James [17].

2.4. Statistical Analysis

The experimental results were presented in mean ± SD of the mean of three replicates. The sample means were compared using Analysis of Variance (ANOVA) to determine the level of significance. Difference in mean values were considered significant at $p<0.05$.

3. RESULTS

3.1. Phytochemical Screening of *Icacina senegalensis* and *Chrysophyllum albidum* Fruits

The result of the phytochemical screening of *Icacina senegalensis* and *Chrysophyllum albidum* fruits revealed the presence of saponin, tannin, phenol, flavonoid, steroid, alkaloid and anthocyanin in the pulp, seed and bark of *Icacina senegalensis* and *Chrysophyllum albidum*. The result revealed tannins were abundantly present in *I. senegalensis* while alkaloids were abundantly present in *C. albidium.* Flavonoids were also abundantly present in all the parts of both species.

Table 1: Phytochemical Screening of *Icacina senegalensis* and *Chrysophyllum albidum* Fruits

Parameters	*Icacina senegalensis*			*Chrysophyllum albidum*		
	Pulp	Seed	Bark	Pulp	Seed	Bark
Saponin	+	+	+	+	+	+
Tannin	+++	+++	+++	++	++	++
Phenol	+	+	+	+	+	+
Flavonoid	+++	+++	+++	+++	+++	+++
Steroid	+	+	+	+	+	+
Alkaloid	++	++	++	+++	+++	+++
Anthocyanin	++	++	++	++	++	++

Keys: + (fairly present), ++ (moderately present), +++ (abundantly present)

3.2. Mean Phytochemical Composition of *Icacina senegalensis* and *Chrysophyllum albidum* Fruits

The result of the mean phytochemical composition of *Icacina senegalensis* and *Chrysophyllum albidum* fruits revealed higher composition of tannin in pulp (23.17±0.071mg/100g), seed (22.14±0.028mg/100g) and bark (22.61±0.679mg/100g) of *I. senegalensis*, while alkaloid and flavonoid was higher in composition in the pulp (24.22±0.141mg/100g and 16.53±0.021mg/100g), seed (25.35±0.021mg/100g and 18.27±0.014mg/100g)and bark (24.62±0.085mg/100g and 16.94±0.035mg/100g) of *Chrysophyllum albidum* respectively (see table 3.2). The results were significantly different at $p<0.05$.

Table .2: Mean Phytochemical Composition of *Icacina senegalensis* and *Chrysophyllum albidum* Fruits

Parameters	*Icacina senegalensis*			*Chrysophyllum albidum*		
	Pulp	Seed	Bark	Pulp	Seed	Bark
Saponin	1.35±0.014	1.22±0.007	1.25±0.014	0.05±0.014	0.02±0.014	0.35±0.035
Tannin	23.17±0.071	22.14±0.028	22.61±0.679	7.45±0.021	9.87±0.014	7.95±0.028
Phenol	4.22±0.007	3.88±0.141	4.15±0.021	3.06±0.021	4.13±0.028	3.57±0.014
Flavonoid	14.43±0.134	14.57±0.021	13.89±0.014	16.53±0.021	18.27±0.014	16.94±0.035
Steroid	1.05±0.014	1.11±0.028	1.18±0.042	0.05±0.014	0.14±0.028	0.10±0.007
Alkaloid	5.54±0.16	5.01±0.035	4.65±0.007	24.22±0.141	25.35±0.021	24.62±0.085
Anthocyanin	7.85±0.021	6.93±0.078	6.77±0.021	5.44±0.163	5.88±0.014	5.54±0.014

3.3. Percentage Proximate Composition of *Icacina senegalensis* and *Chrysophyllum albidum* Fruits

The result of the Percentage Proximate composition of *Icacina senegalensis* and *Chrysophyllum albidum* fruits revealed higher percentage composition of carbohydrate in the pulp (51.52±0.127% and 57.02±0.141%), seed (52.42±0.085% and 56.1±0.198%) and bark (54.89±0.092% and 58.02±0.113%) of *I. senegalensis* and *C. albidum* respectively. The result revealed high percentage composition of fat in the pulp (26.33±0.028% and 9.63±0.028%), seed (25.69±0.014% and 10.24±0.035%) and bark (23.14±0.028% and 9.28±0.071%) of *I. senegalensis* and *C. albidum* respectively. Moisture content was also high in the pulp (12.37±0.014% and 8.35±0.042%), seed (11.45±0.021% and 7.36±0.042%) and bark (11.13±0.014% and 5.23±0.028%) of *I. senegalensis* and *C. albidum* respectively. The pulp (12.68±0.064% and 10.24±0.014%), seed (13.15±0.021% and 10.89±0.028%) and bark (14.34±0.021% and 10.16±0.007%) of *C. albidum* revealed high amount of crude fibre and crude protein (see table 3.3). The results were significantly different at $p<0.05$.

Table 3: Percentage Proximate Composition of *Icacina senegalensis* and *Chrysophyllum albidum* Fruits

Parameters	*Icacina senegalensis*			*Chrysophyllum albidum*		
	Pulp	Seed	Bark	Pulp	Seed	Bark
Moisture Content	12.37±0.014	11.45±0.021	11.13±0.014	8.35±0.042	7.36±0.042	5.23±0.028

Crude fibre	1.05±0.021	1.35±0.014	1.57±0.014	12.68±0.064	13.15±0.021	14.34±0.021
Fat	26.33±0.028	25.69±0.014	23.14±0.028	9.63±0.028	10.24±0.035	9.28±0.071
Ash	3.04±0.035	3.23±0.028	3.53±0.014	2.09±0.007	2.27±0.071	2.98±0.014
Crude Protein	5.7±0.028	5.87±0.007	5.74±0.021	10.24±0.014	10.89±0.028	10.16±0.007
Carbohydrate	51.52±0.127	52.42±0.085	54.89±0.092	57.02±0.141	56.1±0.198	58.02±0.113

3.4. Mean Mineral Composition of *Icacina senegalensis* and *Chrysophyllum albidum* Fruits

The result of the mean mineral composition of *Icacina senegalensis* and *Chrysophyllum albidum* fruits revealed high composition of calcium in the pulp (309.93±0.714mg/100g and 144.23±2.970mg/100g), seed (302.87±2.19mg/100g and 215.35±1.457mg/100g) and bark (299.72±0.092mg/100g and 277.11±1.449mg/100g) of *I. senegalensis* and *C. albidum* respectively. The result revealed high composition of magnesium in the pulp (138.69±0.049mg/100g and 138.88±1.407mg/100g), seed (114.27±0.078mg/100g and 123.68±1.909mg/100g) and bark (122.34±1.725mg/100g and 162.18±1.322mg/100g) of *I. senegalensis* and *C. albidum* respectively. The pulp (120.60±0.035mg/100g and 71.68±0.078mg/100g), seed (121.67±0.021mg/100g and 72.45±0.021mg/100g) and bark (122.48±0.071mg/100g and 73.67±0.021mg/100g) of *I. senegalensis* revealed high amount of phosphorous and iron respectively. Potassium was higher in the pulp (288.05±0.700mg/100g), seed (612.84±2.142mg/100g) and bark (637.65±7.792mg/100g) of *C. albidum* (see table 3.4). The results were significantly different at $p<0.05$.

Table 4: Mean Mineral Composition of *Icacina senegalensis* and *Chrysophyllum albidum* Fruits

Parameters	***Icacina senegalensis***			***Chrysophyllum albidum***		
(mg/100g)	**Pulp**	**Seed**	**Bark**	**Pulp**	**Seed**	**Bark**
Calcium	309.93±0.714	302.87±2.19	299.72±0.092	144.23±2.970	215.35±1.457	277.11±1.449
Magnesium	138.69±0.049	114.27±0.078	122.34±1.725	138.88±1.407	123.68±1.909	162.18±1.322
Sodium	19.44±0.170	18.76±0.007	19.45±0.693	30.32±0.325	27.51±0.530	37.73±0.566
Potassium	10.15±0.042	10.26±0.014	10.56±0.007	288.05±0.700	612.84±2.142	637.65±7.792
Phosphorous	120.60±0.035	121.67±0.021	122.48±0.071	11.14±0.028	13.64±0.014	32.23±0.021
Iron	71.68±0.078	72.45±0.021	73.67±0.021	8.24±0.014	3.77±0.141	3.22±0.014

4. DISCUSSION

The result of the analyses revealed the presence of various phytochemicals, minerals and nutritional compositions in the pulp, seed and bark of *Icacina senegalensis* and *Chrysophyllum albidum*. Phytochemicals such as alkaloids, tannins, flavonoids, saponins, sterols, anthocyanin and phenols; minerals like, calcium, sodium, phosphorus, potassium and magnesium were all present in the plant samples analysed from both plants. These phytochemicals are known to have antimicrobial activities [18] and the minerals help plants and animals to live and be healthy. The highest phytochemical compound in *I. senegalensis* was tannin (23.17±0.071 mg/100g) present in the pulp and the least being steroids (1.05±0.014 mg/100g) present in the pulp also, while in *C. albidum*, alkaloids was also the highest phytochemical compound (25.35±0.021 mg/100g) present in the seed, with the least being saponin (0.02±0.014 mg/100g) found in the seed. Studies have shown that the consumption of phytochemicals enhances reduction in the emergence of degenerating diseases [19].

There are higher amounts of alkaloids in pulp, seed and bark of *C. albidum* as compared to the moderate amounts of alkaloids in the pulp, seeds and bark of *I. senegalensis*. Alkaloids are known to exhibit marked physiological activity when administered to animals [20]. However, pure isolated plant alkaloids and their synthetic derivatives are used as basic medicinal agents for analgesics, antispasmodic and bacterial effects [21]. Tannin composition was higher in the parts of *I. senegalensis* studied as compared to *C. albidum.* Tannins present in the two plants have been found to possess astringent properties which hasten the healing of wounds and inflamed mucus membranes [20, 22]. Also, tannins if ingested in excessive quantities will inhibit the absorption of minerals which may lead to anemia [23]. The presence of flavonoid and anthocyanin in the pulp, seed and bark of both *C. albidum* and *I. senegalensis* supports their medicinal value. However, flavonoids are antioxidants and free radical scavengers which prevent oxidation; they have strong anticancer activity and also protect the cell against all stage of carcinogenesis [20, 24]. In addition, the pulp, seed and bark of *C. albidum* and *I. senegalensis* are found to contain saponins and steroids, although in minute quantities. Saponin is useful in medicine and pharmaceutical industry due to its foaming ability that produces frothy effects in the food industry. Saponin is also used in the manufacture of shampoos, insecticides, various drug preparation and synthesis of steroidal hormone. However, some examples of such compounds include cortisone and the estrogenic contraceptive [25, 26]. Again, steroids are used in the treatment of some endocrine disorder, regulation of blood sugar, salt imbalance, and antimicrobial infections [25]. Phenols, also present in the plants,

although in not-so-little quantity, are germicidal and are used in formulating disinfectants [27]. Phenols are also used to make disinfectants and antiseptics that are used in mouthwash.

On the other hand, the result also revealed the proximate composition of the pulp, seed and bark of *C. albidum* and *I. senegalensis.* Carbohydrate (58.02±0.113%) and (54.89±0.092%) found in the bark of the both plants were the highest proximate content while the least proximate content in *I. senegalensis* was crude fiber found in the pulp (1.05±0.021%) and in *C. albidum* the least proximate content was ash in the pulp (2.09±0.007%). Carbohydrates are hydrolyzed in the body to yield glucose, which can be utilized immediately or stored as glycogen in the muscles and liver for future use. Ash content of any given food material is a measure of food quality and identity, it represent the foodstuff that is carbon free as a result of burning away of organic portion [28]. It has proved helpful in establishing and maintaining acid-alkaline balance of the blood system [29, 30]. Fibre aids and speeds up the excretion of waste and toxins from the body, preventing them from sitting in the intestine or bowel for too long, which could cause a build-up or azotaemia. Dietary fibre is mainly needed to keep the digestive system healthy. It also contributes to other processes, such as stabilizing glucose and cholesterol levels. In countries with traditionally high-fibre diets, diseases such as bowel cancer, diabetes and coronary heart disease are much less common than in Western countries (Department of Health and Human Services, 2017). Fat content in *I. senegalensis* was reasonably high but was moderate in *C. albidum*, therefore, both plants can be a good source of fat for body nourishment. Fats are important in energy production. Also, fats and oils help to regulate blood pressure of vital cell parts [31].

The moisture content of both plants were not so high, the pulps had the highest moisture composition *I. senegalensis* (12.37±0.014%) and *C. albidum* (8.35±0.042%). Moisture content of the food material is an important factor to consider before the food is deemed suitable for consumption, because moisture content affects the physical and chemical quality of food which in turn affects the freshness of the food material and its stability for the storage for a long period of time. The moderate moisture content of *Icacina senegalensis* and *Chrysophyllum albidum* suggests that they can be stored for quite a period of time before spoilage sets in. Protein composition in *C. albidum* was higher than that of *I. senegalensis.* Proteins are body builders, they replace worn out tissues, and proteins are also immune booster and can help in cell division as well as growth, thus, *I. senegalensis* and *C. albidum* have showed to be good source of protein for the body.

The result also revealed that *Icacina senegalensis* and *Chrysophyllum albidum* are rich in calcium, sodium, magnesium, potassium, phosphorous and iron (table 3.4). The primary function of potassium in the body is to serve as an electrolyte. This type of molecule becomes ionized in solution, making it capable of carrying an electrical charge. In this role, potassium influences many body's processes, and it works in concert with sodium to exert its effects but *I. senegalensis* and *C. albidum* have relatively low potassium and sodium content as compared to the daily required consumption of over 250mg. The result revealed high composition of magnesium in the pulp (138.69±0.049mg/100g and 138.88±1.407mg/100g), seed (114.27±0.078mg/100g and 123.68±1.909mg/100g) and bark (122.34±1.725mg/100g and 162.18±1.322mg/100g) of *I. senegalensis* and *C. albidum* respectively. Magnesium is an important mineral for human nutrition. Magnesium is essential for more than 300 biochemical reactions in the body. It helps to maintain normal nerve and muscle function, supports a healthy immune system, keeps the heart beat steady, and helps bones remain strong. The mineral content result revealed high composition of calcium in the pulp (309.93±0.714mg/100g and 144.23±2.970mg/100g), seed (302.87±2.19mg/100g and 215.35±1.457mg/100g) and bark (299.72±0.092mg/100g and 277.11±1.449mg/100g) of *I. senegalensis* and *C. albidum* respectively. Calcium is tightly linked to many of the roles that vitamin D plays in the body. In bone health (and other physiologic systems), calcium is a key player. Calcium is a mineral that must be consumed on a regular basis to build bone and maintain the blood level of calcium. It's essential for blood clotting. The pulp (120.60±0.035mg/100g and 71.68±0.078mg/100g), seed (121.67±0.021mg/100g and 72.45±0.021mg/100g) and bark (122.48±0.071mg/100g and 73.67±0.021mg/100g) of *I. senegalensis* revealed high amount of phosphorous and iron respectively while the phosphorus and iron compositions of *C. albidum* were relatively low. Phosphorus is an essential mineral primarily used for growth and repair of body cells and tissues. According to the University of Maryland Medical Center, all body cells contain phosphorus, with 85 percent found in bones and teeth; together with calcium, phosphorus provides structure and strength. Phosphorus is also required for a variety of biochemical processes including energy production and pH regulation [32]. Iron is a component of haeme in haemoglobin and myoglobin, which are essential for O_2 transport, energy metabolism, cell proliferation, and immune defense against pathogens.

5. CONCLUSION

Icacina senegalensis (false yam) and *Chrysophyllum albidum* (African star apple) are good sources of plant secondary metabolites. They therefore may play vital role in preventing various diseases such as inflammation, bacterial infection, lipid peroxidation, fever, constipation, etc when consumed. The anti-inflammatory, anti-bacterial, antioxidant, analgesic and anti-constipation properties of the plants studied are obviously due to the presence of the above mentioned phytochemicals especially alkaloid, tannin, flavonoid and proximate constituents. The results from this work suggest that *Icacina senegalensis* (Utu) and *Chrysophyllum albidum* (Udala) will be useful in food/feed formulation/supplementation as well as nutraceutical /medicinal and industrial uses.

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