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## Chemical Composition of Calabash (*Crescentia cujete*) and Fluted Pumpkin (*Telfaria occidentalis* Hook. F) Pulp and Their Potential for Use in the Industry

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### ABSTRACT

The chemical composition of Calabash and Fluted Pumpkin pulps was studied. The analyses conducted include: proximate, mineral and phytochemical components of the pulps. Proximate results for Calabash and Fluted Pumpkin pulp, respectively, are: carbohydrate ( $87.62 \pm 0.58$ ) and ( $26.10 \pm 0.57$ ); ash ( $2.47 \pm 0.72$ ) and ( $6.05 \pm 0.21$ ); crude fiber ( $4.87 \pm 0.76$ ) and ( $58.93 \pm 0.81$ ); crude fat ( $1.28 \pm 0.15$ ) and ( $2.73 \pm 0.14$ ); crude proteins ( $3.76 \pm 0.12$ ) and ( $6.17 \pm 0.07$ ); and moisture ( $86.6 \pm 0.82$ ) and ( $91.50 \pm 0.7$ ) per cent. Mineral analysis for Calabash and Fluted Pumpkin pulp in mg/100g respectively are as follows: Calcium (28.62 and 2.74); Sodium (18.40 and 7.84); Potassium (7.25 and 39.63); Iron (0.38 and 0.26); Zinc (3.72 and 0.94); Magnesium (9.48 and 6.03); and Phosphorus (0.43 and 5.27). Fluted pumpkin pulp had the following phytochemicals in mg/100g: alkaloid (8.3); flavonoid (6.4); phenol (12.5); saponin (5.7); and tannin (13.8). Quantitative analysis of toxicants in Calabash in mg/100g gave results as: oxalate (42.38); phytate (16.94); and anti-oxidant (10.82). Phytochemicals in Calabash pulp were determined qualitatively, and represented thus: alkaloid (++) ; flavonoid (++) ; saponin (+) ; tannin (+++) ; and glycoside (+++). These results suggest that Calabash and Fluted Pumpkin pulp could be applied in medicine, industry, nutrition, and agriculture.

**Key words:** Pulp, Proximate content, Minerals, Phytochemicals, Toxicants and Industry.

### INTRODUCTION

Fluted pumpkin (*Telfaria occidentalis* Hook.F) belongs to the family Cucurbitaceae. It is called different names: “ugu” by Ibos in Eastern Nigeria; “egusi iroko” by Yorubas and “uwmenkhen” by Benins in Mid-West Nigeria [1]. The seed is the propagative part of the plant. It has high nutritional and medicinal value as well as the leaves [1]. The other parts of the plant: fruit case and pulp could serve as feedstuff for livestock; and the protein content of the pulp has been used to produce marmalade [2]. The seed is also rich in good cooking oil, and could be used industrially for soap production. Activated carbon produced from Fluted Pumpkin seed can be applied in waste water treatment for the removal of lead II ions ( $Pb^{2+}$ )[2;3]. The leaves are rich in iron, and help in the management of anaemia; and have lactating properties, hence are encouraged for use by nursing mothers [1]. The root contains cucurbitacine, sequiterpene, and lactones: that are used as rodenticides and ordeal poison [1].

Calabash (*Crescentia cujete*) belongs to the Bignoniaceae family. It has a white pulp that changes colour to black with time, which is of medicinal value, with the seeds inside [4]. The other parts of the plant are useful in several ways: the empty shells for storing food stuff, used in craft and arts; for garri processing and for fetching water, as well as in swimming [4]. The wood is good for making farm tools and boat building [4; 5].

This study on calabash and Fluted Pumpkin is centered on the potentials of the fruit pulp for industrial applications.

## MATERIALS AND METHODS

### 2.1 Collection and Preparation of Samples

The Calabash fruit pod (*Crescentia cujete*) was sourced from homes in Mbaise, Imo State. They Fluted Pumpkin pods were purchased from Afor Enyiogugu, Afor Ogbe and Nkwo Mbaise markets, all in Mbaise. The Calabash was cut open and the pulp scooped out. The Fluted Pumpkin seeds were removed, and the pulp collected. They were analysed for their proximate, mineral and phytochemical constituents.

### 2.2 Analysis

The moisture, protein, and phenol contents were determined by the method of [6]. The ash, crude fibre, fat, and carbohydrate determined by method of [7]. Mineral elements were determined by atomic absorption spectrophotometer (AAS), according to [7]. The alkaloids, flavonoids, and saponins were determined by the method of [8]. Tannin was determined by the method described by [9]. The toxicants, oxalate, phytate and anti-oxidants were determined as described by [10].

## RESULTS AND DISCUSSION

The results for the proximate, mineral and phytochemicals are shown in Tables 1 to 7.

### 3.1 Proximate Composition

The results are given in Tables 1 and 2. Fluted Pumpkin and Calabash fruit pulps have high moisture contents: 91.50% and 86.6% respectively. This is the reason they are highly perishable [5]. The ash contents were 6.05% and 2.47% respectively. This is in line with the values 1.63 g/100g to 8.53 g/100g obtained in commonly consumed fruits [11]. These ash values give an idea of their mineral constituents. Samples with high ash contents usually have high mineral elements. These minerals help in metabolic reactions in the body, and hence, improve growth and development.

The crude protein contents were 6.17% and 3.76% for Fluted Pumpkin and Calabash, respectively. This is lower than results from most plants; melon seed (33.8 g/100g), cowpea (21 – 34 g/100g), *Amaranthus vividie* (24%), *Moringa oliefera* (20.72%) and *Lasianthera Africana* (15%) [1]. Comparing our result with melon seed, cowpea, etc, Pumpkin and Calabash pulps are not good protein sources. The crude proteins from our samples are higher than values reported for pineapple (0.4%), cashew and apple (0.7%) [5].

Table 1.0 PROXIMATE COMPOSITION OF FLUTED PUMPKIN PULP

PARAMETER	VALUE
Moisture content (%)	91.50 ± 0.71
Crude fibre (%)	58.93 ± 0.81
Crude protein (%)	6.17 ± 0.07
Crude fat (%)	2.73 ± 0.14
Total Carbohydrate (%)	26.10 ± 0.57
Ash (%)	6.05 ± 0.21

Table 2.0 PROXIMATE COMPOSITION OF CALABASH PULP

PARAMETER	PULP	BACK
Moisture content (%)	86.60 ± 0.82	49.42 ± 0.72
Crude Ash (%)	2.47 ± 0.72	0.86 ± 0.56
Crude Protein (%)	3.76 ± 0.12	1.39 ± 0.10
Crude fat (%)	1.28 ± 0.15	0.54 ± 0.08
Crude fibre (%)	4.87 ± 0.76	2.85 ± 0.63
Total Carbohydrate (%)	87.62 ± 0.58	96.37 ± 0.52

Protein is important in replenishing worn out tissues, and help maintain health. It is an important part of nuclear and cytoplasmic structure that takes part in determining and maintaining cellular organization in the body[1]. Fruits are not rich in nitrogenous components [1]. The protein content is however higher than fat content (2.73%) and (1.28%) respectively. Fruits are generally low in fat, and could reduce cholesterol level and obesity [5]. Crude fiber values were 58.93% and 4.87% respectively for Pumpkin and Calabash. The values reported for most fruits range between 0.1% and 6.8% [5]. Crude fiber is not digested by man, but helps to aid digestion [4]; and reduces risk of cardiovascular diseases cancers and diabetes [1]. Fluted Pumpkin pulp had high value and could serve as potential source of fiber. High fiber is required in adult diets than children, because they cause irritation of the gut mucosa, reduced digestibility, and vitamin and mineral availability. However, it is desirable in adult diets because it helps in movement of food in the intestine, through wave-like contraction; expand the walls of the colon, and ease passage of waste, making it effective anti-constipation agent. High crude fiber improves glucose tolerance, hence good in managing onset of diabetes [11].

The pulp of Calabash has been reported to be used to treat diabetes when mixed with *lignum vitae* leaves [4]. It has been used also as a laxative [4].

The carbohydrate contents are 26.10% and 87.62% respectively, for Fluted pumpkin and Calabash. Calabash pulp can compare well with those of cereals (72 – 90 g/100g) [1]. The two fruits can be said to be good sources of carbohydrate. [1] reported a crude carbohydrate content of 18.61%. Carbohydrates are major sources of energy to cells such as brain, muscle and blood. They help in fat metabolism and form the bulk of the diet, and act as mild natural laxatives for humans. Lack of carbohydrate in the diet may lead to muscle breakdown, ketosis and dehydration [5]. The results from our study are higher than those of common fruits such as guava (13%) and ripe paw-paw (10%) [4].

### 3.2 Mineral Composition

The results for the mineral content of the fruit pulps are given in Tables 3 and 4. The values recorded for Fluted Pumpkin pulp and Calabash were in milligram per 100g of sample analyzed: Calcium (2.74 and 28.62); Magnesium (6.03 and 9.48); Sodium (7.84 and 18.4); Potassium (39.63 and 7.25); Iron (0.26 and 0.38); Zinc (0.94 and 3.72), and Phosphorus (5.27 and 0.43) respectively. Manganese and Copper were determined for Calabash, and values were 0.26 and 0.35 respectively. Phosphorus is present in Banana as 40mg/100g [1].

Recommended Dietary Allowance (RDA) for Magnesium is 420 mg/day[1]; ours is 6.03 and 9.48mg/100g respectively for Pumpkin and Calabash pulps, which is low.

Minerals perform important functions in the body. Calcium and Magnesium give strength to bone and tooth; help in clotting of blood; and provide nerve impulse transmission required for muscle contraction and movement [4; 5]. Calcium also helps in regulating the passage of nutrients through cell walls [5]. Magnesium helps in relaxing muscles along the airway to the lungs, thus allowing asthma patients to breathe easier. It is required in most reactions involving phosphate transfer that are essential in the structural stability of nucleic acid and intestinal absorption. Deficiency of magnesium in man is responsible for severe diarrhea, migraines, hypertension, cardiomyopathy, atherosclerosis and stroke [11].

Sodium and Potassium act as electrolytes and are involved in ion and extracellular fluid balance. They also play great roles in nervous impulse transmission [4]. Potassium plays a key role in proper heart function [4]. The values reported by [5] are lower than our results from this study. It could be as a result of the method used, or other factors. They reported 0.04% Calcium, 0.01% Magnesium, 0.02% Potassium, and 59.77ppm Sodium, against 28.62 mg/100g Calcium, 9.48 mg/100g Magnesium, 18.4 Sodium and 7.25 mg/100g Potassium reported in this study. These imply that Calabash and Fluted Pumpkin pulp could serve as sources of these minerals. Sodium and Potassium also help maintain the pH of the body, control glucose adsorption and enhance normal retention of protein during growth [1]. The sodium/potassium ratio of less than 1 is recommended for preventing high blood pressure. The (Na/K) ratio for Calabash is 2.54 and Fluted Pumpkin 0.2; which implies that Fluted Pumpkin pulp has a better potential for use in managing high blood pressure.

**Table 3.0 MINERAL COMPOSITION OF FLUTED PUMPKIN**

MINERAL	VALUE (mg/100g)
Na	7.84
Mg	6.03
Fe	0.26
Ca	2.74
Zn	0.94
K	39.63
P	5.27

**Table 4.0 MINERAL COMPOSITION OF CALABASH FRUIT**

MINERAL (mg/100g)	PULP	BACK
Ca	28.62	20.76
Mg	9.48	7.67
Na	18.40	12.58
K	7.25	5.53
Fe	0.38	0.28
Mn	0.26	0.24
Cu	0.35	0.24
Zn	3.72	2.84
PO <sub>4</sub>	0.43	0.32

The combination of these minerals is important for proper functioning of the body. For example, sodium-potassium ratio (Na/K) of less than 1 is desirable. Also calcium to phosphorus ratio (Ca/P) of 0.5 is poor, greater than 1 (>1) is good, while (>2) increases calcium adsorption in the small intestine. If the (Ca/P) calcium to phosphorus ratio is low, the concentration of calcium will be low, since high phosphorus intake leads to loss of calcium in urine, calcium and phosphorus function together, contributing to blood formation processes and other supportive structures of the body.

Calcium and Magnesium depend on each other to be assimilated into the body, and are not to be taken alone [1]. Magnesium regulates over 300 biochemical reactions such as DNA and RNA synthesis, cell growth and reproduction through their role as enzyme co-factors. It also helps the body process fat and protein, and its deficiency could affect several organs of the body [1].

The body needs equal amounts of calcium and magnesium. If calcium consumption is high, magnesium intake needs to be high too. The Ca/P ratio for Calabash and Fluted Pumpkin pulp is 66.6 and 0.5 respectively. The Ca/Mg ratio from our study is 3.0 and 0.5 respectively for Calabash and Fluted Pumpkin. The result for Ca/P indicates that calcium adsorption could be high with Calabash pulp, while Pumpkin would be poor adsorption. The Ca/Mg ratio indicates deficiencies from Magnesium and Calcium, respectively for Calabash and Fluted Pumpkin. The values recorded for Iron, Manganese, Copper and Zinc are low, compared to the previous mineral elements discussed. The fruit pulps studied are therefore potential sources of Calcium, Sodium, Potassium, Magnesium and Phosphorus, and are poor in micronutrients.

Manganese is required in enzyme reactions relating to blood sugar metabolism, and thyroid hormone function [5]. Manganese helps the immune system, and is important in energy production and cell reproduction. It works with vitamin K to support blood clotting; and with vitamin B-complex to control effects of stress. Deficiency of manganese in pregnant mothers may result in birth defects [11].

Iron in animal and human diet is important in haemoglobin formation.

Zinc helps in protein and carbohydrate metabolism and aids wound healing of worn-out tissues [5]. Zinc is an essential trace element for protein and nucleic acid synthesis, and normal body development generally. It is needed especially during recovery from illness. Zinc deficiency could result from phytic acid components of foods and could lead to poor growth, impaired immunity, increased morbidity from common infections and mortality [11].

Copper is useful in the absorption, storage and metabolism of iron and the formation of red blood cells [5]. Copper deficiency leads to cardiovascular disorders, anemia, disorders of the bone and nervous systems [11].

These essential elements are needed for the proper functioning of nervous transmission, blood circulation, fluid regulation, cellular integrity, energy production and muscle contraction; and too little can lead to deficiency disease while too much of any can be toxic [11].

### 3.3 Phytochemical Constituents

The results for the phytochemicals present in the fruit pulps are recorded in Tables 5 to 7. The following were present in the fruit pulps of Calabash and Fluted Pumpkin: Alkaloid, Flavonoid, Phenol, Saponin, Tannin, Oxalate, Phytate and Glycoside. Antioxidants were determined for calabash pulp, as 10.82 mg/100g.

Phenols are group of compounds which include salicylic acid (Willow) and rosmarinic acid. They are used in disinfection; and are the standard used to compare other bactericides in official tests. Phenols are corrosive and toxic to living cells (bacteria) [5]. They have such properties as: antibacterial, antioxidant, anti-inflammatory, antiseptic and anti-viral [1]. The presence of phenols in plants helps them ward off infection or attack by insects. The result from our study is in order since phenols have been found in other plants. The plants are Basil, Cinnamon, Thyme, Wintergreen, Rosemary and the Mints [1].

Phenol-containing herbs contribute to natural preservative systems, a quality for use in skin care products [1]. Calabash has been used in the treatment of burns because it contains phenols [5].

Tannins have astringent properties that are applied in wound healing, useful for tightening up loose tissues as found in varicose veins and for drying up secretions. They help to prevent decay and have antimicrobial activity, hence are useful in treating urinary tract infections (UTI) and other bacterial infections [1; 5]. The presence of tannin in both fruit pulps depict that they may be useful antimicrobial agents, finding application in health industry. Calabash pulp syrup is used as medicine for relieving chest or respiratory tract disorders (asthma and cough), and also for the management of dysentery and stomach aches [1]. Also, the pulp of Calabash can be mixed with *Lignum vitae* leaves to treat diabetes [4]. The unripe pulp serves as a laxative, antipyretics, analgesic (relief for headaches), cough and pneumonia treatment, burns, haematoma, shingles, tetanus, vomiting, convulsion, as well as management of menstrual irregularities, prostrate disorders and fever [4].

Flavonoids are polyphenolic compounds present in most plants. They are anti-oxidants that help protect cells from free radical damage which cause various health problems [4]. They help maintain healthy circulation, are anti-inflammatory, anti-viral and capillary strengthening [1].

Alkaloids have analgesic, antispasmodic and bactericidal properties [4]. Their presence in calabash is applied in the management of cough, and as anti-inflammatory agents [4].

**Table 5.0 PHYTOCHEMICAL CONTENTS OF FLUTED PUMPKIN PULP**

PARAMETERS	VALUE (mg/100g)
Alkaloid	8.3
Flavonoid	6.4
Phenol	12.5
Saponins	5.7
Tannins	13.8

**Table 6.0 QUALITATIVE PHYTOCHEMICAL CONTENT OF CALABASH FRUIT**

PARAMETERS	PULP	BACK
Alkaloid	++	+
Tannins	+++	++
Saponins	+	++
Flavonoids	++	++
Glycoside	+++	-

**Table 7.0 QUANTITATIVE PHYTOCHEMICAL CONTENT (TOXICANTS) OF CALABASH PULP**

PARAMETER	VALUE (mg/100g)
Oxalate	42.38
Phytate	16.94

Saponins are found in most medicinal plants. They are known as natural antibiotics and energy booster [4]. They help reduce inflammation of the upper respiratory tract. Also helps in reducing body cholesterol by preventing its re-absorption. Another important attribute is that they help suppress rumen protozoa by reacting with cholesterol in protozoan cell membrane, thereby dissolving it[1]. High concentration of saponin causes gastroenteritis, diarrhea and dysentery (Verla *et al.*, 2014). Saponins foam when mixed with water. This is a characteristic of Calabash pulp juice observed in this study. Saponins serve as foaming, emulsifying agents and detergents (Ogbuagu, 2008). Calabash pulp juice is a potential raw material in the soap and detergent industry.

Cyanogenic glycoside content was determined for calabash pulp too. Calabash has been reported to contain hydrocyanic acid which is used as a purgative [4].

Toxicants; oxalate and phytate were determined in Calabash pulp. The values are 4.24 mg/kg and 1.69 mg/kg respectively for oxalate and phytate, and are lower than the standard toxic level 2.5 g/kg and 50 mg/kg respectively. These results infer that the Calabash juice is not toxic, hence its application in medicine.

Oxalate has negative impact on the availability of minerals in the body; causes irritation in the mouth and could interfere with absorption of divalent minerals, especially calcium by forming irresoluble salts [1]. It is implicated as a source of kidney stones, as high oxalate diet increases renal calcium absorption. Excessive oxalic acid consumption may cause corrosive gastroenteritis [1].

Phytate can bind to essential minerals in the digestive tract and cause mineral deficiencies. It also decreases bioavailability of minerals in monogastric animals [1; 4].

There is need to grow the Calabash and Fluted Pumpkin plants because virtually all parts of these plants are useful to man. For example, Fluted Pumpkin seed is used for vegetable oil production and margarine. The seed oil is also used as drying oil for paints and varnishes. The seed raw flour has water and fat absorption properties and is useful in baking. The rind and pulp serve as feedstuff for livestock. Stems are macerated to produce fibers used as sponge. Calabash on the other hand is used for several purposes. The leaves are used to reduce blood pressure. The tree bark to clean wounds, treat hematomas and tumors. Dried fruit shells are used as natural bowls for drinking and eating, used by craft makers in tourist industry, for jewelry, musical instrument such as rattles, and as souvenirs (money containers and handbags).

The young fruit may be warmed, split open and applied to abscesses and boils to reduce them. The juice from Calabash fruit could be squeezed and simmered with Cinnamon, Nutmeg and Anise to make a herbal syrup. This could be used to treat respiratory conditions, applied to sores, external ulcers and other skin ailments to promote healing [1].

### CONCLUSION

The results from this study have proven that Calabash (*Crescentia cujete*) and Fluted Pumpkin (*Telfairia occidentalis* Hook.F) pulps have application in medicine, agriculture, nutrition and industry. For example, high carbohydrate yield can be hydrolysed to reducing sugars that could find use in the biofuel industry.

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