

Phytochemistry Analysis of Tiger Nut (*Cyperus esculentus*) Juice Fortified with Organic Additives

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Abstract

Plants' juices are widely consumed due to their presumed high nutritional and medicinal qualities. This research evaluated the phytochemical properties of tiger nut (*Cyperus esculentus*) tuber juice/milk fortified with a mixture of ginger (*Zingiber officinale*) and Negro pepper (*Xylopia aethiopica*) extract. The freshly prepared tiger nut juice was fortified with 0%, 2%, 4% and 6% of the plants extracts, and accordingly coded TME 0, TME 1, TME 2 and TME 3; and their Phytochemical parameters measured through standard procedures. The findings indicated that the plants' extract significantly increased, regardless of the phytochemical parameter investigated. The cardiac glycoside level in the juice fortified with 2%, 4% and 6% plants' extract was 4.40%, 5.11% and 5.53% respectively; while the saponin content in the TME 0, TME 1, TME 2 and TME 3 juice samples was 6.68%, 6.82%, 7.40% and 7.70% respectively. Furthermore, it was observed that the anthocyanins and alkaloid levels in the juice increased from 3.12% - 3.93% and 5.13% - 7.34%, as the plants' extract concentration increased from 0 to 6%. It was observed that the anti-nutrient compositions (phytate and tannin) of the tiger nut juice, increased in an uneven pattern as the fortification degree increased from 0% to 6%. This study's findings will be useful in food industries in optimizing nutrient enhancement of foods and drinks, without accumulating excessive anti-nutrients in the fortified products.

INTRODUCTION

Phytochemical compounds are nutritional and non-nutritive substances, commonly found in plants, which helps in preventing chronic ailments in human beings. Phytochemicals have numerous pharmacological effects on human health, as they can impede cancer cells formation, prevent heart failure, lower low-density lipoprotein (LDL) production, and significant antimicrobial actions (Gühr and Lachance, 1997). According to Russell et al. (2016), foods rich in phytochemical compounds have the potential to regulate the blood sugar level, when consumed in a balanced diet format. Plants' juice which numerous people widely consumed contain substantial amount of bioactive compounds. These compounds functions are beyond nutritional value, but also include pharmacological qualities. Chung *et al.* (1998) stated that several polyphenols components have anti-carcinogenic potentials; thus, their incorporation in diets has enormous benefits.

Plants have a lot of bioactive compounds, which include several phytochemical compounds and organic acids most essentially, ascorbic and citric acids (Singh *et al.*, 2020; Uguru *et al.*, 2022a). Phytochemical compounds are extensively distributed in different parts of plant

- the root and shoot systems. These phytochemicals are active ingredients in both orthodox and traditional medicines (Richter *et al.*, 2023). Diets with moderate spices, fruits and vegetables help mitigate heart disease, cataracts and respiratory problem. Juices are widely used as laxative; thus averting constipation in humans. Roots and tubers not only contain large amounts of carbohydrates and fibres, but also a fair amount of amino acids and antioxidants. This multipolarity nature of plants makes their fibres, extracts and juice useful in several engineering and medical applications. The concentration of the biochemical parameters in a plant's body is a factor of the plant's variety, prevailing climatic conditions, soil nutritional status, pre-harvest treatment and storage conditions (Ekruyota *et al.*, 2021; Uguru and Obah, 2020).

Tiger nut (*Cyperus esculentus*) and ginger (*Zingiber officinale*) are some of the commonly cultivated crops in Africa, but their parts are widely underutilized in Africa continent. In southern Nigeria ginger is found growing wide, probably due to the high nutritional status of the region's soil, moderate temperature, and the region's high (but evenly spread) rainfall pattern (Uguru *et al.*, 2021). Like most agricultural materials, the tuber of tiger nuts has several medicinal and cosmetics qualities, due

to the presence of vitamins, antibacterial, antioxidants and phytochemical compounds in the tubers. Tiger nut juice and ginger powder have numerous nutritional and pharmacological compounds (Musa *et al.*, 2022); hence, their extracts are widely utilized in the pharmaceutical industry. Benavides *et al.* (2016) reported that tiger nut extract inhibits tumor growth, hinders cholesterol formation, and reduce the chances of heart related problems. In spite of the numerous advantages of tiger nut juice, it contains some amount of anti-nutrients such as, tannin, oxalate and phytate. These compounds inhibit the absorption of essential nutrients by the human body; thus increasing the chances of nutrient deficiency related illnesses (Akpokodje and Uguru, 2019). Despite the nutrients antagonizing characteristics of anti-nutrients, some still have health benefits, including hindering tumor formation, and lowering the blood cholesterol and sugar level content. Most anti-nutrients belong to the antioxidant family, which are strong oxygen scavengers.

Plants extracts are usually used to enhance the plant's juice biochemical properties and storability. Extracts from spices are commonly used to improve the nutritional, stability and medicinal qualities of plant's juice/milk. This phenomenon could be linked to the high antimicrobial, antioxidants, phenolic and phytochemicals compositions embedded in the plants tissues (Yashin *et al.*, 2017). Several studies have been done on fortifying (blending) plants' juice with green extracts to increase their storability and nutritional values (Pyo *et al.*, 2014; Jayachandran *et al.*, 2015). Information dearth still exists on the blending of tiger nut juice with natural extract, to improve its nutritional value. Therefore, this research's main purpose was to enhance of tiger nut juice with Negro pepper (*Xylopia aethiopica*) and ginger waste extract. Results obtained from the laboratory tests will be helpful in the food processing industry, and aids further utilization of agricultural waste materials in the production of green extracts.

MATERIALS AND METHODS

Materials

The tiger nut and ginger were planted in Ozoro, Delta State of Nigeria, using the organic farming method. The soil was the alluvial type, with moderate water holding capacity. Ozoro is located in Southern Nigeria with two main climatic seasons - rainy and dry seasons. The main annual rainfall of the region is approximately 1800 mm pa, and the area is characterized by a high water table during the rainy season (Uguru *et al.*, 2022b). The tiger nut tubers and ginger rhizomes were harvested at peak maturity, washed and sorted.

The Negro pepper (*Xylopia aethiopica*) pods were purchased from a local market in Delta State, Nigeria. The pods were sorted to discard all the damage and pests infested ones. All the reagents and equipment used for the laboratory analysis were obtained from the biomaterial Laboratory, Department of Agricultural Engineering, Delta State University of Science and Technology, Ozoro, Nigeria.

Preparation of tiger nut juice

The prepared tiger nut tubers were crushed and the juice (milk) was extracted manually using a 0.075 mm plastic sieve. Further concentration of the liquid obtained after the sieving was not carried out.

Plant extracts preparation

The dried Negro pepper skin and ginger rhizomes, were blended at a ratio of 1:1 (by mass), and grind with a mechanical grinder. Thereafter, an extract was prepared from the ground mixture by using solvent (ethanol) method (Abubakar and Haque, 2020).

Blending (formulation) of the tiger nut juice

The tiger nut juice was fortified with 0%, 2%, 4% and 6% of the plants extracts, and coded accordingly, by using the following pattern:

TME 0 - Fresh tiger nut juice with 0% plants' extract

TME 1 - Fresh tiger nut juice incorporated with 2% plants' extract

TME 2 - Fresh tiger nut juice blended with 4% of the plants' extract

TME 3- Fresh tiger nut juice fortified with 6% of the plants' extract

Phytochemical analyses

The phytochemical analyses of the unblended and blended juice were done using the Gas Chromatography-Mass Spectroscopy (Banu and Cathrine *et al.*, 2015).

RESULTS AND DISCUSSION

Phytochemical parameters of juice

The laboratory findings of the phytochemical parameters of both the blended and unblended tiger nut juice are presented in Table 1. As shown by the phytochemistry analysis of the tiger nut drink, there is substantial presence of alkaloids and phenolic compounds - which were higher in the blended juice when compared to the unblended juice. Generally, the results revealed that the cardiac glycoside level in the juice increased remarkably (from 4% to 5.5%), after adding the blended plants' extract to the juice. Table 1 depicted that the cardiac glycoside concentration in the juice blended with 0%, 2%, 4% and 6% plants' extract was 4.06%, 4.40%, 5.11% and 5.53% respectively. Also it was noted (Table 1) that the saponin concentration in the juice was 6.68%, 6.82%, 7.40% and 7.70% in the TME 0, TME 1, TME 2 and

TME 3 samples. Additionally, the Tannin content in the tiger nut juice increased from 12.83% to 14.95% as the combination of the ginger and Negro pepper extracts increased from 0% to 6%. The Tannin values recorded for the TME 0, TME 1, TME 2 and TME 3 samples were 12.83%, 13.31%, 14.30% and 14.95% respectively (Table 1). The results revealed that the flavonoid content in the tiger nut juice was 7.79%, 8.55%, 8.99% and 9.29% for the TME 0, TME 1, TME 2 and TME 3 prepared samples respectively.

Furthermore, the alkaloid concentration of fresh tiger nut juice (TME 0) was 5.13%, and after fortification was 5.88% (THE 1), 6.66% (THE 2) and 7.34% (TME 3). This indicates that the fortified extract has significantly influence on level of alkaloid present in the juice. It was observed that the unblended juice phytate concentration was 0.69%. The values increased to 0.74%, 0.79% and 0.86%, after fortification with 2%, 4% and 6% plants' extract respectively. Likewise, the anthocyanins concentration in the juice increased from 3.12% to 3.93% as the plants' extract concentration increased from 0 to 6%. It was recorded that for the TME 0, TME 1, TME 2 and TME 3 juice samples, the anthocyanins level was 3.12%, 3.25%, 3.68% and 3.93%, respectively. The phenol concentration in the prepared juice samples was 2.46 mg/kg, 2.71 mg/kg, 2.97 mg/kg and 3.12 mg/kg for the tiger nut juice fortified with 0%, 2%, 4% and 6% plants' extract. These findings are indications that the two crops' extracts increased the phytochemical properties of the tiger nut juice, hence boosting the nutritional and health benefits of the juice.

It was observed in the findings that the concentrations of the phytochemical properties of the tiger nut juice produced in this study were different, when compared to the reports from other studies report (Ekeanyanwu *et al.*, 2010; Bando *et al.*, 2020). This could be linked to the difference in pre and post harvesting methods, which the tiger nuts were subjected to. Farming method, maturation stage, processing method and prevailing environmental conditions are some of the critical factors that influence the engineering and biological properties of plants materials (Umaru *et al.*, 2018; Eboibi *et al.*, 2019; Uguru *et al.*, 2021b; Idama *et al.*, 2021).

Table 1: The phytochemical properties of the juices samples

Parameter	Juice samples			
	TME 0	TME 1	TME 2	TME 3
Cardiac glycoside (%)	4.06±0.07	4.40±0.09	5.11±0.23	5.53±0.37
Sapnins (%)	6.68±0.12	6.82±0.41	7.40±0.06	7.70±0.07
Tannin (%)	12.83±0.12	13.31±0.22	14.30±0.21	14.95±0.08
Alkaloid (%)	5.13±0.04	5.88±0.14	6.66±0.21	7.34±0.07
Flavonoid (%)	7.79±0.06	8.55±0.07	8.99±0.09	9.29±0.09
Phytate (%)	0.69±0.02	0.74±0.02	0.79±0.02	0.86±0.03
Anthocyanins (%)	3.12±0.12	3.25±0.09	3.68±0.09	3.93±0.08
Phenol (mg/kg)	2.46±0.03	2.71±0.03	2.97±0.11	3.12±0.06

The significant increment observed in the phytochemical parameters of the fortified fresh tiger nut juice, is similar to the reported studies by Eke-Ejiofor and Beleya (2018) and Musa *et al.* (2022). Liu *et al.* (2021) reported that plants' extract and oil can be used to improve the poor nutrients compositions of most foods and juice. This study's findings affirmed previous reports that spices are good fortifying agent (additives), enhancing the biological composition of foods and drinks (Srinivasan, 2014; Singhal *et al.*, 2017). Yashin *et al.* (2017) reported that spices tissues are rich in phenolic compounds. The increment in the phytochemical parameters of the tiger nut drink after fortification has a lot of health benefits attributes. Cardiac glycoside is an essential phytochemical compound that helps to reduce the occurrence of heart attack and arrhythmias; while sapnins have the ability of alleviating hypercalciuria problem in human beings, minimize cancer hazards, and also a potential antidote to lead toxicity (Richter *et al.*, 2023). According to Khoo *et al.* (2017), anthocyanins possess excellent antidiabetic and antimicrobial qualities, and can prevent cardiovascular disorders.

Remarkably, the blended juice anti-nutrients components increased non-linearly with increase in the extract quantity (from 2% to 6%). The blended juice obtained through 4% extract mixture gave the best results, considering both the nutrients and anti-nutrients concentrations recorded in the fortified juice. The high percentage of the anti-nutrients noted in the juice fortified with 6% extract mixture, shows that caution

should be taken when enhancing foods and drinks with spices. Lower dosage anti-nutrients level has several health benefits; however, research findings had indicated high at high dosage anti-nutrients has serious health implications in human beings. Chung *et al.* (1998) stated that high bio-accumulation of tannins in human body could be carcinogenic. Consumption of this fortified juice will be of great nutritional help to humans; as it will help to reduce the occurrence of nutrient-borne deficiency diseases. Interestingly, this study's findings will be helpful in food industries in optimizing nutrient enhancement of foods and drinks, without accumulating excessive anti-nutrients in the fortified products.

CONCLUSION

This study was conducted to assess the impact of natural additives, on the phytochemical composition of tiger nut juice. The findings revealed that the combination of ginger and Negro pepper extract significantly increased the phytochemical parameters of the tiger nut drink. It was noted that apart from the nutrients component of the juice, the anti-nutrients composition of the tiger nut juice increased un-evenly, as the extract quantity increased from 2% to 6%. The higher concentration of anti-nutrients in the juice samples, blended with higher percentage (6%) of the plants extract, indicates that moderate quantity of spices should be used for foods and drinks fortification. In summary, the results showed that adding small amount of spices and herbs to plant's juice helps improve its nutrient composition.

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