Phytochemical Composition of Ice Cream from Tigernut (Cyperus esculentus) milk and Coconut (Cocos nucifera) Milk

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ABSTRACT

Background: *Coconut and tiger nut are widely used for human consumption. Coconut milk and tiger nut milk can be extracted for ice cream production.*

Objective: *This study determined the phytochemical composition of tiger nut milk (Cyperus esculentus) and coconut milk (Cocos nucifera) ice cream.*

Method*: The research design was an experimental design. The tiger nuts and the endosperm of the coconuts were ground separately. The milk extracted were used in preparing ice cream using standard recipe. Cow milk ice cream served as the control. All the samples of ice cream were quantitatively screened for phytochemical determination using standard methods. Mean and standard deviation were calculated for all the samples. Analysis of variance (ANOVA) were used to compare the means. Significant differences were accepted at P<0.05 level of significance using Duncan's Multiple Range Test.*

Results: *The phytochemical analyses carried out on the ice creams from coconut milk, tiger nut milk and blend of coconut milk and tiger nut milk (50:50) showed the presence of alkaloids, tannins, saponins, and flavonoids in low concentration. Research results revealed significant differences in tannins content among tiger nut ice cream (0.06 ± 0.00), coconut ice cream (0.01 ± 0.00) as well as their blend (0.03 ± 0.00) at P<0.05 level of significance. Tiger nut milk ice cream, coconut milk ice cream and their blends contain flavonoids and alkaloids. However, saponins were present in the plant milk ice creams with the exception of coconut milk ice-creams (0.00 ± 0.00).*

Conclusion: *Coconut milk, tiger nut milk and the blends of coconut milk and tiger nut milk have been recommended for ice cream production due to their phytochemical constituents.*

Keywords: Tiger nut *(Cyprus esculentus)*, coconut *(cocos nucifera),* photochemical, ice cream.

INTRODUCTION

Food is a key factor that affects the health of people. Therefore, it is important to make the right choices in order to be in good health (1, 2, 3). Recently researchers have shown strong interest in plant milk ice cream due to their high nutritional values and economic potentials. Plant milk ice cream contains enzymes and substances that make digestion easier as they stimulate digestive juice and speed up the intestinal tract and so prevent constipation. Plant milk ice cream is also good for the vegetarians (4).

Ice cream is a foam that is stabilized by freezing much of the liquid. In its frozen state, ice cream is made up of some liquids containing dissolved

salts, sugars, suspended milk proteins and milk fats (5). Ice cream is an important source of calcium. Martinez (6) expressed the need to find a milk substitute for those that are intolerant to lactose in animal milk and animal milk products.

Tiger nut (*Cyperus esculentus*) is a member of the family cyperaceae. It is a tuber that grows and is consumed widely in West Africa. Tiger nut has been reported as a wholesome food and its derived product tiger nut milk also. It is widely used for animal (feed) and human consumption. In Igbo land tiger nut is known as 'aki- awusa' and three varieties are cultivated; among these only two varieties-yellow and brown are sold in the market. The yellow variety is preferred to all other varieties because of its inherent properties like bigger size, attractive colour and fleshier body. The yellow variety also yields more milk upon extraction, contains lower fat and more proteins, and less anti-nutritional factors (7). It is eaten unprepared, soaked in water, or dried and mixed with roasted peanuts. Tiger nut is also known by various other names such as earth nut, yellow nut sedge, groundnut and rush nut (8). Tiger nut has been reported to be a "health" food, since its consumption can help prevent heart disease and thrombosis and is said to activate blood circulation (9). It was also found to assist in reducing the risk of colon cancer (10). Its sweet almond-like tubers are highly appreciated for their health benefits and nutritive value: high content of fiber, proteins, and sugars. They are rich in oleic acid and glucose, as well as in phosphorus, potassium, and vitamins C and E. This tuber is rich in energy content (starch, fat, sugar, and protein), minerals (mainly phosphorus and potassium), and vitamins E and C (11, 12).

Foods based on tiger nut are prepared by a wide range of recipes and preparation methods. The best - known application of tiger nut in food technology is the production of "horchata de chufa" (tiger nut milk). Other uses include fermented milk products (such as yoghurt), flour, edible oil, honey, jam, chocolate, candies and soaps (13). It is also used successfully as a flavouring agent in ice cream. Flour of roasted tiger nuts are sometimes added to biscuits and other bakery products (14), as well as in making oil, soap and starch extracts (15). Belewu and Abodunrin (16) found tiger nut useful in the preparation of kunnu (a local beverage in Nigeria). Kunnu is a non alcoholic beverage prepared mainly from cereals (such as millet or Sorghum).

Coconut (*cocas nucifera*) is an important member of the family Aracaceae and genus cocas. Coconut is a large palm, growing up to 30m tall, with pinnate leaves 4 - 6m long and pinnae 60-90cm long; old leaves break away cleanly leaving the trunk smooth. Coconut water is the liquid or clear fluid found within the coconut seed, while the coconut milk is extracted from coconut meat (endosperm - the white inner flesh of mature coconuts). Grated coconut meat or desiccated coconut is squeezed to extract thick coconut milk. The squeezed coconut meat is soaked in warm water and squeezed again to make thin coconut milk. Coconut milk is a sweet, opaque, milk-white protein-oil-water emulsion liquid extracted from the grated pulp of mature coconuts. This milky liquid can be either thick or thin, thus forming the two different types of coconut milk. Thick coconut milk is used for the thick, rich creams and sauces for desserts, while thin coconut milk is more commonly used for soup. In addition to these, coconut meat can be eaten with boiled or roasted maize. The quality attributes are affected by many factors, such as the variety of nuts, water quality and volume used for coconut milk extraction. Due to its high oil content, coconut milk products are highly susceptible to chemical and biochemical spoilage, like lipid oxidation. The opacity and rich taste of coconut milk are due to its high oil content, most of which is saturated fat. Coconut milk is differentiated into subtypes based on fat content. They can be generalized into coconut cream (or thick coconut milk) with the highest amount of fat; coconut milk (or thin coconut milk) with a maximum of 20% fat; and coconut skim milk with negligible amounts of fats (17).

The composition of coconut milk is affected by the composition of coconut kernel. It is important to highlight that the difference in oil content at various ages of the coconut kernel relates to the yield and quality of coconut milk obtained. While a young coconut at eight to nine months old has only about 18 - 26% oil content, a mature coconut at 10-13months has up to 43% oil content. Therefore, these mature coconuts are typically harvested for coconut milk production (18). The milk is also a good source of several vitamins and minerals (19).

Coconut milk is a relatively stable oil- in - water emulsion with proteins that act as emulsifiers and thickening agents. Based on fat content, coconut

milk is divided into different subtypes generally simplified into "coconut cream" (also called " thick coconut milk" and "thin coconut milk", respectively) (20). Coconut milk can also be used to produce milk substitutes (differentiated as "coconut milk beverages"). These products are not the same as regular coconut milk products which are meant for cooking, not drinking (21).

Phytochemicals ('phyto' is from the Greek word meaning plant) are bioactive plant chemicals in fruits, vegetables, grains and other plant foods that may provide protective or disease - preventive effects thereby reducing the risk of major chronic diseases. They have been associated with protection from and / or treatment of chronic diseases such as cancer, hypertension, diabetes, coronary heart disease, diabetes, inflammation, infection, ulcers and other medical conditions. Also, they promote health, slow the ageing process and reduce the risk of many diseases (22). Phytochemicals have great antioxidant potential and are of great interest due to their beneficial effects on health of human beings. They have been shown to protect our cells against oxidative damage caused by free radicals. Phytochemicals with antioxidant activity include lycopene in tomatoes, is flavones in soy beans, flavonoids in fruits, alkyl sulfides found in onions, leeks and garlic; carotenoids found in fruits and carrots; flavonoids found in fruits and vegetables; polyphenols found in tea and grapes. The importance of alkaloids, saponins and tannins in various antibiotics used in treating common pathogenic strains has been reported (1, 3, and 23).

Tannins have both beneficial or anti nutritional properties depending upon their chemical structure and dosage. They are classified as anti-nutrients as a result of their toxic properties and as phytochemicals due to their health beneficial properties. Tannins react to cause enzymatic browning on the cut or bruised surfaces of fresh fruits and vegetables. The tannin content of fruits and vegetables varies. Banana, grapes, spinach, sorghum and red wine contain high levels. The amount of tannin in tea varies with the type of tea and its stage of growth. Green tea has 4% tannin and black tea have as much as 33% (3, 24).

Alkaloids in plants were recognized for their religious, medical and social uses (3). Alkaloids are the most effective therapeutically significant plant substance. The clinical success of quinine and quinidine which are constituent of alkaloid are used in the treatment of malaria (25,26).

Saponins are found in various parts of the plant: leaves, stems, roots, bulbs, blossom, and fruit. They are characterized by their bitter taste. The word sapon means 'soap', referring to the permanent froth saponins make on being mixed with water (27). Saponins exhibit a range of biological properties, both beneficial and deleterious (28, 29). Studies have shown that the presence of saponins in edibles have important therapeutic activities such as hemolytic properties, anti-inflammatory, antifungal or anti yeast, antibacterial or antimicrobial, anti parasitic and antiviral (30,31,32).
The most prevalent flavonoids are anthocyanin's. Although most yellow colors in food are attributable to the presence of carotenoids, some are attributable to the no anthocyanin-type flavonoids. No anthocyanin flavonoids are also responsible for whiteness in onions and potatoes (3).
Recently researchers have shown strong interest in plant milk ice-cream due to its high nutritional values and economic potentials (4,6). Plant milk ice creams contain enzymes and substances that aid digestion and prevent constipation (4). Research report indicate a dramatic decrease in the consumption of milk and ice cream which stimulated in part the processing of milk from plant sources (33). Also, the high cost of milk from animal sources necessitates the development of cheaper milk from plant sources (34). Martinez (6) documented the need to find a milk substitute for those that are intolerant to lactose. Ice cream made from coconut and tiger nut milk has been recognized for their health benefits.

The production of ice cream from plant sources that can be used to combat certain sicknesses has become necessary as a result of high rate of diseases. Parsley (35) reported that coconut *(Cocoas nucifera*) is being used to produce confectionaries, biscuits and ice cream. In addition to these, coconut milk can be taken raw or as a substitute for animal milk in tea and coffee. Therefore, this study sought to determine the phytochemical composition of ice cream made from coconut milk (*Cocoas nucifera),* tiger nut milk *(Cyprus esculents)* and their blends.

Objectives of the Study
The purpose of this study was to determine the phytochemical composition of ice cream produced from tiger nut *(Cyprus esculents)* and coconut (*Cocoas nucifera)* milk. Specifically, the

study:
1. Produced ice cream from tiger nut milk.
2. Produced ice cream from coconut milk.
3. Produced ice cream from the blend of tiger nut milk and coconut milk (50:50).
4. Determined the phytochemical composition of ice cream from tiger nut milk, coconut milk and their blends.
5. Compared phytochemical composition of ice cream from tiger nut milk, coconut milk, blend of tiger nut and coconut with cow milk.

Materials
Yellow variety tiger nuts and white variety coconuts were purchased from Ariaria International market in Aba, Abia State. Coconut milk is made by grating flesh from brown coconuts which are soaked in water and then strained to produce a milk- like consistency. Powdered cow milk was bought from a supermarket in Umuahia, Abia State. Cow milk served as control for the study.

Method
The research was carried out using an experimental design. The procedure for the experiment involved extraction of tiger nut milk and coconut milk for the production of ice cream and the determination of phytochemical composition of ice cream from coconut milk, tiger nut milk and the blend of coconut milk and tiger nut milk in the ratio of 50:50. The ice cream samples were analyzed in triplicates in the laboratory (25).

Preparation of tiger nut milk
Preparation of tiger nut milk was done by picking out the bad nuts that could affect the taste and keeping quality of the ice cream. Water Extraction (aqueous) method was used in extracting the tiger nut milk. The tiger nuts were washed and rinsed with potable water. The washed nuts were soaked overnight to soften the fiber. 6 liters of potable water were added to 1 1kg of the tiger nuts and blended several times with a blender, filtered with a muslin cloth and squeezed in order to extract the milk. The tiger nut milk was used to prepare ice cream.

Preparation of coconut milk
Coconuts were dehusked and broken to release the solidified endosperm (kernel). The endosperm was washed, grated. Water Extraction (aqueous) method was used in extracting the tiger nut milk. Preparation of coconut milk was done by shelling the coconut. The meat was separated from the shell with a dull knife. The brown skin was removed from the coconut meat with a razor blade. The meat was thoroughly washed and grated. The grated meat was put in a bowl. 1 liter of warm water was added to the grated meat and left for a five minutes before filtering with a muslin cloth in order to extract the milk. The coconut milk was used to prepare ice cream.

Coconut milk is traditionally made by grating the white inner flesh of mature coconuts and mixing the shredded coconut pulp with a small amount of hot water in order to suspend the fat present in the grated pulp. The grating process can be carried out manually or by machine.
Coconut is also traditionally divided into two grades: coconut cream (or thick coconut milk) and thin coconut milk. Coconut cream contains around 20% to 50% fat; while thin coconut milk contains 5% to 20% fat. Coconut cream is extracted from the first pressings of grated coconut pulp directly through cheesecloth. Sometimes a small amount of hot water may be added, but generally coconut cream is extracted with no added water. Thin coconut milk, on the other hand, is produced by the subsequent pressings after soaking the squeezed coconut pulp with hot water (28).

Recipe for ice cream: Four ice cream samples namely coconut ice cream, tiger nut ice cream, coconut and tiger nut ice cream and cow milk ice cream (control) were produced separately.

Ingredients	Quantity
Egg yolks (emulsifying agent)	50ml
Fine sugar	25g
Coconut milk	350ml
Tiger nut milk	350ml
Coconut / Tiger nut milk blend (50:50)	350ml
Vanilla essence	5ml
Cow milk powder (Control)	300g
Water (for reconstituting cow milk powder)	50ml

Table 1: Phytochemical Composition of the Ice Cream Samples

	Tannins (%)	Flavoniod (%)	Alkaloids (%)	Saponins (%)
Tiger nut milk ice cream	$0.06^{a}\pm0.00$	$0.11^{a}\pm0.01$	$0.07^{a}\pm0.01$	$0.03^{a}\pm0.01$
Coconut milk ice cream	$0.01^{c}\pm0.00$	$0.05^{c}\pm0.01$	$0.03^{b}\pm0.01$	$0.00^{b}\pm0.00$
Tiger nut and coconut milk ice cream (50:50)	$0.03^{b}\pm0.00$	$0.07^{b}\pm0.01$	$0.05^{b}\pm0.01$	$0.05^{ab}\pm0.01$
Cow milk ice cream (control)	$0.00^{d}\pm0.00$	$0.00^{d}\pm0.00$	$0.00^{c}\pm0.00$	$0.00^{b}\pm0.00$

Values are expressed as mean ± standard deviation of triplicate determinations
^{a,b,cd} means in a column with different superscripts are significantly different ($P<0.05$).
% percent

Method

1. Whisk egg white until it forms a thick cream.
2. Mix or fold gently the icing sugar, milk (sample 1: coconut milk; sample 2: tiger nut milk; sample 3: blend of coconut and tiger nut milk; sample 4: cow milk) and vanilla essence using a clean metal spoon in order to retain as much air as possible.
3. Place the bowl over a saucepan of simmering water and continue stirring until the mixture is thick enough to coat the wooden spoon.
4. Remove the bowl from the heat and cover the surface directly with plastic wrap or waxed paper to prevent a skin from forming.
5. Allow to cool.
6. Freeze for 30minutes, or until half frozen. Beat the mixture vigorously.
7. Return to the freezer at least two hours before serving (3, 4, and 5).

Chemical analysis

All the samples of ice cream were quantitatively screened in triplicates for phytochemical determination according to the procedure enumerated by Harbored (36) method for tannins and alkaloid; Sofowora (37) method for saponins; Ververidis, Transat, Douglas, Vollmer, Kretzschar and Panopoulos (38) method was used for the determination of flavonoids.

Statistical Analysis

Mean and standard deviation were calculated for all the samples. One-way analysis of variance (ANOVA) were used to compare the means. Significant differences were accepted at 5% level of significance using Duncan's Multiple Range Test.

Results

Findings on the phytochemical composition of tiger nut milk ice cream (Cyprus esculents) , coconut milk ice cream(*cocas nucifera*) and their blends were presented in Table 1.

Result from analysis revealed significant differences in tannins content among tiger nut ice

cream (0.06^{a}±0.00), coconut ice cream (0.01^{c}±0.00) as well as their blend (0.03^{b}±0.00) at 0.05 probability level. However, tannin content in tiger nut ice cream was greater than that of coconut ice cream and their blend. Flavonoid in tiger nut (0.11± 0.01)) was greater than that of the blend (0.07±0.01) and showed a significant difference at (P< 0.05) with that of the blend. Coconut milk ice-cream contained (0.05±0.01) flavonoid. Flavonoid was absent in cow milk ice-cream (0.00±0.00) and therefore showed a significant difference (P<0.05) in flavonoid content when compared with cow milk.

Alkaloids in tiger nut (0.07±0.01) was significantly different from coconut milk ice-cream (0.03±0.01) and the blend (0.05±0.01) and absent in cow milk ice-cream (0.00±0.00). Tiger nut milk ice cream has a higher saponin content (0.03±0.01) but showed no significant difference (p<0.05) with that of tiger nut milk and coconut blend ice cream. Coconut milk ice-cream and cow milk ice cream (0.00±0.00) do not contain saponin.

Discussions

The phytochemical analyses on the ice cream from tiger nut and coconut milk showed the presence of alkaloids, saponins and tannins in low concentration. Result from analysis revealed significant differences in tannins content among tiger nut ice cream (0.06^{a}±0.00), coconut ice cream (0.01^{c}±0.00) as well as their blend (0.03^{b}±0.00) at 0.05 level of significance. However, tannin content in tiger nut ice cream (0.06) was greater than that of coconut ice cream (0.01) and their blend (0.03). Research results are in agreement with the findings of Ekeanyanwu, *et al.* (39) and Martinez (6) on phytochemical composition of Nigerian tiger nut. The authors reported that alkaloids, tannins and saponins were present in the raw tuber. Tannins have properties that hasten the healing of wounds and aid in the prevention of tooth decay. Tannin compounds have antimicrobial activities and are responsible for preventing and treating urinary tract infections and other bacterial infections.

Flavonoid in tiger nut (0.11± 0.01) was greater than that of the blend (0.07±0.01) and showed a significant difference at (P< 0.05) with that of the blend. Coconut milk ice-cream contained (0.05±0.01) flavonoid. Coconut milk ice-cream contained (0.05±0.01) flavonoid. Flavonoid was absent in cow milk ice-cream (0.00±0.00) and therefore showed a significant difference (P<0.05) in flavonoid content when compared with cow milk. Findings are in agreement with the documentation of Ghanson (4). Phytochemical compounds determined by Chukwuma *et al.* (9) indicated that tiger nut tubers have some biologically active compounds which could serve as potential sources of drugs. They are invaluable sources of raw materials for both traditional and orthodox medicine.

Findings from the study indicate that tiger nut milk ice cream, coconut milk ice cream and their blends contain alkaloids. Alkaloids, saponins and tannins are known to have antimicrobial activity as well as other physiological activities. Similarly, Chukwuma *et al.* (9) investigated the phytochemical composition of the raw and the roasted tiger nut tuber. The phytochemical screening showed a high content of alkaloids, sterols and resins. Saponins and tannins were detected in raw tiger nut tubers. In the roasted tuber, only alkaloids, sterols and resins were detected.

Alkaloids in tiger nut (0.07±0.01) was significantly different from coconut milk ice-cream (0.03±0.01) and the blend (0.05±0.01) and absent in cow milk ice-cream (0.00±0.00). Research results confirmed report by Martinez (6). Some have been used as analgesic, antispasmodic, and antibacterial agents (9). According to Isitua *et al.,* (40), Trease and Evans (41), alkaloids are one of the largest groups of phytochemicals that have led to the invention of powerful pain killer medications.

Tiger nut is not a real nut; despite its name, tiger nut is a tuber. However, its chemical composition shares characteristics with tubers and with nuts. Tiger nut milk ice cream has a higher saponin content (0.03±0.01) but showed no significant difference (p<0.05) with that of tiger nut milk and coconut blend ice cream. Coconut milk ice-cream and cow milk ice cream (0.00±0.00) do not contain saponin. Saponins have been reported to be useful in reducing inflammation of the upper respiratory passage and also chiefly as foaming and emulsifying agents and detergents. Coconut milk ice cream, tiger nut milk ice cream and their blends have been recommended as good substitutes for cow milk (23, 24, and 41).

Conclusion

Tiger nut milk ice cream, coconut milk ice cream and their blends contain phyto-chemicals which included flavonoids, alkaloids and saponins. The content and concentration of phytochemicals in tiger nut and coconut milk ice cream suggest that they also contribute to the beneficial role of plant foods in health promotion and disease

prevention. Considering the nutritive and health benefits of tiger nut milk ice cream and coconut milk ice cream, there is need to create awareness of their health benefits in order to increase their utilization. Development of new products from tiger nut and coconut could enhance more interest in these plant foods. It was concluded that coconut milk and tiger nut milk could be used as a substitute to animal milk in producing ice creams. It is necessary to investigate the shelf-life of tiger nut and coconut milk ice-creams for optimal utilization needed for achieving adequate nutrition of Nigerian citizens.

Recommendations

Based on findings of this study, the following recommendations have been made:

1. Tiger nut milk and coconut milk can be utilized in producing ice creams for individuals, families, hotels and fast food industries.
2. Tiger nut and coconut milk ice creams are recommended for their phytochemical composition which suggest that they also contribute to the beneficial role of plant foods in health promotion and disease prevention for Nigerian consumers.

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