

QUALITY OF CAFFEINE EXTRACTED FROM KOLA NUT (*Cola acuminata*) OBTAINED FROM IGBOORA, OYO STATE NIGERIA

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Abstract

The research investigated the quality of caffeine extracted from kola nut obtained from Igboora, Oyo state Nigeria. Caffeine is an important body stimulant commonly used for food flavoring, beverages (energy drinks) and pharmaceutical industries. Solvent extraction was used (Chloroform) with standard procedure. Physical and phytochemical properties were determined using standard methods. The results showed that density (g/cm^3), melting point ($^{\circ}\text{C}$), boiling point ($^{\circ}\text{C}$), and pH are 1.18, 234, 177.6 and 7.8 respectively. The extract is soluble in water and white crystalline in appearance. The physical parameters examined were close to supplementary chemical data of caffeine and 5% of the kola nut contains caffeine. Phytochemical determination revealed presence of alkaloids, phenols, flavonoids, saponins and tannins at 8.70%, 3.13%, 20.30%, 0.21% and 0.13% respectively. The results showed that kola nut from Igboora are good source of quality caffeine with appreciable quantity.

Keywords: Quality of Caffeine; Phytochemical; Extraction; Pharmaceutical; Kolanut

Introduction

Kola nut is the fruit of kola tree, a tropical African fruit indigenous to West Africa genus which belongs to the *Sterculiaceae* family. The genus is about 140 species and the most common ones are *Cola acuminata*, *Cola nitida*, and *Cola anomala* (Niemenak, *et al.*, 2008). The trees, which reach heights of 40 to 60 feet, produce a star-shaped fruit. It is a non-timber forest products, cultivated by subsistence farmers combined with cacao and/or coffee as a shade plant. Fruits consist of 1 to 10 follicles placed perpendicularly to the peduncle. The seeds comprise two cotyledons (*C. nitida*) or 3–6 cotyledons (*C. acuminata* and *C. anomala*). The plant was introduced to the Central and South American countries where it became popular during the Slave Trade of the 17th century. Its popularity resulted from being a stimulant, increasing energy and strength, dispelling drowsiness and staving off hunger (Niemenak, *et al.*, 2008). These properties could be attributed to the endowment of the seeds in purine, alkaloids, polyphenols and sugar. Kola has an important usefulness in cultural activities in West Africa, without these seeds, traditional hospitality, cultural and social ceremonies are considered incomplete. In Europe, America and Nigeria, the seeds are used in the production of several pharmaceutical drugs, wines and liquors (Blancke, 2001). Kola nut have a bitter taste when chewed fresh, but when dried the taste becomes milder and smell of nutmeg. About

the size of a chestnut, this little fruit is packed with caffeine each contains more caffeine than two large cup of American coffee.

Caffeine is a natural product that is colorless, odorless, crystalline solid and melts at $235\text{--}236^{\circ}\text{C}$ but has the ability to sublime under reduced pressure at a temperature below its melting point. It is more soluble in organic solvent (petroleum ether and Benzene) but shows moderate solubility in alcohols, acetone and water (2.2g/100 mL). It is an alkaloid of the methylxanthine family with formula $\text{C}_8\text{H}_{10}\text{N}_4\text{O}$ (Komes, *et al.*, 2009). (Yunus and Nulamuga, 2020; Vallambroso, 2006).

It can be naturally found in the coffee and cocoa beans, tea leaves and other plant species (Amare and Admassie, 2012; Castro *et al.*, 2010). It can be consumed in the form of coffee, tea, cocoa, chocolate and popular carbonated energy drinks where it is intentionally added. Moreover, it is considered to be one of the most commonly consumed drug with more than 80 percent of the world's population consuming caffeine daily (Carrillo and Benitez, 2000; Norton *et al.*, 2011). The Europeans are found to be the world's largest consumers of caffeine intake of approximately 4.6 kg/person/year. Caffeine is quickly absorbed by the body. The human salivary level, which indicates the extent of absorption, peaks around 40 minutes after caffeine consumption (Chou and Bell, 2007). This pharmacologically active substance stimulates

the central nervous system, increases heartbeat rate, dilates blood vessels and works as a weak diuretic. However, the high amounts of caffeine can cause trembling, nausea, nervousness and seizure. A fatal dose of caffeine has been evaluated to be more than 10 g (about 170 mg/kg of body weight). It is also considered to be a risk species for cardiovascular diseases, kidney malfunction, asthma, and may also cause hyperactivity (Abebe *et al.*, 2008). Other important usage of caffeine is as an analgesic adjuvant in drug formulations for the treatment of headache and pain related to postpartum, postoperative, and dental surgery and it is therapeutically applied for the treatment of migraine in combination with other drugs such as aspirin, paracetamol and tramadol. According to literature, adding caffeine to pain analgesics can make pain pills work 40% more effectively. This added boost to medications pain relieving ability allows you to take less medication and reduce the risk of becoming the addicted to the pharmaceutical preparation especially if it contains opioid component (Nevena Grujić-Letić, *et al.*, 2016). Caffeine also eliminates possible sedative effects that can be evoked by various analgesics. Together with its light mood elevating effects, it contributes to the completeness of the desired therapeutic effect for patients (Madhusudhan, 2013; Straube *et al.*, 2011). However, a person taking combined drugs containing caffeine are more likely to experience adverse effects like tachycardia, anxiety and ectopic beats (Sawynok, 2011).

Caffeine is also employed in humans as supplements which aids weight loss as a result of its capacity to act as an appetite suppressant and in invigorating thermogenesis.

Some regulatory agencies such as U.S. Department of Agriculture (USDA) and European Food Safety Authority (EFSA, 2015) stated the concentration of caffeine that is safer to adults with no health challenges to be 300-400 mg per day (Richling *et al.*, 2003). The US Food and Drug Administration (USFDA) indicated that caffeine consumption below 130 - 300 mg/day is low/moderate whereas an intake of above 400 mg/day is high (U.S. Code of Federal Regulations, 2003; Ogah and Obebe, 2012). Previous studies indicated that, consistent intake or drinking caffeine even without exceeding the amounts needed by human; can cause chronic headaches and migraines (Akpomie, *et al.*, 2020). Mumin, *et al.*, (2006), reported that; every time tea, coffee, cocoa, chocolate, or cola, are taken the body will be given a hit of caffeine. In light of the usefulness of caffeine that required it's readily available source at affordable cost. This research attempts to evaluate

the quality of caffeine extracted from kolanut obtained from Igboora by examines the physical and phytochemical properties.

Materials and methods

Extraction method

Two 100g batches of kola nut were weighed into 2 metal pots. 750cm³ of water was added to each and boiled for about one hour. 200cm³ of 0.3M lead acetate was added while the mixture was allowed to precipitate acids and albumin. The hot mixtures of kola and water plus additives were filtered using a white cloth. The solids were removed and re-boiled with 500cm³ of water while a stand by hot water was used to wash the system. After filtration, 2M sulphuric acid was added to the filtrate to precipitate lead ions. The lead sulphate was filtered off, 2M of ammonia was added to the solution until it turns slightly alkaline and concentrated to four times its initial strength. The concentrate was allowed to settle for about five minutes, decanted and the sediment filtered with filter paper while hot. The filtration was kept hot with steam. The latter filtrate was combined with the decanted portion before drip extraction. The concentrated Filtrate was extracted with 3 times, 80cm³ portions of trichloromethane. The mixture was frequently inverted in each extraction and allowed to stand for at least 45minutes before isolation of layers. The extracts were combined. The chloroform was distilled to one quarter of its original volume. The remaining chloroform was evaporated to dryness and the crude caffeine was extracted (Johnson, 2012).

Purification of caffeine

The crude caffeine was dissolved in hot water; Activated charcoal was added to absorb the gas and the colouring matter and filtered. The filtrate was cooled to room temperature followed by drip extraction. The solvent was evaporated on a hot plate. The purified dry caffeine was recovered and stored in the desiccator.

Caffeine yield

%yield = weight of dried extract/weight of dried plant sample X 100

Results and Discussion

Table 1 Phytochemical quality of caffeine extracted from kola nut

Parameters	Igboora Kolanut	Oyeleke et al., %
Alkaloids	8.70	0.23
Phenol	3.13	0.44
Flavonoids	20.30	0.02
Saponins	0.21	0.56
Tannins	0.13	0.02

Table 2 Physical properties of caffeine extracted from kola nut and caffeine standard

Parameters	Igboora Kolanut	Supplementary chemical data
Density (g/cm ³)	1.18	1.23
Melting Point (°C)	234	235
Boiling Point (°C)	177.6	178
pH	7.8	7.5
Solubility in water	Soluble	Soluble
Appearance	White crystalline	White crystalline

Caffeine contents yields of 5% was noticed from Kola nut used in this work and was higher compared to those of Jayeola, (2001) findings with 1.50% for fresh kola nut, and Yalwa and Bello, (2017) at ranges of 2.5-3.0% for kola nitida but in accordance with Okoli *et al.*, (2012), with caffeine in *K. acuminata* at 4.7%. Environmental conditions during the growth of the plant might have affected the quality and yield of caffeine content (Heckman *et al.*, 2010).

Phytochemicals and Physical quality of the caffeine extracted from kola nut obtained from Igboora, Oyo State were presented in Table 1 and Table 2 respectively.

Alkaloids in the extract were 8.70%, and more than the 0.23% reported by Oyeleke *et al.*, (2008). The presence of alkaloids supports the findings by Oyeleke *et al.*, (2008), this may support the antibacterial activity of this plant. Alkaloids have been reported to possess various pharmacological activities including antihypertensive effects, anti arrhythmic effect, anti malarial and anticancer activity (Saxena *et al.*, 2013). The value of phenols present in the extract was 3.13%, this is more than that obtained by Oyeleke *et al.*, (2008) at 0.44%. This confirmed that caffeine from this kola nuts are good source of antioxidants for human and plants (Dillard and German, 2010).

The highest phytochemical contents in this work is flavonoids present at 20.3% and still higher than the values obtained by Oyeleke *et al.*, (2008) 0.02% and others. Flavonoids a secondary metabolite that refers to a class of naturally occurring polyphenols, are found in plants.

The value of saponins present in the extract was 0.21% the value is in line with the value obtained by Oyeleke *et al.*, (2008) (0.56%).

Saponins from fruits and vegetables are important dietary supplements and are known to exhibit antimicrobial activities and protect plants from microbial pathogens (Sczkowski *et al.*, 2008). They could be beneficial in modulating blood lipids, lower cancer risks and improve blood glucose response as well as possess antioxidant activity (Igidi and Edene, 2014).

The Tannins also present at 0.13%, this was the lowest value of phytochemical present and it is in line with the value obtained by Oyeleke *et al.*, (2008) 0.02%. The presence of tannins in caffeine extracted from kola nut made the fruit to be a good source for the treatment of wounds emanating from varicose ulcers and hemorrhoids (Njoku and Akumufula, 2007). Plants that contain tannins are used as astringents, against diarrhea, as diuretics, against stomach and duodenal tumours (Saxena *et al.*, 2013).

The results from Table 2 on physical properties of extracted caffeine are including melting point (°C), boiling point (°C), and pH. The value of density for caffeine extracted from kolanut was 1.18g/cm³. This value was different partially with the supplementary chemical data on caffeine (1.23g/cm³) according to World Health Organization standard (2010) these variations could be traced to soil compositions, geographical location and method of extraction (Ahmed *et al.*, 2009). According to these authors, these factors can cause serious variation in nutritional properties of the kola nut, which therefore includes the caffeine content.

Other physical characters like melting point, boiling point, pH, solubility and appearance are in accordance with the supplementary chemical data of caffeine as presented by World Health Organization (2010)

Conclusion and recommendation

The physical and phytochemical parameters of caffeine extracted from kola nut obtained from Igboora, Oyo state Nigeria showed that it has a good quality compared with standard/pure caffeine contents. Extracted caffeine from this kola nut could be use in pharmaceutical and beverages industries as natural source rather than inorganic synthesized sources. Marketing of kola nut for this purpose and aids from government could encourage farmer to improve production and facilitate international exportation.

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