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ORIGINAL ARTICLE

Antioxidant activity, lipid quality, proximate composition and mineral content of Rambutan seeds (*Nephelium lappaceum*) from Cameroon

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Abstract

Plant and fruit seeds, rings and peels which are usually disposed as wastes as well as other agricultural byproducts can have good nutritional and functional properties. The aim of this research was to determine some physicochemical characteristics of rambutan seeds (*Nephelium lappaceum*) from Cameroon. Rambutan seeds were purchased at Sandaga Market in Douala-Cameroon. The seed oil was extracted using the maceration method in Hexane. The antioxidant activity of the oil was evaluated with different tests; 2, 2-diphenyl-1-picrylhydrazyl (DPPH) radical scavenging activity, the Ferric reducing antioxidant power and the Hydroxyl radical scavenging activity. The result of this study demonstrated that rambutan seeds extract is a good DPPH radical scavenger. The characteristics of the oil extracted from its seeds were 38.09 meq O_2/kg for the peroxide value (PV), 4.41 ppm for the thiobarbuturic acid value (TBA value), 48.22 g/100g for the Iodine value, 21.01 % for the acid value and the oil color was white. The proximate analysis showed that the seed contained 39.09 % lipids, 22.18 % carbohydrates, 8% proteins, 29.03 % fiber, and 1.7 % ash. The major minerals elements present in rambutan seeds included; Calcium 616 mg/100g, Potassium 515 mg/100g, Phosphorus 146 mg/100g, Magnesium 131 mg/100g, Sodium 52 mg/100g and Ion 0.08 mg/100g. These results suggest that rambutan seeds could contribute partially to the overall daily intake of these minerals and macronutrients.

Practical application

Rambutan seeds from Cameroon can be used as supplement in food formulation upon toxicological investigations are done.

Keywords: *Nephelium lappaceum*, antioxidant, physicochemical properties, oil.

1.Introduction

Rambutan (*Nephelium lappaceum*), is a medium size evergreen tropical tree, which bears succulent fruits and grows to a height of 12-20 m (Sopark & Punnee, 2012). Rambutan belongs to the Sapindaceae family, and is closely related to longan, lychee, pulgan which are all subtropical and tropical species in the same family (Marissa, 2006). It is an important tropical fruit in Indonesia, Malaysia and Southern Thailand (Sopark & Punnee, 2012). The cultivation of this plant species spreads from Malaysia, Thailand, Philippines, Northern Australia, Sri Lanka, India, Madagascar, Costa Rica, Congo, and some South American countries. Studies in 1999 showed that the world rambutan production statistics estimate is 1.06 million tonnes; Thailand, the largest producer with 588,000 tonnes (55.5%), Indonesia with 320,000 tonnes (30.2%) and Malaysia with

126,300 tonnes (11.9%) collectively accounted for 97% of the world's rambutan production as reported by Prakash (2016). The rambutan fruit is generally consumed fresh, canned or processed and appreciated for its refreshing flavour and exotic appearance. Recent studies have shown that rambutan is industrially processed into jam, jelly, marmalade and spread in Malaysia and Thailand (Morton, 1987).

Rambutan fruit contain carbohydrates (18.5%), proteins (0.9%), fat (0.3%), vitamin C (70 mg/100 g), calcium (15 mg/100 g), magnesium (10 mg/100 g) and potassium (140 mg/100 g). The bark and fruit skin is used for medicinal purpose in Indonesia and Malaysia (Prakash, 2016). Due to its ability to provide beneficial health effect, rambutan can be used as functional food.

Recent studies have shown that rambutan seeds contains relatively high amount of edible fat (between 17-39%) with a bitter taste which is similar to cocoa butter and can be used in the food industry (Zee, 1993; Tindall, 1994; Prakash, 2016). Rambutan seeds have also been reported to have a high amount of polyphenols. Fat extracted from rambutan seeds cannot only be limited for the manufacturing of soaps, candle and fuels but can be used as a natural sustainable edible fat with potentials for industrial use (Sirisompong *et al.*, 2011).

Underutilised part of rambutan (seed and rind) contains some active components which are reported to prevent some diseases (Rohman, 2017). Little or no attention has been given to the use or recycling of the waste part of this fruit and as such it is discarded.

New research on the development of new products based on by-products is very much required. With the nutritional problems facing the society today (hunger indicators and the growing world population), preventing any mishandling of food parts which can be used as food has been ignored over the years and is gradually becoming a priority nowadays. This is because proper use of these by-products as raw material or food addictive contributes to reduce malnutrition, generate economic gain and improve human health through food enriched with health enhancing substances (phenols, carotenoids, and other pigments, vitamins, dietary fibers).

Although several researches have been reported on the nutritional composition, the physicochemical properties, antioxidant potential of fruit seed (Harahap *et al.*,2012, Sopark & Punnee 2012, Essua *et al.*, 2016, Hajar *et al.*,2017), almost no report is available on Cameroon rambutan. It is therefore necessary to evaluate the nutritional composition, the physicochemical properties, and antioxidant potential of Cameroon rambutan seeds, so that the knowledge derived can be used to encourage adequate consumption and re-utilisation of these seeds in possible value-added applications.

The objective of this study was to determine some physicochemical properties of Rambutan (*Nephelium lappaceum*) seeds from Cameroon.

2. Material and Methods

2.1. Material

The fresh rambutan fruits were purchased at Sandaga Market, Douala, Cameroon, in October 2018. All the chemicals and reagents used were of analytical reagent grade.

2.2. Methods

2.2.1. Sample preparation and processing

The fruits were consumed and the seeds collected, cleaned and dried under sunlight to constant weight. The dried seeds were used for further studies.

2.2.2. Oil extraction

Oil was extracted from the dried seeds using the maceration method as described by Womeni *et al*. (2016). The seeds were separately ground to pass 1 mm sieve. 80 g of the powder was separately macerated in 400 ml of hexane at room temperature for 24 h with constant shaking. After that, the mixture was filtered using the wathman paper N°1, and the filtrate concentrated on a rotatory evaporator at 40 °C. The extracted oil was stored in the refrigerator at 4 °C for further analysis. The remaining solid fraction was dried in the oven at 50 °C for the determination of their proximate composition.

2.2.3. Extraction of rambutan seed polyphenols

100 g of rambutan powder was extracted with 400 ml of methanol for 48 h at room temperature. The mixture was regularly subjected to shaking during the extraction. The extract was filtered with a Whatman No. 1 filter paper, and residue was again extracted with 200 ml of methanol to ensure maximum extraction of phenolic compounds. The combined filtrates were subjected to rotary evaporation at 40 °C under reduced pressure for the removal of the solvent. The dried extract was used for further analysis.

2.2.4. Evaluation of the antioxidant activity

The ability of each extract to scavenge the DPPH radical was determined according to the method of Braca *et al.* (2002). A total of 4.5 ml of 0.002% alcoholic solution of DPPH was added to 0.5 ml of different concentrations (250, 500, 1000, and 2000 µg/ml) of samples and standard solutions separately, in order to have final concentrations of products of 25-200 µg/ml. The samples were kept at room temperature in the dark and after 30 min and the absorbance of the resulting solution was measured at 517 nm. The absorbance of the samples, control, and blank was measured in comparison with methanol. The antioxidant activity (AA) was calculated according to the formula:

$$AA\% = [(Abs_{control} - Abs_{sample}) \times 100 / Abs_{control}]$$

AA = Antioxidant activity, Abscontrol = Absorbance of the DPPH solution, Abs= Absorbance of the sample

2.2.5. Oil characterization

The determination of the peroxide value of rambutan seeds oil was made following the spectrophotometrical IDF standard method, 74A:1991 (IDF, 1991). Its iodine and acid values were determined according to the procedure of AOCS Official Method CD 1-25and CD 3d-63 (AOCS, 2003) respectively. Finally, its thiobarbituric acid value was evaluated as described by Draper & Hadley (1990).

2.2.6. Analysis of the proximate composition of rambutan seeds

The fat, ash and protein contents of rambutan seed powder was determined using standard analytical methods described by AOAC (1990) procedures. Ash content was determined by incineration of the dried pulps at 550 °C according to the AOAC procedures 942.05. Nitrogen (N) content was determined using

micro-Kjeldahl method, according to AOAC procedures 984.13, the protein content was calculated as N x 6.25. Lipid content was determined using Soxhlet apparatus with hexane, following AOAC 963.15 methodology. The total carbohydrate content was determined by the difference method as reported by Onyeike *et al.* (2015). This method involved adding the total values of crude protein, crude fat and ash constituents of the sample and subtracting it from 100. All samples were analyzed in triplicate.

2.2.7. Determination of the Mineral content of rambutan seeds

For the determination of minerals, the rambutan seeds were ashed at 550 °C and dissolved with 10 mL of 20% HCl in a beaker and then filtered into a 100 mL standard flask to determine the mineral content. Calcium (Ca), magnesium (Mg), sodium (Na), potassium (K) and iron (Fe) were determined by atomic absorption spectrometer (Varian 220FS Spectra AA, Les Ulis, France). Phosphorus (P) was determined colorimetrically using the vanadomolybdate, according to AOAC procedure 965.17(AOAC, 1999). Mineral contents of the samples were determined from calibration curves of standards minerals. All samples were analyzed in triplicate.

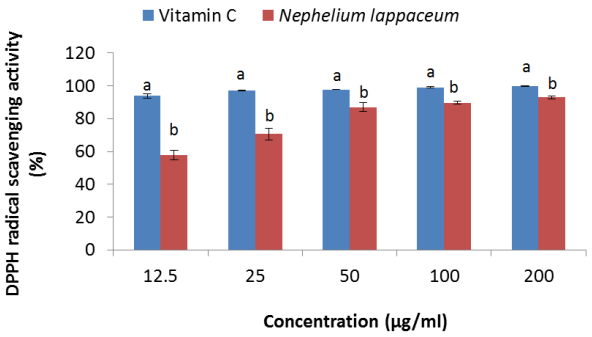
2.3. Statistical analysis

Results obtained in the present study were subjected to one-way analysis of variance (ANOVA) with Student-Newman-Keuls tests using Graphpad-InStat version 3.05, to evaluate the statistical significance of the data. A probability value at $p<0.05$ was considered statistically significant.

3. Results and discussion

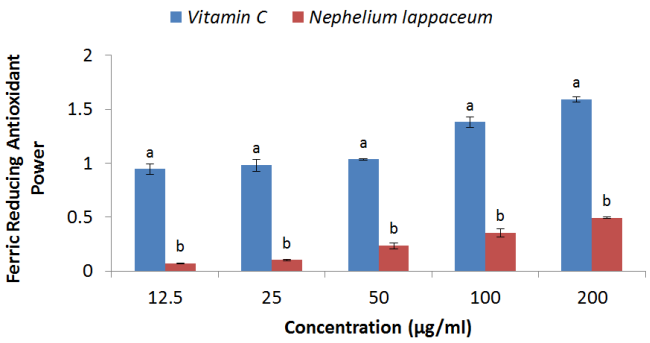
3.1.1. DPPH Radical scavenging activity

Figure 1 shows the DPPH radical scavenging activity of *Nephelium lappaceum* methanolic extract in comparison with vitamin C. At all concentrations, the activity of the plant extract was significantly lower ($p < 0.05$) compared to that of the synthetic antioxidant. From concentration 12.5 to 200 mg/ml, the activity of *Nephelium lappaceum* extract increases with its concentration, while that of vitamin C remains almost constant. The highest activity observed with vitamin C compared to the extract can be attributed to its purity. In fact, *Nephelium lappaceum* methanolic extract apart from the antioxidant contain other molecules that can be considered here as impurities. So, the amount of antioxidant is not really known because those antioxidants and other molecules in the extract are the ones making its concentration. The fact that *Nephelium lappaceum* extract has good antioxidant activity has already been proven. Fidrianny *et al.* (2015) showed that the DPPH radical scavenging activity of 4 varieties of *Nephelium lappaceum* peels were ranged between 90.84- 93.26% when extracted with ethyl acetate and 89.94-93.71% when extracted with ethanol. However, the result obtained in this study showing that *Nephelium lappaceum* seed extract has good antioxidant activity are not in agreement with those of Soeng *et al.* (2015) who obtained activities ranging from 20 to 45% using water, butanol, hexane, ethyl acetate fractions and the extracts itself. The nature of the solvent can explain these differences. On the other hand, Nethaji *et al.* (2015) reported that the antioxidant activity of *Nephelium lappaceum* epicarp methanolic extract is similar to that of vitamin C (0-60.59% for vitamin C and 0-62.49% for the methanolic extract at concentrations 0-50 mg/ml).



Data are presented as mean ± SD (n = 3). Values with different superscripts are significantly (p < 0.05) different.

Figure 1: DPPH Radical scavenging activity of *Nephelium lappaceum* extract



Data are presented as mean ± SD (n = 3). Values with different superscripts are significantly (p < 0.05) different.

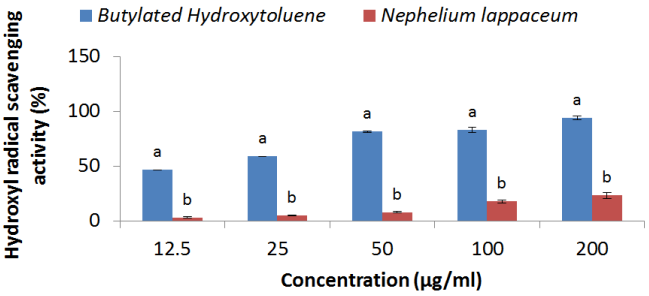
Figure 2: Ferric reducing antioxidant power of *Nephelium lappaceum* extract

3.1.2. Ferric Reducing Antioxidant Power

The Ferric reducing antioxidant power of *Nephelium lappaceum* extract and vitamin C is illustrated in Figure 2. As previously observed with the DPPH test, the activity of the extract is significantly low ($p < 0.001$) compared to that of vitamin C. However, the performances of both sample was significantly increasing ($p < 0.05$) with the concentration. The low ferric reducing power of the extract can be attributed to the low concentration of antioxidant having the ability to reduce the ferric ions. The low FRAP registered with *Nephelium lappaceum* seed extract is in accordance with the report of Thitilertdecha *et al.* (2008) who showed that, the methanolic fraction of *Nephelium lappaceum* peels has a very high reducing ability than the seed extract. This extract is a poor electron donor.

3.1.3. Hydroxyl radical scavenging activity

Figure 3 presents the hydroxyl radical scavenging activity of *Nephelium lappaceum* methanolic extract and butylated hydroxyltoluene. Globally, the activity of the synthetic antioxidant and the extract was concentration dependent. However, the hydroxyl radical scavenging activity of the plant extract was significantly lower ($p < 0.001$) compared to that of the synthetic antioxidant. The low hydroxyl radical scavenging activity of *Nephelium lappaceum* extract can still be attributed to its poor content in antioxidant with such mechanism of action. It has been proven that, an extract can be a very good DPPH radical scavenger but a very poor hydroxyl radical scavenger (Massodi *et al.*, 2018).



Data are presented as mean ± SD (n = 3). Values with different superscripts are significantly (p < 0.05) different.

Figure 2: Hydroxyl radical scavenging activity of *Nephelium lappaceum* extract

3.1.4. Characteristics of Nephelium lappaceum seeds oil

The quality parameter of *Nephelium lappaceum* seed oil is presented in Table 1. Results showed

that the oil extracted from *Nephelium lappaceum* seed has a peroxide value of 38.09 meqO_2 /Kg, a thiobarbituric acid value of 4.41ppm, an Iodine value of 48.22 g/100g, an acid value of 21.01% and is white in colour. The iodine value of *Nephelium lappaceum* seed oil obtained in this study was not far from that reported by Lourith *et al.* (2016) who obtained a value of 44.17 g I_2/100g. However, this value was higher than 37.64 g I_2/100g reported by Harahap *et al.* (2012). This suggests that rambutan seed oil is saturated because low iodine value generally indicates that the oil has high melting point. The acid value obtained in this study was significantly higher than that reported in other studies. Lourith *et al*. (2016) and Hajar *et al*. (2017) have demonstrated that the acid value of rambutan are 4.35 and 1.21% respectively. This acidity is the proof of the presence of acidic compound in rambutan seed oil such as free fatty acids and other acidic molecule. High acid value suggests that, the triglycerides present in the oil were significantly hydrolysed. This result is higher than 4% which is the normal acid value recommended for cold pressed and virgin oils (Codex alimentarius, 1999). The peroxide value of this oil was also significantly higher compared to 9.6 meqO_2 /Kg reported by Hajar *et al.* (2017). As per homologation when this value is higher than 15 meqO_2 /Kg, the oil is not suitable for consumption. This oil might contain some substances that can easily react with ammonium thiocyanate to increase the intensity of the red colour considered during the determination of the peroxide value. The thiobarbuturic acid value obtained in this study was lower than 5ppm which is the TBA value that is generally considered to confirm that fish samples are still fresh (Ukekpe *et al.*, 2014). From our knowledge there is no report showing the standard TBA value for vegetable oils. As far as the colour is concerned, the oil obtained had yellow colour but turned white upon saturation.

Table 1: Quality parameters of *Nephelium lappaceum* seeds oil

Quality parameter	
Peroxide value (meq O_2/Kg)	38.09±0.23
Thiobarbituric acid value (ppm)	4.41±1.35
Iodine value (g/100 g)	48.22±0.31
Acid value (%)	21.01±1.56
Color	White

3.1.5.Fourier-Transformed-Infrared Spectroscopy of rambutan oil

The FTIR Spectrum of rambutan seed oil used in this study is presented in figure 4. The spectrum obtained was similar to those reported by other authors with edible oils and fats (Van de Voort & Sedman, 2000; Vlachos *et al.*, 2006; Rohman *et al.*, 2012). The band appearing at 3477.2 cm^{-1} marks the presence of molecules with hydroxyl groups such as water (H_2O), Alkoxyl radicals (ROH) and hydroperoxides (ROOH) (Voort & Sedman, 2000). This suggests that, rambutan seed oil was primarily oxidized, and was containing water residues. This can justify the high peroxide value obtained with this oil. The potential presence of water residue can explain the high acid value obtained with this same oil, as water is a catalyst of the hydrolysis of triglycerides. The bands registered at 2916.3, 2851.0 cm^{-1} and 3007 cm^{-1} fall in the range 2750-3250 cm-1 which characterizes the symmetric and asymmetric streching vibration of the aliphatic CH_2 group and shoulder of the aliphatic CH_3 group (Vlachos *et al.*, 2006). The peak appearing at 1707.8 cm^{-1} in the rambutan

oil sample falls within 1500-2000 cm-1 which characterizes the ester carbonyl functional group of triglycerides, free fatty acids shoulders and the C=C streching vibration of *cis*-olefins (Vlachos *et al.*, 2006). The peak zone between 900-1500 cm^{-1} is the fingerprint region of the oil (Voort & Sedman, 2000) characterized by the presence of several functional groups. There are found the bending vibrations of the CH_2 and CH_3 aliphatic groups, the rocking vibrations of CH bonds of *cis*-disubstituted olefins, the bending plane vibrations of CH *cis*-olefinic groups and finally the bending vibrations of CH_2 groups (Vlachos *et al.*, 2006). Below 900 cm^{-1} (500-800 cm^{-1}) are found other important peaks which can be attributed to isolated *trans* bonds C=C-H bend, CH_2 rocking and trans/trans and *cis/trans* conjugated bonds (Voort & Sedman, 2000).

3.1.6. Proximate composition of Nephelium lappaceum seeds

The proximate composition of *Nephelium lappaceum* seeds showed that it contains 39.09% of Lipid, 8% of Protein, 29.03% of Fibers, 1.70% of ash, and 22.18% of Carbohydrates (Table 2). The energy value provided by this sample is 472.53 Kcal. The lipid and ash content obtained in this study, were in agreement with that reported by Harahap *et al*. (2012), who respectively obtained 38.90% and 2.26% with the seeds of the same plants in Malaysia. In the same line, Manaf *et al*. (2013) showed that rambutan seeds contain 38% of lipids and 1.22/2.26% of ash. However, the carbohydrates and protein contents obtained in this work were significantly lower than those reported by Harahap *et al*. (2012) who respectively obtained 48.10% and 12.40%, but similar to those reported by Rohman (2017) who respectively obtained 28.7% and 7.6%.

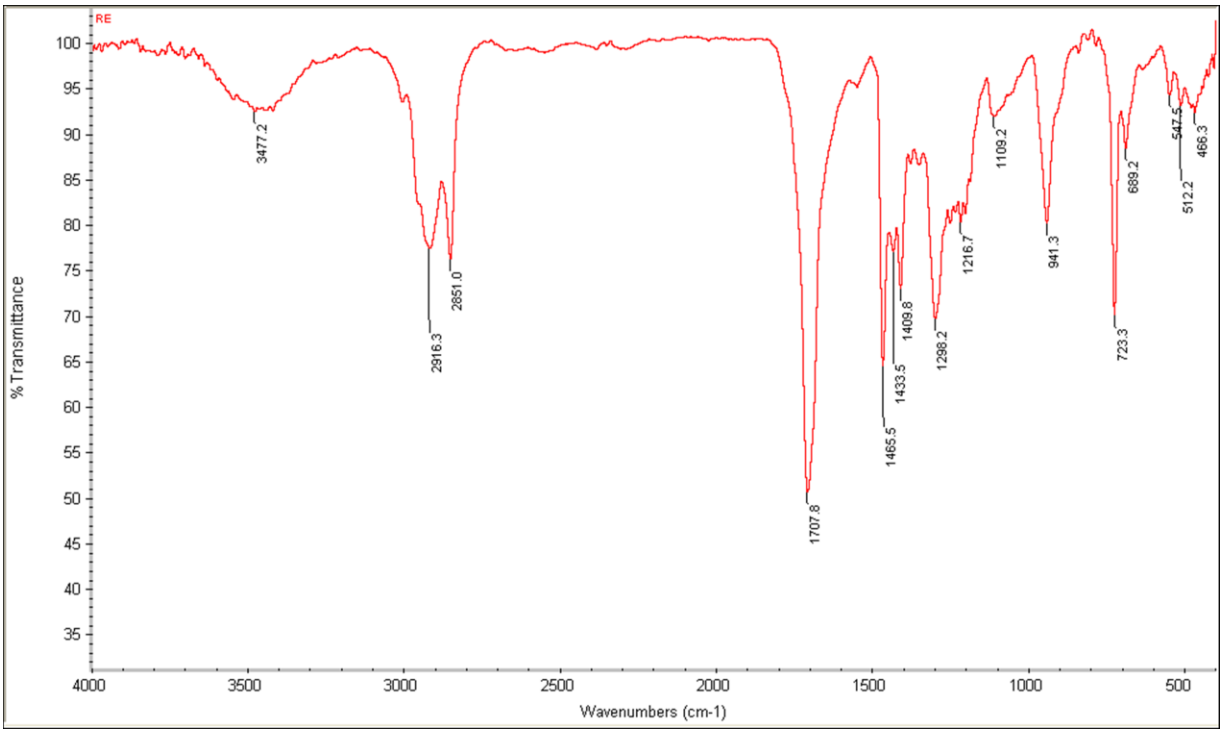


Figure 4: FT-IR spectrum of Rambutan seed oil

Concerning the fibers content the value obtained in this work was significantly higher than 2.4% reported by Rohman (2017) in the same seeds.

Table 2: Proximate composition of *Nephelium lappaceum* seeds

Parameter	
Lipids (%)	39.09 ±0.33
Proteins	8.00±0.00
Fibers (%)	29.03±0.34
Ash (%)	1.70±0.00
Carbohydrates	22.18±0.03

3.1.6. Mineral composition of Nephelium lappaceum seeds

The mineral composition of *Nephelium lappaceum* seed oil is presented in Table 3. From that table, *Nephelium lappaceum* contains 0.08 mg/100g of Iron, 146.00 mg/100g of Phosphorus, 616.00 mg/100g of Calcium, 131.00 mg/100g of Magnesium, 552.00 mg/100g of Potassium and 52.00 mg/100g of Sodium. The amount of iron obtained in this study was significantly lower than that obtained in the same seeds by Issara *et al. (*2014) who obtained 34% mg/100g. However, the magnesium content 12.3 mg/100g reported by these authors was significantly lower than that found in this study. Similar observations were met with phosphorus, calcium, potassium and sodium where the following quantities were obtained: 16.6, 9.58, 84.1 and 20.8 mg/100 g (Issara *et al.*, 2014). The presence of these minerals in food is of great importance because of their role and implications in several biological functions of the body. Calcium and phosphorus are very important for bone metabolism (Nwaoguikepe *et al*., 2012), sodium and potassium important in controlling hypertension in humans, iron important to prevent anaemia and Magnesium important for the good functioning of the brain.

Table 3: Mineral composition of *Nephelium lappaceum* seeds

Mineral	
Iron (mg/100 g)	0.08±0.00
Phosphorus (mg/100 g)	146.00±1.13
Calcium (mg/100 g)	616.00±11.10
Magnesium (mg/100 g)	131.00±1,22
Potassium (mg/100 g)	552.00±4.55
Sodium (mg/100 g)	52.00±3.34

Conclusion

The objective of this work was to determine the physicochemical properties of rambutan seeds (*Nephelium lappaceum*) from Cameroon. Results indicated that rambutan seeds have good DPPH radical scavenging activity, they are rich in saturated fat and have good nutritional composition. They can be used after toxicological studies in the formulation of foods.

Conflict of interest

The authors declare that there are not conflicts of interest.

Ethics

This Study does not involve Human or Animal Testing.

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