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Determination of the Mineral Composition of the Pulp and Evaluation of the Acute Toxicity of the Seeds of *Carica papaya* L. Consumed in Lubumbashi and Kinshasa in the Democratic Republic of the Congo

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Abstract

This work aimed, on the one hand, to determine the mineral and phytochemical composition of *Carica papaya* in order to guarantee the food safety of consumers and on the other hand, to evaluate the acute toxicity of papaya seeds. The papayas were bought at the Mzée market in Lubumbashi and Selembao in Kinshasa. Fruit sampling was done according to the ISO 7002 standard on agricultural and food products; the papayas were firm, mature, and without stains or physical damage. The analysis results of the papaya pulp showed both for the samples from the city of Lubumbashi and for the city province of Kinshasa that it contains respectively 85.87% and 84.46% water, 0.59% and 0.53% ash content. The mineral evaluation of our two samples presented a potassium content of 200 ± 8 mg, magnesium 13.12 ± 3 mg, calcium 22.15 ± 2 mg, sodium 3 mg ± 0.5 for the sample from Lubumbashi and 192.32 ± 8 mg of potassium, 14.458 ± 3 mg of magnesium, 20.58 ± 2 mg of calcium and 3.58 ± 0.5 mg of sodium for the sample from Kinshasa in macroelements. Concerning the trace elements, after analysis, we found zinc content (0.29 ± 0.1 mg and 0.12 ± 0.1 mg), copper (0.02 ± 0.01 mg and 0.14 ± 0.01 mg), and iron (2.22 ± 0.5 mg and 2.04 ± 0.5 mg) respectively for Lubumbashi and Kinshasa. The chemical

screening indicates the presence of alkaloids, saponosides, tannins catechics, flavonoids and anthocyanins in the palm wine and ethanolic extract of the seeds of *Carica papaya* and an absence of cyanogenic glycosides and gallic tannins. With mild toxicity, the seeds of the fruit of *Carica papaya* L. can be used with moderate risk by the population.

Keywords

Carica papaya, Mineral Composition, Acute Toxicity

1. Introduction

For centuries and even millennia, men have used plants to relieve their pain, heal their ailments and heal their wounds. Currently, despite the progress of pharmacology, the therapeutic use of medicinal plants is very present in some countries of the world, especially in developing countries. Indeed, there are about 500,000 species of plants on Earth, 80,000 of which have medicinal properties [1]. Among these plants is the species *Carica papaya* which belongs to the family of *Caricaceae*. The latter is known for its multiple biological activities, including its antioxidant and antimicrobial properties [2]. This allows it to have an important role in the body's defense and in the fight against infections [3]. The *Carica papaya* species is widely used in traditional medicine (leaves, roots, bark and seeds), to treat and relieve digestive and abdominal disorders such as: dyspepsia, gastric hyperacidity, dysentery and constipation [4]. The plant is also used as an anti-inflammatory [5].

The plant produces a tasty fruit, highly appreciated by many consumers and is one of the fruits, whose consumption is recommended. This fruit also has a high mineral density, which allows it to reinforce mineral intake without the risk of excess calories [6]. Its multiple pharmacological properties are due to the richness of the plant in primary and secondary metabolites and its mineral composition. Compounds present in the plant are among the most important groups of natural products due to their biological properties and structural diversity [7].

Papaya is considered one of the most nutrient-dense tropical fruits. It is especially rich in sugars, minerals, vitamins (vitamin C, thiamine, riboflavin, niacin, vitamin B6, vitamin K) and fiber [8]. Its mineral density is high, which makes it valuable for a good nutritional balance. Minerals have very different functions in the body. They play the role of antioxidants (Zinc and Selenium), including numerous roles as enzyme activators or oxygen transport [9]. Papaya contributes to the daily intake of minerals.

Secondary metabolites are molecules with a limited distribution in the plant organism. They play different roles, including that of a means of defense against external attacks. However, they are not always necessary for the survival of the plant. The products of secondary metabolism are very numerous, with more than 200,000 defined structures [10] and are of an extraordinary structural variety but are produced in small quantities. These molecules mark a species, family or genus of plant

in an original way and sometimes make it possible to establish a chemical taxonomy. Phenolic compounds, terpenoids, steroids and alkaloids are examples of secondary metabolites; they have many pharmaceutical applications.

However, many plant species have their own toxicity, direct or indirect, which must be known before any use. Perfect knowledge of the constituents of a plant is therefore necessary.

Thus, this study aims to determine the mineral composition of papaya pulp as well as to evaluate *in vivo* the acute toxicity of the ethanolic extract of its seeds and of the seed macerate in palm wine from samples collected in Lubumbashi and Kinshasa in the Democratic Republic of the Congo, in order to guarantee food security for consumers.

2. Materials and Methods

This work was carried out in Lubumbashi, a city in the Haut Katanga province in the Democratic Republic of the Congo, in the analysis laboratories of the Congolese Control Office (OCC); in Kinshasa, capital of the DRC, in the laboratories of the Faculty of Pharmaceutical Sciences of the University of Kinshasa (pharmacognosy and biochemistry laboratory), in the animal facility of the National Institute of Biomedical Research (INRB) in April 2021.

The papayas were purchased on the Mzée market in Lubumbashi and Selembao in Kinshasa (DRC), the selection of fruits was made with great care; the papayas were firm, mature without spots or physical damage, without microbial attack and the identification was carried out, at the plant physiology and ecology laboratory, of the faculty of agronomic sciences of the University of Kinshasa.

The sampling was carried out according to the ISO 7002 standard for agricultural and food products.

The pulp of the fruit was used for the determination of the composition in mineral elements and the seeds for the determination of the acute toxicity. Moisture was determined by oven drying at 105˚C to constant mass. The total ashes were measured by calcination in a muffle furnace at 550˚C until the white residues were obtained.

Mineral elements were quantified by inductively coupled plasma spectrometry [11].

2.1. Dosage of Mineral Elements by ICP (Inductively Coupled Plasma Spectrometry)

Principle: An atom has a certain number of energy levels. When excited, one or more electrons leave their ground state orbital to migrate to an orbital further away from the nucleus and have a higher energy level. When the excitation ceases, the atom, which is found in an excited state, tends to return to the ground state by emitting electromagnetic radiation of wavelength characteristic of the atom, which is de-excited. If the relaxation concerns a large number of atoms simultaneously, an emission spectrum is observed where all the radiations corresponding to the photons emitted are present. Each radiation emitted depends on the energy gap between

the levels affected by the quantum jump

Operating mode:

- ✓ Weigh 2 grams of the sample previously dried in an oven at 105˚C for 24 hours, calcined in a muffle furnace at 500˚C for 4 hours to obtain the ash.
- ✓ Leave to cool in a desiccator, and treat the residues with 5 mL of concentrated (nitric acid) HNO_3.
- ✓ Heat the mixtures to a gentle boil on a hot plate to obtain a clear solution.
- ✓ Transfer the solution into a 100 mL volumetric flask and add distilled water up to the gauge mark.
- ✓ The solution obtained is called mineralizate, which will be used for the determination of mineral elements in particular calcium, magnesium, iron, etc.
- ✓ Then place the latter under the peristaltic pump, which sucks it while transmitting in the atomization chamber.

2.2. Phytochemical Screening [12]

This paper made it possible to search for bioactive compounds (secondary metabolites) in particular alkaloids, coumarins, flavonoids, quinones, saponins, steroids, tannins and terpenoids. In addition, cyanogenic glycosides have been researched because they provide information on possible toxicity due to cyanide released by thermal or enzymatic hydrolysis.

1) Alkaloids

Principle: The detection of alkaloids consists of precipitating them using six precipitation reagents.

Procedure: 1 g of dry plant material powder is macerated in 10 mL of methanol at room temperature for 24 hours. The solution obtained is filtered, and then the marc is washed with portions of hot methanol. The filtrate is evaporated to dryness in an oven at 50˚C. The residue is collected twice with 2 mL of hot 1% hydrochloric acid solution and is then filtered. The acid solution obtained is alkalized with concentrated ammonia in a separating funnel. Add 15 mL of chloroform to the separatory funnel, and two phases form. Shake then rest to separate the phases and then separate them. Repeat this operation three times. The organic phase is evaporated to dryness in the open air and the residue, taken up in 0.5 mL of chloroform, is transferred to a hemolysis tube. Add 0.5 mL of 1% HCl to this tube and shake. Alkaloids that have been protonated are assumed to be in the aqueous phase. This, which is above, is taken using a Pasteur pipette. Six drops are placed on a slide. Each of these drops is treated with one of the six precipitation reagents, which are: Dragendorff's reagent, The Bouchardat reagent, Mayer's reagent, Hager's reagent, Wagner's reagent, and Bertrand's reagent.

The presence of alkaloids is only considered certain if each of the six reagents gives a precipitate. The method makes it possible to detect alkaloid contents of less than 0.01% on a 1 g sample.

2) Coumarins

Principle: In the presence of 10% NaOH, the appearance of a yellow color indicates the presence of coumarins.

Procedure: The coumarins are revealed from 2 mL of the 5% infusion placed in a tube to which 3 mL of NaOH (10%) are added. After stirring the solution, the appearance of a yellow color indicates the presence of coumarins.

3) Flavonoids and anthocyanins

Principle: The aqueous flavonoic extract gives, in the presence of concentrated hydrochloric acid and magnesium shavings, a pink-red and purplish-red color in the supernatant layer of iso-amyl alcohol. After heating in a water bath, without adding magnesium, the appearance of a red color indicates the presence of anthocyanins.

Procedure: 5 g of plant material placed in an Erlenmeyer flask are infused in 50 mL of distilled water for 30 minutes. After filtration, 5 mL of filtrate are treated with the reagent SHINODA (97% ethyl alcohol, then 5 mL of distilled water, 5 mL of concentrated HCl, a few drops of iso-amyl alcohol) and 0.5g of magnesium chips are added successively. The red-orange (flavone), red or purple-red (flavonones), and cherry red (flavonol) coloring appear in the supernatant layer (alcoholic phase) if the solution contains flavonoids.

Likewise, the reaction carried out for two minutes in a water bath in the absence of magnesium shavings allows the characterization of anthocyanins when a red color appears.

4) Quinones

Principle (Bornträger reaction): In the presence of a base (1% NaOH or KOH), quinones give a characteristic color ranging from orange-red to purple-purple.

Procedure: 5 g of powdered plant material are macerated for one hour in toluene or for 24 hours in petroleum ether. After filtration, 10 mL of toluene or ethereal filtrate are treated with 5 mL of 1% NaOH. The appearance of a purplish-red color in the aqueous phase indicates the presence of free quinones and that of yellow or orange the bound quinones.

5) Saponins

Principle: The detection of saponins is based on their foaming power. For non-persistent foam, the filtrate in an acidic environment in the presence of potassium dichromate gives a dirty green or purple color turning red.

Procedure: In an Erlenmeyer flask containing 10 g of coarsely ground plant material, 100 mL of distilled water is added to make a decoction for 30 minutes. Filter the solution after cooling. 15 mL of decoctions are introduced into a test tube 16 mm in diameter and 160 mm high. The contents of the tube are shaken tightly for one minute. After stirring, the solution is allowed to stand for 10 minutes and then the height of the foam is measured. If a foam of less than 10 mm is obtained, test for the presence of saponins using the reagents (mixture of 1N sulfuric acid and 10% potassium dichromate). The appearance of a purple color turning red or green indicates the presence of saponins.

6) Steroids and terpenoids

Principle: In the presence of anhydrous acetic acid and concentrated sulfuric acid, the extract ethereal organic containing steroids gives mauve and green colorings.

The identification of terpenoids follows the same pattern with the addition of Hirschson's reagent (trichloroacetic acid). The yellow color turning red indicates the presence of terpenoids.

Procedure: 5 g of plant material are macerated for 24 hours in petroleum ether or toluene. After filtration, the solvent is evaporated to dryness. To the residue obtained, 2 mL of chloroform, 0.5 mL of acetic anhydride and three drops of concentrated sulfuric acid are added successively and with stirring. The appearance of purple or green colors indicates the presence of steroids.

In addition to the test used for the detection of steroids, a few drops of Hirschson's reagent are added to 4 or 5 mL of the acidified solution. The yellow color turning red indicates the presence of terpenoids.

7) Tannins

Principle: In the presence of 1% ferric chloride, the aqueous tannic extracts give blue-green, dark blue and green colorings or precipitates.

Procedure: 5 g of plant material are infused in 50 mL of water contained in an Erlenmeyer flask for 30 minutes. 5 mL of the infusion are taken and added with 1 mL of 1% ferric chloride. The test is positive when a precipitate or color (blue-green, dark blue or green) appears. 15 mL of Stiasny reagent are added to 30 mL of the infusion, the mixture is brought to a water bath at 90˚C. The appearance of a precipitate indicates the presence of catechic tannins. The solution is then filtered, the filtrate is saturated with sodium acetate before adding a few drops of ferric chloride. The formation of a precipitate in this case reveals the presence of gallic tannins

8) Cyanogenic glycosides

Principle: In the presence of hydrocyanic acid, the yellow-colored picrosodized paper turns orange or red depending on the concentration of HCN.

Procedure: 5 g of vegetable powder are placed in an Erlenmeyer flask with 10 mL of water distilled. Close the Erlenmeyer flask with a cap to which is attached a strip of picrosode paper lightly moistened with water. Heat the solution slightly. The yellow picrosodized paper turns orange or red if the plant extract releases hydrocyanic acid.

The papaya seeds obtained after peeling the fresh fruits were dried away from the sun and at ordinary temperature. The dry material was crushed and reduced to powder using a mortar and a pilot. The extracts were obtained using maceration. The acute oral toxicity study of papaya seed extract in palm wine and ethanol was conducted according to OECD (Organisation for Economic Cooperation and Development) 425 guidelines. To do this, female mice of the NMRI SUISSE species were used. The method of Kraber and Behrens allowed the determination of the lethal dose 50 (LD50) by approximation by close calculation.

$$DL50 = (DL100 - AB)/N.$$

where A: The difference between 2 successive doses.

B: Average death between 2 successive doses.

N: Average number of animals per batch.

The level of toxicity of the seeds was determined according to the Hodger and Sterner scale after calculating the LD50 [13].

The test substances are administered by gavage in a single dose using a stomach tube. The mice were left fasting for 3 to 4 hours before administration of the substance. After this fasting period, the animals are weighed and then the substance is administered to them. The dose is calculated based on the fasting body weight of each mouse. After administration of the substance, the mice are deprived of food for 1 to 2 hours.

The animals are observed individually, at least once during the first 30 minutes following administration of the product and regularly during the first 24 hours (with particular attention during the first 4 hours), then daily thereafter, the period of observation totaling 14 days. The weight of each mouse was determined shortly before administration of the test substance and then at least once after two days.

Regarding the accommodation and feeding conditions, the temperature of the experimental room was maintained at 22˚C (±3˚C), exempt from artificial lighting alternating sequences of 12 hours of light and 12 hours of darkness. The animals were housed in individual cages. They were fed with standard preparations for laboratory rodents and were provided with tap water.

At the end of the experiment, the mice will be anesthetized by injection of ketamine using a 1cc syringe for their sacrifices and the blood will be taken from the heart then will follow the dissection. After dissection, the liver, spleen, heart, and kidneys will be preserved in 10% formalin solution for histopathological study.

The noble organs will be explored by the analysis of biochemical parameters evaluated by spectrophotometric methods. The blood collected during the sacrifice of the animals will be collected in tubes without anticoagulant and centrifuged at 14,680 rpm for 20 minutes to obtain the serum with which we will carry out some biochemical tests in particular transaminases (AST and ALT) which will allow us to explore liver function. They will be measured using the Reitman method described in the Human prospectus. Urea and creatinine will allow us to explore renal function. Serum urea levels will be determined by the urease method described in the Human prospectus and those of creatinine by the Jaffe method described in the Cypres prospectus.

Data were entered into an Excel sheet (Microsoft Office 2006, USA) and analyzed with SPSS Statistics software version 20. Quantitative data were presented as mean ± standard deviation as appropriate in the table. One-way ordered analysis of variance (ANOVA I) was used to compare the means between the 3 groups. The significance level was set at ($\alpha = 0.05$)

3. Results

3.1. Determination of Water Content

The results in **Figure 1** show that the pericardium of the papaya from Lubumbashi

has a slightly high water content compared to that of Kinshasa, with 30.1 g as the mass of the sample + crucible before calcination, 22.66 g as the mass of the sample and 10.64 g as the mass of the sample + crucible after calcination for Lubumbashi and 30.1 g as the mass of the sample + crucible before calcination, 22.47 g as the mass of the sample and 11.12 g as mass of the sample + crucible after calcination for Kinshasa.

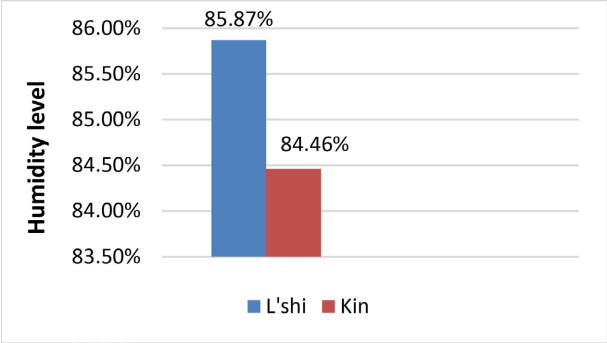

Figure 1. Water content of the pericardium of *Carica papaya* Linn from Kinshasa and Lubumbashi.

3.2. Determination of Total Ash Content

The results in **Figure 2** show that the pericardium of papaya from Lubumbashi has a slightly high level of ash despite the lower sample size compared to that of Kinshasa; with 0.24 g as the weight of the empty paper; 6.73 g as the weight of the sample and 0.28 g as the weight of the paper + sample after incineration for Lubumbashi and 0.25 g as the weight of the empty paper; 7.5 g as the weight of the sample and 0.31 g as the weight of the paper + sample after incineration for Kinshasa.

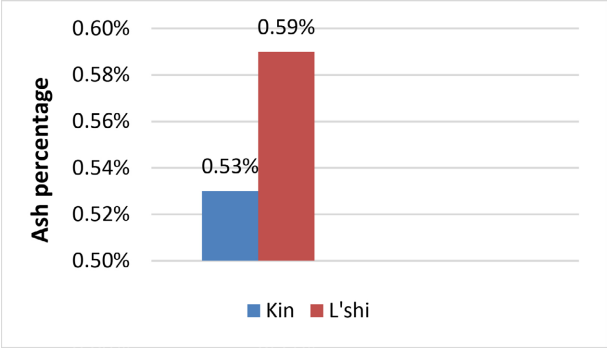

Figure 2. Total ash content of the pericardium of *Carica papaya* Linn from Kinshasa and Lubumbashi.

3.3. Determination of Mineral Content

Table 1 shows the contents of mineral elements present in the pericardium of papaya samples from Lubumbashi and Kinshasa. The table shows the values in mg/100 g of dry matter of the various microelements and macroelements of minerals present

in the pericardium of two samples of papaya.

Table 1. Mineral composition of dry matter of *Carica papaya* Linn pulp.

Mineral elements	**Lubumbashi** (mg/100 g)	**Kinshasa** (mg/100 g)
Calcium	22.15 ± 2	20.58 ± 2
Cobalt	0	0
Chrome	0.02 ± 0.01	0.01 ± 0.01
Copper	0.02 ± 0.01	0.14 ± 0.01
Iron	2.22 ± 0.5	2.04 ± 0.5
Potassium	200 ± 8	192.32 ± 8
Magnesium	13.12 ± 3	20.58 ± 3
Sodium	3 ± 0.5	3.58 ± 0.5
Lead	0	0
Zinc	0.29 ± 0.1	0.12 ± 0.1

3.4. Extract Yields

Extraction by maceration of *Carica papaya* seeds in palm wine and ethanol had a yield of 34.07 g or 154.86% for palm wine and 6.22 g or 28.27% for the ethanolic extract. It should be noted that the value greater than 100% of the yield of the palm wine extract is due to the presence of other metabolites in the palm wine.

3.5. Phytochemical Screening

Table 2 shows the phytochemical screening of *Carica papaya* from Lubumbashi and Kinshasa seeds.

Table 2. Phytochemical screening of *Carica papaya* Lubumbashi and Kinshasa seeds.

Code	Alk	Cou.	Anth	Flv.	Tannins		Sapo.	Quinones	Ster and terp	Hcn
					Catch.	Gal.				
SLub	+	+	+	+	+	−	+	−	+	−
SKin	+	+	+	+	+	−	+	−	+	−

SLub: Sample from Lubumbashi; SKin: Sample from Kinshasa, Alk: Alkaloids; Cou.: Coumarins; Anth: Anthocyanins; Flv.: Flavonoids; Sapo.: Saponins; Ster and terp: Steroids and terpenoids; Catch.: Catechists; Gal.: Gallics, Hcn: Cyanogenic glycosides; +: Presence; −: Absence.

3.6. Assessment of Acute Toxicity

- **Evolution of the weight growth of mice**

Table 3 shows the evolution of the weight growth of the mice during the treatment.

- B1AE1, B1AE2, B1AE3: Alcoholic extract of the seeds of *Carica papaya*.
- B2PW1, B2PW2, B2PW3: Palm wine extract of the seeds *Carica papaya*.

- D0, D2… = Day 0, Day 2…

Table 3. Evolution of the weight growth of the mice during the treatment.

	D0	D2	D4	D6	D8	D10	D12	D14
Groups	Weight in g							
Control 1	19.23	19.2	19.35	19.80	20.63	20.75	20.72	20.02
Control 2	19.20	19.3	20.32	20.65	19.96	20.56	20.81	20.54
1st batch of mice								
B1AE1	19.02	18.78	19.45	20.45	20.84	20.68	20.23	20.82
B1AE2	19.23	20.14	20.12	20.05	21.32	21.06	21.25	21.01
B1AE3	18.56	19.23	19.05	20.25	20.79	21.04	20.25	21
2nd batch of mice								
B2PW1	17.54	19.23	19.78	18.45	20.76	20.96	21.03	21.03
B2PW2	19.72	19.03	19.98	20.58	20.59	20.75	21.45	21.36
B2PW3	18.06	19.86	19.75	21.03	20.53	21.09	21.23	21.36

- **Effect of treatment on biochemical parameters**

Table 4 shows the effect of palm wine and ethanolic extracts of *Carica papaya* seeds on the biochemical parameters of mice.

Table 4. Effect of palm wine and ethanolic extracts of *Carica papaya* seeds on the biochemical parameters of mice.

Parameters	CREAT (mg/l)	UREA (g/l)	SGOT (UI/l)	SGPT (UI/l)
Witness (control)	5.50 ± 0.70	0.52 ± 0.02	106.60 ± 4.10	30.70 ± 0.14
Batch 1/ethanolic extract	5 ± 1.00	0.56 ± 0.18	198.50 ± 51.08	47.30 ± 42.69
Batch 2/palm wine extract	4.33 ± 0.57	0.59 ± 0.12	158.70 ± 35.17	25.33 ± 4.25
p-value	0.340	0.879	0.122	0.622
Decision	NS	NS	NS	NS

NS: Non-significant difference.

Data are presented as mean ± standard deviation. NS: Not significant. SPSS Statistics version 20 software was used to make comparisons with the control.

Table 5 shows the effects of palm wine and ethanolic extract of papaya seeds on some physiological parameters in mice.

3.7. Determination of LD50

After 14 days of observation, no death was observed in the treated mice, which did not allow the determination of the LD50. Oral administration of a single dose of 5000 mg/kg of palm wine and ethanol extract of *Carica papaya* seeds did

Table 5. Effects of palm wine and ethanolic extract of papaya seeds on some_physiological parameters in mice.

Period	1 h	2 h	3 h	4 h	D1	D2	D3	D4	D5	D6	D7
Grooming	N	N	N	N	N	N	N	N	N	N	N
Coat	N	N	N	N	N	N	N	N	N	N	N
Tremor	N	N	N	N	N	N	N	N	N	N	N
Motility	N	N	N	N	N	N	N	N	N	N	N
Reaction to noise	N	N	N	N	N	N	N	N	N	N	N
Appearance of stools	N	N	N	N	N	N	N	N	N	N	N
Number of deaths	0	0	0	0	0	0	0	0	0	0	0

N = Normal; D1 = Day 1.

not cause significant changes in NMRI mice. Indeed, no signs of toxicity such as a decrease in sensitivity to pain or noise or locomotion were observed during the 4 hours following the administration of the extracts. According to the classification of chemical products by Hodger and Sterne, our extracts are on scale 5 of products corresponding to a slightly toxic product (500 to 5000 mg/kg).

4. Discussion

Analysis of papaya pulp from the city of Lubumbashi (Mzée Market) and that of Kinshasa (Selembao Market) shows a water content of 85.87% and 84.46% respectively. This shows that this climacteric fruit is very perishable, hence the many losses observed in the fruit markets. The moisture content of papaya is therefore included in the range of water contents of fresh fruits; this result is almost similar to that of Lobo *et al.* [14] and Muhamad [3] who worked on the same variety of papaya and found a water content of 83.53%.

Carica papaya fruit pulp collected in Lubumbashi and Kinshasa contains 0.53% and 0.59% total ash content respectively. These results show that papaya could be an excellent source of minerals. Our results are lower than those of Larraurie [15] and Martínez *et al.* [16] who found respective contents of 2.85% and 5% on mango and papaya in 100 g of pulp.

With regard to the mineral elements, the analysis of the samples revealed at the level of the macroelements for 100 g of dry matter, a potassium content of 200 ± 8 mg, magnesium 13.12 ± 3 mg, calcium 22.15 ± 2 mg, sodium 3 ± 0.5 mg for papaya from Lubumbashi (Mzée Market) and 192.32 ± 8 mg of potassium, 14.458 ± 3 mg of magnesium, 20.58 ± 2 mg of calcium and sodium 3.58 ± 0.5 mg for papaya from Kinshasa (Selembao Market). These results show some inequalities in terms of content which would surely be due not only to the difference in soil composition but also to different cultivation and climatic conditions [17]. With a potassium (200 ± 8 mg; 192.32 ± 8 mg) and calcium (22.15 ± 2 mg; 20.58 ± 2 mg) levels, our results are slightly higher than those found by Lobo and Pastor, 2012 who have found as potassium value 182mg and 18.61mg as calcium content on papaya pulp.

Regarding the trace elements, the analyzes showed as zinc content (0.29 ± 0.1 mg and 0.12 ± 0.1 mg), copper (0.02 mg ± 0.01 and 0.14 ± 0.01 mg), iron (2.22 ± 0.5 mg and 2.04 ± 0.5 mg). The results are almost different between the two sampling sites because of the environmental parameters mentioned above. Compared to the results found by Lobo and Pastor [14], some of the results of this study are superior as is the case of copper and iron. The contents of other elements are lower than those of Lobo and Pastor [14], namely: sodium (9.61 mg), zinc (1.97 mg).

The yield of extracts obtained after maceration of papaya seeds in palm wine is much higher than that of ethanol. The yield obtained after maceration of papaya seeds in palm wine of 34.07 g or 154.86% was higher than that of ethanol 6.22 g or 28.27%. These results are contrary to those of the studies conducted by Amazu *et al*. [18] and Rasha *et al*. [12] in which the extraction of papaya seeds with palm wine had a higher yield than those of methanol but lower than that of an extraction made with absolute ethanol [12] [18].

Phytochemical screening revealed the presence of alkaloids, saponosides, tannins (catechics), flavonoids and anthocyanins in the palm wine and ethanol extract of *Carica papaya* seeds and an absence of cyanogenic glycosides. These results confirm those reported by Mangambu *et al*. who found the same result in papaya seeds [19].

Oral administration of a single dose of 5000 mg/kg of the palm wine extract and the ethanolic extract of the seeds of *Carica papaya* did not cause significant changes and no deaths were reported in mice. No signs of toxicity such as decreased sensitivity to pain, noise or locomotion were observed. The extracts have a toxicity index equivalent to 5, according to the scale of toxicity of a chemical substance according to the LD50 and the route of administration established by Teke and Kuete [13]. Other studies on aqueous and ethanolic extracts of *Carica papaya* leaves at a dose of 5000 mg/kg did not lead to any toxic effect. Administration of palm wine and ethanol extracts of papaya seeds for 14 days promoted weight gain in mice. These results correspond to those found by Etame *et al*., whose palm wine extract had promoted weight gain in rats [20].

The biochemical analyzes carried out showed an increase in the enzymatic activity of ASAT for the two extracts and a decrease in the activity of ALAT. These results relate to those found by Etame *et al*. [20]. After biochemical analyses, the latter found an increase in ASAT in both sexes and at all doses as well as a decrease in ALAT in rats. ALAT activity is more specific for liver damage than ASAT activity. However, in our study, the variations in enzyme activity were not significant, compared to the values in the group of control mice.

The serum urea and creatinine assay revealed that the administration of the extracts did not cause any significant change. These results also relate to those found by Etame *et al*. [20]. Serum urea and creatinine are considered the main markers of nephrotoxicity [21].

5. Conclusions

This study aimed to evaluate the mineral composition of the pulp as well as the acute

toxicity of the seeds of the fruits of *Carica papaya* Linn consumed in Kinshasa and Lubumbashi in the Democratic Republic of the Congo in order to guarantee the food safety of consumers and contribute to the prevention of certain pathologies. Specifically, it involved quantifying mineral elements (macroelements and trace elements) and determining the phytochemical composition as well as evaluating the acute toxicity of *Carica papaya* Linn seeds on laboratory mice.

The results of this study show that the fruit pulp of *Carica papaya* contains macro and trace elements with very distinct contents in potassium, magnesium, calcium, sodium, zinc, copper and iron in the dry matter. These contents differed insignificantly between the samples from Lubumbashi and Kinshasa. The results of the chemical screening show the presence of alkaloids, saponosides, catechic tannins, flavonoids, anthocyanins, coumarins, steroids and terpenoids in the palm wine and ethanol extract of the seeds of *Carica papaya* Linn.

Extracts from the seeds of the fruit of *Carica papaya* L. can be used with a moderate risk for the population. Indeed, the oral administration of a single dose of 5000 mg/kg of the palm wine extract and the ethanolic extract of papaya seeds did not cause any sign of acute toxicity in mice. At this dose, no deaths were noted. This observation makes it possible to determine the LD50 of the extracts and assign them a slight toxicity, according to the scale of Hodger and Sterner. No hepatic and renal damage was observed in mice.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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