World Journal of Advanced Research and Reviews
eISSN: 2581-9615 CODEN (USA): WJARAI
Cross Ref DOI: 10.30574/wjarr
Journal homepage: https://wjarr.com/

(RESEARCH ARTICLE)

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Evaluation of the acute and subacute toxicities and of the anti-inflammatory effect of the aqueous extract of the fruits of *Grewia coriacea* Mast. (Malvaceae) in laboratory rodents

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World Journal of Advanced Research and Reviews, 2022, 16(02), 022–031

Publication history: Received on 14 August 2022; revised on 25 October 2022; accepted on 28 October 2022

Article DOI: https://doi.org/10.30574/wjarr.2022.16.2.0847

Abstract

The fruits of *Grewia coriacea* Mast are among the most traded picking fruits and consumed in the Republic of Congo. The objective of this present work was to estimate the toxicity and to evaluate the antiinflammatory effect of the aqueous extract of the fruits of *Grewia coriacea* Mast. in rats. Thus, the estimation of acute toxicity was carried out in mice in accordance with OECD guideline No. 423 and revealed that the extract is not very toxic with an LD50 greater than 5000 mg/Kg by oral administration. The results obtained from the evaluation of the anti-inflammatory activity show that the aqueous extract of the fruits of *Grewia coricea* Mast. reduces edema induced by carrageenan 1 % and formaldehyde 2.5 % respectively by 52.17 % and 73.33 % at a dose of 500 mg/Kg. Other wise, the evaluation of chronic inflammation (formaldehyde 2.5 %) revealed that the extract inhibits the development of edema in rats at a dose of 500mg/Kg with a maximum percentage of 36.13 %. In conclusion, these results justify the consumption of these fruits by the population on the one hand and encourage its use in traditional medicine as a food supplement on the other hand.

Keywords: *Grewia coriacea* Mast; Acute toxicity; Subacute toxicity; Inflammation; Medicinal plant

1. Introduction

Grewia coriacea Mast is a species of tree with red fruits, native to tropical Africa. These picking fruits are the most marketed in the Republic of Congo. They are widely consumed for their juice, which is used in the manufacture of various drinks (Madiélé, 2015). Used in the traditional pharmacopoeia in the treatment of various pathologies, these fruits are rich in antioxidants which give it, among other things, anti-anemic and anti-inflammatory properties (Mbama, 2018; Muganza Musuyu, 2014). According to an ethnobotanical study carried out with traditional health therapists, herbalists and others, several plants are used in herbal medicine by the Congolese population against cardiovascular and metabolic diseases, including food plants. Among the vegetable resources that the Congolese forests have, there are especially fruit trees which occupy a rather important place in the human diet. And for several decades now, a real awareness of the importance of a diet rich in fruits and vegetables has emerged, particularly in the context of the prevention of metabolic diseases (Mbama, 2018).

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But the excessive consumption of certain fruits and medicinal plants can lead to the risk of poisoning for consumers. Faced with this reality, the WHO in its resolution AFR/RC50/ R3 of August 31, 2000, encouraged African countries to develop strategies on traditional medicine in order to undertake research on plants and promote their use in health care (Tra BI et al., 2008). With regard to ecology, which tends to link nature and the economy, traditional medicine is today presented as a new discipline linking the ethnological tradition to the management of certain diseases (MSP, 2006). Let's not forget that at all times, with the exception of the last hundred years, men have only had plants to heal themselves. acts of benign illnesses, cold, cough, or more serious (Iserin et al., 2001). It is in this perspective that the fruit of *Grewia coriacea* Mast. was chosen to be the subject of an evaluation of acute and subacute toxicities but also of the anti-inflammatory effect. This will make it possible to establish safety criteria for human consumption (OECD, 2015).

2. Material and methods

2.1 Plant material

The plant material used consisted of the fruits of *Grewia coriacea* Mast.,harvested in the forest of the Plateaux Department about 194 km from Brazzaville (Congo). The plant was formally identified at the National Institute for Research in Exact and Natural Sciences (IRSEN) in Brazzaville – Congo by Doctor MOUTSABOTE Jean-Marie, Lecturer CAMES from samples of leaves and fruits harvested.

2.2 Animal material

The study population consisted of mice Swiss albinos (females) and rats wistar (males and females) weighing between 240-300 g and 20-23 g respectively. These animals were raised in the animal facility of the Faculty of Sciences and Techniques of Marien NGOUABI University at an ambient temperature of 27 ± 1 °C with free access to food and tap water.

2.3 Preparation of the aqueous extract of the fruits of *Grewia coriacea* Mast at 10%

100 g of fruit powder *Grewia coriacea* Mast. previously dried and ground are put in 1000 mL of distilled water and brought to the boil. After filtration, the decoction obtained was placed in an oven at 70 °C. until complete evaporation of the water. The extract obtained was stored in a bottle protected from humidity and heat sources for the experiment.

2.3.1 Evaluation of the acute and subacute toxicities of the aqueous extract of the fruits of Grewia coriacea Mast.

Evaluation of the acute toxicity of the aqueous extract of the fruits of *Grewia coriacea* Mast. in mice

The acute toxicity of the aqueous extract of the fruits of *Grewia coriacea* Mast. has been assessed in accordance with OECD Guideline No. 423 (2001). It provides information on the class of toxicity of the extract from the DL_{50}.

Thus, six (6) mice fasted 18 hours before the experiment were divided into two (2) batches of three (3) mice each and treated as follows:

- Batch 1: Distilled water at 1 ml/30 g of body weight;
- Batch 2: Aqueous extract of the fruits of *Grewia coriacea* at 5000 mg/Kg of body weight.

After the administration of all the products, the parameters (aggressiveness, mobility, spontaneous sleep, alivation, tremor, pinch reaction, vigilance, vocalization, stool condition, polyuria and number of dead) were observed at half (½) hour, then every hour for four (4) hours, then every two (2) days for two (2) weeks.

Evaluation of the subacute toxicity of the aqueous extract of the fruits of *Grewia coriacea* Mast. in rats

It was evaluated according to the method described by the OECD (2008a) by respective and daily administration (oral route) in rats of the products to be tested.

To do this, three (3) batches of three (3) rats each were formed and treated for 4 weeks as follows:

- Batch 1: Distilled water (10 ml/Kg/d);
- Batch 2: Aqueous extract of the fruits of *Grewia coriacea* (250 mg/Kg/d);
- Batch 3: Aqueous extract of the fruits of *Grewia coriacea* (500 mg/Kg/d).

The body weight and food consumption of the rats were recorded at the end of each week during the four (04) weeks of treatment.

At the end of the 28 days of treatment (subacute toxicity), the animals distributed and treated as described above are fasted the night before. They are sacrificed and the blood is collected in EDTA and dry tubes respectively, for the assay of hematological and biochemical parameters.

2.3.2 Evaluation of the anti-inflammatory effect of the aqueous extract of the fruits of Grewia coriacea Mast.

Evaluation of the effect of the aqueous extract of the fruits of *Grewia coriacea* Mast on acute inflammation in mice: edema induced by 1% carrageenan

The evaluation of the aqueous extract of the fruits of *Grewia coriacea* Mast. on acute inflammation was performed according to the method reported by Elion Itou et al (2014). To do this, the mice were divided into four (04) batches of five (05) mice each receiving respectively distilled water (10 mL/Kg, the reference product, Diclofenac* (5 mg/Kg) and the aqueous extract of the fruits of *Grewia coriacea* Mast. (250 and 500 mg/Kg). Edema in mice was induced by subplantar injection of 1% carrageenan (0.1 mL/rat), 1 hour after oral administration of the test products. The evolution of the edema was measured using the 7500 DIGITAL BIOSEB plethysmometer at ½;1; 2; 3; 4; 5 and 24 hours after carrageenan injection.

Evaluation of the effect of the aqueous extract of the fruits of *Grewia coriacea* Mast. on acute inflammation: edema induced by 2.5% formaldehyde

The animals were divided into four (04) batches of five (05) mice each. Each batch respectively received the aqueous extract of the fruits of *Grewia coriacea* Mast. (250 and 500 mg/Kg), Diclofenac* (reference product 5 mg/Kg) and distilled water (10 mL/Kg). Edema in mice was induced by subplantar injection of 0.2 mL of 2.5% formaldehyde 1 hour after oral administration of the test products. The volume of the paws was measured 1; 2; 3; and 4 hours after injection of formaldehyde using a plethysmometer (Elion Itou et al., 2014).

Evaluation of the effect of the aqueous extract of the fruits of *Grewia coriacea* Mast. on chronic inflammation

Inflammation was induced using a 2.5% formaldehyde solution (Freitas et al., 2013).

Four (04) batches of five (05) rats each were formed, receiving respectively orally: distilled water (10 mL/Kg), Diclofenac* (reference product 5 mg/Kg) and the aqueous extract of fruit of *Grewia coriacea* (250 and 500 mg/Kg). 1 hour after administration of the test products, all the animals receive under the left hind paw 0.2 mL of 2.5% formaldehyde. The animals were treated for nine (9) days with a single oral administration of the test products per day. A second and third subplantar (sp) administration of 2.5% formaldehyde was performed respectively on the third and fifth day of treatment. Paw volume was measured daily as previously described (Sarahi et al., 2013).

Evaluation of the effect of the aqueous extract of the fruits of *Grewia coriacea* Mast. on the biochemical parameters of inflammation (CRP and albumin)

At the end of the nine (9) days of treatment, the animals were anesthetized with diethyl ether. And about 2 mL of blood for each rat was collected from the ophthalmic vein into the dry tubes and then centrifuged at 3000 rpm for 15 minutes. The serum obtained was used to assay the C Reactive Protein and the albumin using a Micro Touch Biochemistry Analyzer brand spectrophotometer.

2.4 Statistical analysis of results

The values expressed in the figures correspond to the mean of a series of values plus or minus the standard error on the mean (SEM). These values were calculated using Excel. The comparison of the means of the two series of values is made using the test Student's t.

3. Results

3.1 Acute toxicity of the aqueous extract of the fruits of *Grewia coriacea* Mast in mice

3.1.1 Effect on behavior, general condition and mortality of mice

The aqueous extract of the fruits of *Grewia coriacea* Mast administered at a single dose of 5000 mg/Kg, causes a slight increase in aggressiveness and alertness in mice at 30 minutes and 4 hours after administration of the extract compared to control rats (distilled water). However, it does not cause the death of mice 48 h after administration of the various products until 14th day of sighting. Also, polyuria was observed only in those treated with the extract. The summary of the observations made on the animals is presented in Table 1.

Table 1 Signs of toxicity observed in mice having received distilled water and those treated with the aqueous extract (5000mg/Kg) of the fruits of *Grewia coriacea* Mast.

Settings	**Distilled water (1mL/100g)**	***Grewia coriacea* (5000 mg/Kg)**
Aggressiveness	A	P
Mobility	N	N
Spontaneous sleep	A	A
Salivation	N	A
Tremor	A	A
Pinch reaction	N	A
Vigilance	N	AN
Vocalization	A	A
Stool condition	N	N
Polyuria	A	P
Number of dead	0	0

A: absent; N: normal; P: presence; AN: abnormal

3.1.2 Effect of aqueous extract of the fruits of Grewia coriacea Mast. *Mast on the weight evolution of mice*

The weighings carried out every two days during the 14 days of the experiment made it possible to follow the weight evolution of the mice. Figure 1 represents the weight evolution of the mice as a function of time (day). As a result, compared to the first day, the control and treated mice gained slightly in weight.

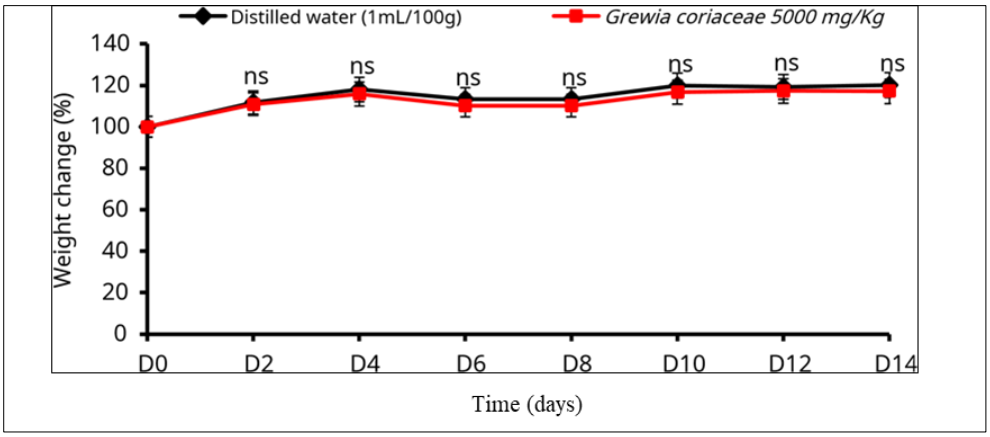

Figure 1 Effects of the aqueous extract of the fruits of *Grewia coricea* Mast. on evolution weight in mice. Each point is a mean ± SEM, with n = 3. ns : no-significant difference compared to the control (distilled water)

3.2 Subacute toxicity of the aqueous extract of the fruits of *Grewia coriacea* Mast. in wistar rat

3.2.1 Effect of aqueous extract of the fruits of Grewia coriacea Mast. *Mast on the weight evolution of the rats during 28 days of treatment*

The evolution of the weight of the rats during the 28 days of the study of the subacute toxicity is presented in Figure 2. It emerges that all the animals had a weight gain compared to the first day on the one hand and compared to the control (distilled water) on the other hand.

3.2.2 Effect of aqueous extract of the fruits of Grewia coriacea Mast*. on food consumption*

Figure 3 below illustrates the food consumption of the rats during the experiment. Overall, it emerges that the aqueous extract of the fruits of *Grewia coricea* Mast. moderates food consumption in animals compared to control rats (distilled water).

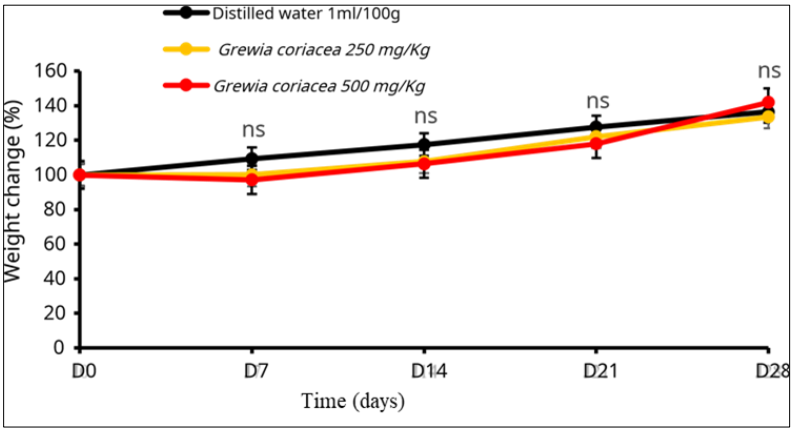

Figure 2 Effects of the aqueous extract of the fruits of *Grewia coriacea* Mast. on weight change in rats. Each dot is a mean ± SEM, with n = 3. ns : no significant difference compared to the control (distilled water)

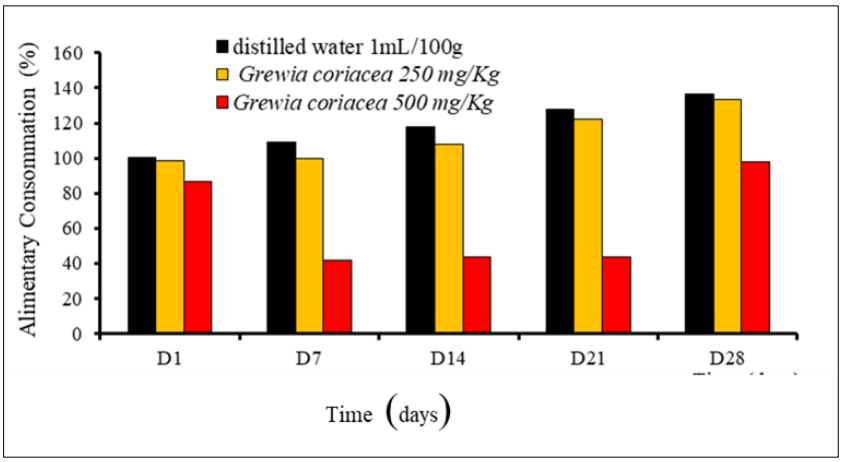

Figure 3 Effects of the aqueous extract of the fruits of *Grewia coriacea* Mast. on Food Consumption of Rats. Each stitch is a mean ± SEM, with n = 3. D: day

3.2.3 Effect of aqueous extract of fruits of the Grewia coriacea Mast. *on haematological and biochemical parameters in wistar rats after 28 days of treatment*

Effect of aqueous extract of the fruits of *Grewia coriacea* Mast. on hematological parameters

The effect of the aqueous extract of the fruits of *Grewia coriacea* Mast. on the hematological parameters in the rat treated for 28 days in the subacute toxicity test is presented in Table 2. The results indicated on the parameters measured show, on the one hand, a significant reduction in white blood cells at a dose of 500 mg/Kg (5.93±0.79; $p<0.01$) and in mean globular volume (57.67±2.33; $p<0.001$ for 250 mg/Kg and 54.52±2.11 $p<0.01$ for 500 mg/Kg). This also results in a

significant increase in the hemoglobin level (16.32±0.36 and 17.86±0.13; p<0.01); mean corpuscular hemoglobin content (20.03±0.29; p<0.05 and 21.63±1.18 p<0.01); platelets (504.67±213.16 p<0.001 and 584.67±124.58 p<0.001) and monocytes (0.53±0.12 p<0.001 and 0.77±0.02 p<0.001) respectively at doses of 250 and 500 mg/kg compared to the control batch.

Table 2 Effect of the aqueous extract of the fruits of *Grewia coriacea* Mast. on Hematological Parameters in normal rats after 28 Days of Treatment

Hematological parameters		**Treatments**	
	DW 1mL/100 g	**Gc 250 mg/Kg**	**Gc 500 mg/Kg**
WBC (103/mm^3)	8.39 ±0.34	8.53±0.31ns	5.93±0.79**
RBC (106/ mm^3)	8.17±0.49	5.05±0.47ns	7.39±0.16ns
HGB (g/dL)	13.41±0.41	16.32±0.36**	17.86±0.13**
HCT (%)	42.93±2.43	37.91±3.95ns	45.00±3.60ns
MCV (µm^3)	86.66±2.02	57.67±2.33**	54.52±2.11***
MCHC (pg)	18.76±0.35	20.03±0.29*	21.63±1.18 **
PLA (103/ mm^3)	324.00±108.91	504.67±213.16***	584.67±124.58***
MON (103/ mm^3)	0.40±0.05	0.53±0.12***	0.77±0.02***
GRA (103/ mm^3)	3.06±0.81	0.77±0.17***	1.52±0.05***
LYM (103/ mm^3)	2.40±0.41	3.08±0.23ns	2.75±1.09ns

Values are means ± SEM, with n = 3; ns: non-significant difference; *p<0.05; **p<0.01; * * * p < 0.001 significant difference from control; compared to the witness. In bold significant values. DW: distilled water; Gc: *Grewia coriacea* ; WBC: white blood cells; RBC: red blood cells; HGB: hemoglobins; HTC: hematocrit; MCV: mean corpuscular volume; MCHC: Mean corpuscular hemoglobin content; PLA: blood platelets; MON: monocytes; GRA: granulocytes LYM: lymphocytes.

Effect of aqueous extract of fruits *of* the *Grewia coriacea* Mast. on biochemical parameters

Table 3 Effect of the aqueous extract of the fruits of *Grewia coriacea* Mast on biochemical parameters in normal rats after 28 days of treatment

Biochemical parameters		**Treatments**	
	DW 1mL/100g	**GC 250 mg/Kg**	**Gc 500 mg/Kg**
Acid U. (Umol/L)	175.78± 12.23	296.94± 62.38**	270.32 ± 74.66**
AST (IU/L)	34.34 ±0.38	30.00 ±2.88ns	15.05±6.63**
ALT (IU/L)	53.66±2.14	25.00 ±2.88***	43.00±5.77ns
Creat (mg/L)	11.54± 0.04	8.19±0.49ns	8.44±0.40ns
Gly (g/L)	0.99 ± 0.19	0.86± 0.33ns	0.86±0.13ns
ChoT (g/L)	1.00± 0.08	0.72±0.02**	0.68±0.14**
HDL (g/L)	0.44 ± 0.04	0.48±0.06ns	0.54±0.02ns
LDL (g/L)	0.35±0.03	0.42±0.25ns	0.05±0.03***
TG (g/L)	2.41± 0.13	1.11± 0.09***	1.19 ±0.02***

Values are means ± SEM, with n = 3. ns: difference not significant; *: p<0.05; **p<0.01;* * * p < 0.001 significant difference from control (distilled water). In bold significant values. GC: *Grewia coriacea* ; DW: distilled water; Acid U.: uric acid; AST: aspart amino-transaminase; ALT: alanine amino transaminase; Creat: serum creatinine; Gly: blood sugar; ChoT: total cholesterol; HDL: High Density Lipoprotein; LDL: Low Density Lipoprotein; Sorting: triglycerides.

The effect of the aqueous extract of the fruits of *Grewia coriacea* Mast. on the biochemical parameters in the rat treated for 28 days in the subacute toxicity test is presented in Table 3. The results obtained show a significant decrease in the

levels of AST (15.05±6.63 p<0.01 at 500 mg/Kg), ALT (25.00±2.88 p<0.001 for 250 mg/Kg) and total cholesterol (0.72±0.02 p<0.01 for 250 mg/Kg and 0.68±0.14 p<0.01 at 500 mg/Kg), LDL (0.05±0. 03 p<0.001 at 500 mg/Kg), triglycerides (1.11± 0.09 p<0.001 at 250 mg/Kg and 1.19 ±0.02 p<0.001 at 500 mg/ Kg). On the other hand, it results in a significant increase in uric acid (296.94 ± 62.38 p<0.01 and 270.32 ± 74.66 p<0.01) respectively at doses of 250 and 500 mg/Kg compared to the control batch (distilled water 1 mL/100g).

3.2.4 Effect of aqueous extract of fruits of the Grewia coriacea Mast. on the mass and the general state of some organs of the rats 28 days after the treatment

Table 4 shows the effect of the aqueous extract of the fruits of *Grewia coriacea* Mast. on organ mass. As a result, the aqueous extract of the fruits of *Grewia coriacea* Mast. at the different doses evaluated, has no effect on the mass of the organs.

Table 4 Effect of the aqueous extract of the fruits of *Grewia coriacea* Mast. on organ mass of rats after 28 days of treatment

	organ masses (g)				
treatments	**heart**	**missed**	**liver**	**left kidney**	**right kidney**
DW 1mL/100 g	0.46±0.04	0.23±0.03	3.11±0.44	0.32±0.05	0.33±0.03
GC 250 mg/Kg	0.42±0.08ns	0.25±0.01ns	2.86±0.20ns	0.30±0.01ns	0.29±0.05ns
GC 500 mg/Kg	0.46±0.04ns	0.23±0.02ns	3.00±0.10ns	0.30±0.014ns	0.30±0.071ns

DW: distilled water; GC: *Grewia coriacea* ; ns: no-significant difference compared to the control (distilled water)

3.2.5 Effect of the aqueous extract of the fruits of Grewia coriacea Mast *on inflammation*

Effect of aqueous extract of the fruits of *Grewia coriacea* Mast. on acute inflammation: edema induced by carrageenan 1%

Table 5 presents the effect of the aqueous extract of the fruits of *Grewia coriacea* Mast on the evolution of edema over time. It shows that the oral administration of the aqueous extract of the fruits of *Grewia coriacea* significantly prevents inflammation induced by carrageenan 1%. Animals having received the extract (500 mg/Kg) show moderate edema for leg volumes ranging from 0.28 ± 0.008 (1h) to 0.26 ± 0.03 (4h) p<0.001 after induction. The percentages of inhibition of the extract at the same dose are 18.18% (1 hour) and 52.17% (4 hours). However, in animals having received Diclofenac (reference product), the inhibition of edema is greater with percentages of 63.63% (1 hour) and 65.21% (4 hours).

Effect of aqueous extract of the fruits of *Grewia coriacea* Mast. on acute inflammation: edema induced by formaldehyde 2.5%

Table 5 Effect of the aqueous extract of the fruits of *Grewia coriacea* Mast on carrageenan 1% induced edema

Treatments	**Volume of edema (mL)**					**Inhibition (%)**	
	1/2 h	**1h**	**2h**	**3h**	**4h**	**1h**	**4h**
DW 0,5 mL/Kg+ carrageenan 1mL /mouse	0.36±0.013	0.37±0.026	0.40±0.008	0.42±0.020	0.38±0.048	/	/
Diclo 5 mg/Kg+ carrageenan 1mL /mouse	0.24±0.016***	0.23±0.036***	0.20±0.038***	0.21±0.015***	0.23±0.029***	63.63	65.21
Gc 250 mg/Kg+ carrageenan 1mL /mouse	0.32±0.012*	0.35±0.031ns	0.38±0.012ns	0.34±0.005***	0.32±0.003***	9.09	26.08
Gc 500 mg/Kg+ carrageenan 1mL /mouse	0.28±0.008***	0.33±0.008*	0.35±0.120*	0.32±0.008***	0.26±0.03***	18.18	52.17

DW: distilled water; Diclo: Diclofenac*; GC: *Grewia coriacea* ; Each point is a mean ± SEM, with n=3. ns: difference not significant; * p < 0.05 and *** p < 0.001 significant difference compared to the control batch treated with distilled water.

The results presented in Table 6 show that the aqueous extract of the fruits of *Grewia coriacea* Mast. at a dose of 500 mg/Kg, significantly reduces the evolution of edema by 0.18 ± 0.00 (1/2h) and 0.19 ± 0.03 (4h) p<0.001after administration of 2.5% formaldehyde with an inhibition of 73.33% (4h). However, the reference product (diclofenac*) presents a significantly moderate edema (p<0.00) with a percentage inhibition of 86.67% (4h).

Table 6 Effect of the aqueous extract of the fruits of *Grewia coriacea* Mast. on the evolution of edema induced by formaldehyde 2.5%

Treatments	**Volume of edema (mL)**					**Inhibition (%)**	
	1/2 h	**1h**	**2h**	**3h**	**4h**	**1h**	**4h**
DW 0,5 mL/Kg+ formaldéhyde 2,5 mL /mouse	0,27±0,02	0,25±0,07	0,24±0,02	0,27±0,04	0,30±0,01	/	/
Diclo 5 mg/Kg+ formaldéhyde 2,5 mL /mouse	0,17±0,01***	0,18±0,03***	0,19±0,03***	0,18±0,01***	0,17±0,02***	70	86,67
Gc 250 mg/Kg+ formaldéhyde 2,5 mL /mouse	0,23±0,01ns	0,21±0,02ns	0,21±0,02ns	0,22±0,03*	0,21±0,00**	40,44	60
Gc 500 mg/Kg+ formaldéhyde 2,5 mL /mouse	0,18±0,00***	0,20±0,03*	0,20±0,01ns	0,21±0,01*	0,19±0,03***	50	73,33

EW: distilled water, Diclo: Diclofenac, Gc: *Grewia coriacea* . h: hour. Each point is a mean ± SEM, with n = 3.ns: difference no significant; *p<0.05; **p<0.01; ***p<0.001 significant difference compared to the control group treated with distilled water.

Effect of aqueous extract of the fruits of *Grewia coriacea* Mast. on chronic inflammation: edema induced by formaldehyde 2.5%

The results presented in Table7 show that the aqueous extract of the fruits of *Grewia coriacea* Mast (250 and 500 mg/Kg) significantly reduced the progression of edema respectively by 0.23±0.02 and 0.19±0.00 p<0.001 on the first day after administration of formaldehyde. The dose of 500 mg/Kg is more effective with 36.13% inhibitions on the 3rd day and 25.33 on the 9th day. However, Diclofenac significantly inhibited the evolution of edema in animals during the nine days of treatment for a more pronounced percentage of 47.05% on the 3rd day.

Table 7 Effect of the aqueous extract of the fruits of *Grewia coriacea* Mast. on the evolution of edema induced by 2.5% formaldehyde for nine days

Treatments	**Volume of edema (mL)**					**Inhibition (%)**		
	D1	**D3**	**D5**	**D7**	**D9**	**D1**	**D3**	**D9**
DW 0.5 mL/Kg+ formaldéhyde 2.5 mL /rat	0.26±0.01	0.39±0.03	0.25±0.02	0.22±0.00	0.25±0.01	/	/	/
Diclo 5 mg/Kg+ formaldéhyde 2.5 mL /rat	0.17±0.01***	0.21±0.01***	0.21±0.01***	0.18±0.01***	0.16±0.00***	34.61	47.05	30.33
Gc 250 mg/Kg+ formaldéhyde 2.5 mL /rat	0.23±0.02***	0.25±0.03*	0.24±0.01ns	0.19±0.00 ns	0.21±0.00*	10.25	10.92	14.67
Gc 500 mg/Kg+ formaldéhyde 2.5 mL /rat	0.19±0.00***	0.24±0.00*	0.21±0.01ns	0.18±0.01**	0.18±0.88***	24.35	36.13	25.33

DW: distilled water, Diclo: Diclofenac, Gc: *Grewia coriacea* , D: days. Each point is a mean ± SEM, with n = 5.ns: difference no significant; *p<0.05; **p<0.01; ***p<0.001 significant difference compared to the control batch treated with distilled water

Effect of aqueous extract of the fruits of *Grewia coriacea* Mast. on the biochemical parameters of inflammation

Table 8 shows the effect of the aqueous extract of the fruits of *Grewia coriacea* Mast. on two biochemical parameters of inflammation. The results obtained show that the aqueous extract of the fruits of *Grewia coricea* does not influence CRP and albumin levels in rats compared to controls (distilled water and Diclofenac).

Table 8 Effect of the aqueous extract of the fruits of *Grewia coriacea* Mast. on the biochemical parameters of inflammation in rats treated for 9 days with 2.5% formaldehyde

Biochemical (inflammatory) parameters	**Treatments**			
	DW (1 mL/100 g)	**Diclo (10 mg/Kg)**	**Gc (250 mg/Kg)**	**Gc (500 mg/Kg)**
CRP (mg/L)	2.41±0.65	2.23±1.11ns	2.23± 0.66ns	1.91± 1.09ns
Albumin (mg/dL)	3.65± 0.17	3.18± 0.34ns	4.20±0.764ns	3.52± 0.18ns

DW: distilled water; Diclo: Diclofenac; Gc: *Grewia coriacea* ; CRP: C-reactive protein

4. Discussion

At the end of this work, it appears that the aqueous extract of the fruits of *Grewia coriacea* Mast. administered at a single dose of 5000 mg/Kg causes a slight increase in aggressiveness and alertness in mice respectively half an hour and four hours after administration of the extract compared to control rats (distilled water). It did not cause any mouse mortality. Therefore, the aqueous extract of the fruits of *Grewia coriacea* Mast is considered non-toxic or slightly toxic with an LD50> 5000 mg/Kg and it is classified in the GHS (Globally Harmonized Classification System) hazard 5 category corresponding to substances with relatively low acute toxicity (OECD, 2001). The weighings carried out during the 14 days of the experiment show that compared to the control animals, the mice having been treated with the aqueous extract of the fruits of *Grewia coriacea* Mast. had no significant weight gain. This would be proportional to the food consumption observed during the assessment of subacute toxicity for 28 days.

The dosage of hematological parameters in the treated animals reveals a significant rise in hemoglobin and platelets justifying the use of the fruit extract. *Grewia coriacea* Mast. in the prevention and treatment of anemia. The increase in observed monocytes would suggest that the extract would enhance immunity. This result is similar to those obtained by Morabandza et al. (2017). On the other hand, the dosage of biochemical parameters show a significant decrease in serum values of total cholesterol and triglycerides which could prevent the onset of metabolic and cardiovascular diseases in particular, arterial hypertension, diabetes and obesity (Abete et al., 2008). Also, obesity being considered as a chronic inflammatory disease, the evaluation of the anti-inflammatory activity of the extract is important. However the aqueous extract of the fruits of *Grewia coriacea* Mast. at the different doses tested had no significant effect on the mass of the organs of the treated animals.

The effect of the aqueous extract of the fruits of *Grewia coriacea* on inflammation was evaluated. First, a model ofacute inflammation induced by subplantar administration of carrageenan 1% has been evaluated. It appears that the animals which received the extract orally at a dose of 500 mg/kg show a significantly moderate edema for an inhibition of 18.18% (1/2h) and 52.17% (4h). Secondly, the oral administration of the aqueous extract of the fruits of *Grewia coriacea* at the same dose, significantly prevents the inflammation induced by 2.5% formaldehyde with an inhibition of 73.33%. Similar effects were observed on chronic inflammation (nine days) induced by 2.5% formaldehyde. These results are in agreement with those obtained by Nsonde-ntandou et al (2010) who demonstrated the antiinflammatory effect of *Cassia siamea* Lam. In order to assess the levels of inflammation in the blood, the assay of two inflammatory parameters CRP and albumin was performed. And the results obtained show that the inflammation induced by formaldehyde had no effect on the parameters evaluated. The aqueous extract of the fruits of *Grewia coriacea* Mast. would have an anti-inflammatory effect. All these properties give fruits an important place in the diet of populations.

5. Conclusion

This study shows that the aqueous extract of the fruits of *Grewia coriacea* Mast. is weakly toxic with a LD_{50}> 5000 mg/Kg and has an anti-inflammatory effect in laboratory animals. These results encourage the food consumption of these fruits and their use in traditional medicine.

Compliance with ethical standards

Acknowledgments

Our thanks go to anyone who, near or far, has participated in the productionand writing of this article.

Disclosure of conflict of interest

There are no known conflicts of interest associated with this publication

Statement of ethical approval

The present research work does not contain any studies performed on animals/humans subjects by any of the authors.

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