



HAL
open science

Effect of Bryophyllum pinnatum Leaf Extract Consumption on Lipid Concentrations and Cardiovascular Risk Indices in Apparently Healthy Individuals

Ibiene Sarah Kalio, Echeonwu Victoria Chidinma, Margret Deinma Aleru-Chuku

► To cite this version:

Ibiene Sarah Kalio, Echeonwu Victoria Chidinma, Margret Deinma Aleru-Chuku. Effect of Bryophyllum pinnatum Leaf Extract Consumption on Lipid Concentrations and Cardiovascular Risk Indices in Apparently Healthy Individuals. Asian Journal of Biochemistry, Genetics and Molecular Biology, 2023, 13 (4), pp.40-48. 10.9734/ajbgmb/2023/v13i4302 . hal-04085754

HAL Id: hal-04085754

<https://hal.science/hal-04085754>

Submitted on 29 Apr 2023

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.



Distributed under a Creative Commons Attribution 4.0 International License



Effect of *Bryophyllum pinnatum* Leaf Extract Consumption on Lipid Concentrations and Cardiovascular Risk Indices in Apparently Healthy Individuals

Ibiene Sarah Kalio ^{a*}, Echeonwu Victoria Chidinma ^a
and Margret Deinma Aleru-Chuku ^b

^a School of Medical Laboratory Science, Rivers State College of Health Science and Management Technology, Rumueme, P.M.B 5039, Port Harcourt, Rivers State, Nigeria.

^b School of Foundation Studies, Rivers State College of Health Science and Management Technology, Rumueme, P.M.B 5039, Port Harcourt, Rivers State, Nigeria.

Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/AJBGMB/2023/v13i4302

Open Peer Review History:

This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: <https://www.sdiarticle5.com/review-history/98680>

Original Research Article

Received: 18/02/2023

Accepted: 20/04/2023

Published: 29/04/2023

ABSTRACT

Bryophyllum pinnatum has been consumed locally for various ailments without proper documentation of its effect on Lipid concentrations and cardiovascular risk indices in humans. This study sought to determine the effect of *Bryophyllum pinnatum* leaf extract consumption on lipid concentrations and cardiovascular risk indices in apparently healthy individuals by estimating Total

*Corresponding author: E-mail: ibienekalio@gmail.com;

cholesterol, Triglycerides, High Density Lipoprotein (HDL), Low Density Lipoprotein (LDL), Atherogenic Index of Plasma (AIP), Castelli Risk Index I and II, Total protein and Albumin in 15 apparently healthy individuals after consumption of 1.32g/180ml of *Bryophyllum pinnatum* leaf extract for 14 days. Samples taken before the commencement of the study served as control samples, while samples collected on the 1st, 7th and 14th day after consumption of 1.32g/180ml of *Bryophyllum pinnatum* leaf extract served as test samples. Total Cholesterol, Triglycerides, High Density Lipoprotein were estimated using Colorimetric methods. Total protein was estimated using Biuret method while Albumin was estimated using Bromocresol green method. The results showed that levels of LDL(1.04±0.44mmol/l), AIP(-0.34±0.09), Castelli index I (2.16±0.53) and Castelli index II(0.94±0.47) were significantly reduced ($p < 0.05$) after 7 days of consumption when compared to control LDL(2.65±0.18mmol/l), AIP(-0.15±0.18), Castelli index I (3.84±0.32) and Castelli index II(2.44±0.33). Further comparison of levels of LDL(2.22±0.74mmol/l), AIP((-0.15±0.18), Castelli index I ((3.74±1.80) and Castelli index II (2.42±0.98) after 14 days of consumption with levels after 7 days LDL(1.04±0.44mmol/l), AIP(-0.34±0.09), Castelli index I (2.16±0.53) and Castelli index II(0.94±0.47) showed significant increase ($p < 0.05$). Results obtained suggest that short term consumption of *Bryophyllum pinnatum* leaf extract would reduce cardiovascular risk indices in humans but continuous long term use can predispose consumers to increased risk of developing cardiovascular pathological consequences.

Keywords: *Bryophyllum pinnatum*; cardiovascular risk indices; lipids; traditional medicine; miracle plant; castelli index.

1. INTRODUCTION

Bryophyllum pinnatum also known as *kalanchoe pinnata* of the family crassulaceae. It is also known as air plant, cathedral bells, life plants, miracle leaf, resurrection plant. *Bryophyllum pinnatum* is a leafy plant commonly found in Madagascar and other parts of the world such as Pakistan, Nepal, Brazil and United States [1,2]. The plant is locally called "Never Die" in Nigeria. It is a plant that is classified as weed. *Bryophyllum pinnatum* grows widely throughout the southern part of Nigeria [3]. It is a tall, erect and succulent perennial herb measuring up to 2meter in height [4]. Its leaves are oval in shape with rounded tips measuring 5-25cm long and 2-12cm broad [5]. *Bryophyllum pinnatum* has been reported to contain a wide range of active compounds such as alkaloids, glycosides, flavonoids, steroids, lipids and organic solvents [6]. The plant is widely used in traditional medicine for the treatment of variety of ailments hence the name 'miracle plant' as it is known for its haemostatic and wound healing properties [7,6].

In traditional medicine, the leaves of the plant have been used for antimicrobial [8] anti-ulcer, anti-inflammatory [9], antihypertensive [10] uses. The leaves and bark are used as bitter tonic, useful in treating diarrhea and vomiting [11]. It is applied externally and taken internally for all types of pains and inflammations, bacterial, viral and fungal infections, earaches, upper respiratory infection, stomach ulcers and fever

[4]. *Bryophyllum pinnatum* acts as a herbal remedy for an array of human disorders, including hypertension, diabetes mellitus, bruises, wound and boils [7,12], abscesses, insect bites, arthritis, rheumatism, joint pain, headaches and body pain [13]. Reports indicate that the leaves of the plant (*Bryophyllum pinnatum*) have strong medicinal value and are used both externally and internally [5]. *Bryophyllum pinnatum* is highly recommended in treatment of nocturia [14], bleeding disorders, piles and is suggested to be a good source of vitamin [15]. It is consumed with the belief that the plant helps to clean the bladder and also serves as a toxin remover in the intestines [16]. Reports suggest that it helps in weight loss [17], treatment of inflammation [18] and bronchial condition [19]. Study by Raymond et al. [20] suggest possible safety of the aqueous extract of *Bryophyllum pinnatum* in Sprague-Dawley rats.

Lipid concentrations can be used to determine "Good cholesterol" and "Bad cholesterol" and serve as initial screening tool for abnormalities in lipids. The result of lipid test can identify certain genetic diseases, certain forms of pancreatitis and cardiovascular disorders. Fasting lipid test includes four (4) basic parameters; Total cholesterol (T.C), Triglycerides (T.G), High density lipoprotein (HDL) cholesterol, Low density lipoprotein (LDL) cholesterol [21].

High density lipoprotein (HDL) cholesterol, also known as the 'good cholesterol' absorbs cholesterol and carries it back to the liver where

it flushes it from the body. High levels of high density lipoprotein can lower the risk for heart diseases and stroke while High levels of low density lipoprotein (LDL) cholesterol known as 'bad cholesterol' leads to a buildup of cholesterol in the arteries where it forms plaque. The plaque builds up in the arteries leading to Atherosclerosis [22]. This study therefore sought to determine the effect of *Bryophyllum pinnatum* leaf extract consumption on lipid concentrations and cardiovascular risk indices in apparently healthy individuals.

2. MATERIALS AND METHODS

2.1 Study Area

The study was conducted in Rivers State College of Health Science and Management Technology Port Harcourt, Rivers state, Nigeria.

2.2 Study Population

A total of fifteen (15) apparently healthy individuals aged between 20-25 years and weighing between 55-75kg were recruited for the study. All participants were volunteers who were well informed about the study before giving their written consent to participate.

2.3 Plant Purchase and Identification

The plant parts used for the study were fresh leaves of *Bryophyllum pinnatum* obtained from a botanical garden in Iwofe district in Port Harcourt, Rivers state in Nigeria. The leaf of *Bryophyllum pinnatum* was identified by a pharmacist in the department of Pharmacy in Rivers State College of Health Science and Management Technology.

2.4 Plant Preparation

Freshly cut leaf from a botanical garden in Iwofe district in Port Harcourt, Rivers State, Nigeria were carefully plugged and sorted out to remove contaminated matters. The leaves were weighed using a digital weighing balance (dw100) made in china. The weight was noted.

The leaves were then washed and allowed to dry and reweighed in a clear jar with 13.3 liters of water. It was allowed to stand for an hour than filtered to remove the shaft leaving the concentrate.

2.5 Calculation of Plant Concentration

Weight of leaves before grinding = 450g
Weight of leaves after grinding and removal of shaft = 97.4g

Total volume of water used to macerate leaves = 13.3 liters (13,300ml)

Concentration of leaf extract in 13.3 liters of water = 97.4g/13.3 liters

Each cup used by participant can contain 180ml by volume

13.3 liters (13300ml) leaf extract contains 97.4g.

180ml will contain $97.4g \times \frac{180ml}{13300ml}$
=1.318g

Concentration of leaf extract consumed daily by each participant = 1.32g/180ml daily for 14 days.

2.6 Sample Collection

Blood samples were collected from each participant before commencement of the study as control samples while test samples were collected on day 1, day 7 and day 14 from each participant. All samples were collected by veinpuncture and dispense into well labeled lithium heparin bottle. The samples were centrifuged at 1500 rotations per minute for 5minutes to obtain plasma samples which were analysed immediately for fasting lipid parameters.

2.6.1 Determination of test parameters

Total cholesterol, Triglycerides, High density lipoproteins were determined using Colometric methods as described by Ochei. and Kolhatkar [23]. Total protein was determined using Biuret method while Albumin was estimated using Bromocresol green method [24].

Atherogenic index of plasma (AIP) was calculated using the formular $\log_{10} (TG/HDL-C)$ as described by Kanthe, et al. [24] and Nyat et al. (2018).

2.6.2 Castelli Risk Index I and II

Castelli Risk Index I and II were calculated using the formula as described by Oguejifor et al. [25].

$$CAST I = \frac{TC}{HDL - C}$$

$$CAST II = \frac{LDL - C}{HDL - C}$$

2.7 Statistical Analysis

Data were analyzed using Microsoft excel version 2007 and Graph pad prism version 5 to determine the statistical significance. P < 0.05 was considered to be statistically significant

3. RESULTS

The study was conducted to determine Total cholesterol, Triglycerides, High Density Lipoprotein, Low Density Lipoprotein, Atherogenic Index of Plasma, Castelli Risk Index

I and II, Total Protein and Albumin) in Apparently 15 healthy Individuals after the Consumption of *Bryophyllum pinnatum* for 14 days.

Results are summarized in the Table 1 to Table 5.

Table 1 shows that, Total cholesterol, Triglycerides, High Density Lipoprotein, Low Density Lipoprotein, Atherogenic Index of Plasma, Castelli Risk Index I and II, Total Protein and Albumin did not show any significant difference when the test group was compared to the control after one day of consumption of *Bryophyllum pinnatum*. P>0.05.

Table 1. Lipid Concentrations, Atherogenic Index, Castelli Risk Index I and II in Apparently Healthy Individuals after one day of Consumption of *Bryophyllum pinnatum* and control n=15

Parameter	Control Mean±SD n =15	Test (After day one) Mean±SD n= 15	T-test	P-value
Total cholesterol(mmol/L)	4.13± 0.08	3.10± 1.07	2.13	0.10
Triglycerides (mmol/L)	0.87±0.33	0.65±0.18	1.83	0.14
HDL (mmol/L)	1.08±0.09	1.02±0.16	0.83	0.17
LDL (mmol/L)	2.65±0.18	1.78±1.11	1.67	0.17
AIP	-0.15±0.18	-0.20±0.13	0.85	0.45
CAST I	3.84±0.32	3.13±1.35	0.99	0.38
CAST II	2.44±0.33	1.83±1.32	0.94	0.40
Total Protein(mmol/L)	72.20±5.36	74.80±5.07	0.64	0.56
Albumin(mmol/L)	42.00±1.87	40.20±1.48	1.45	0.23

HDL – High Density Lipoprotein LDL – Low Density Lipoprotein
 AIP – Atherogenic Index of Plasma CAST I – Castelli Risk Index I
 Cast II – Castelli Risk Index II P<0.05 – Significant

Table 2. Lipid concentrations, Atherogenic index, Castelli Risk Index I and II in Apparently Healthy Individuals after Seven days of Consumption of *Bryophyllum pinnatum* and control n=15

Parameter	Control Mean±SD n =15	Test (after 7days) Mean±SD n = 15	T-test	P-value
Total Cholesterol(mmo/L)	4.13± 0.08	2.43±0.57	6.66	0.00
Triglycerides (mmol/L)	0.87±0.33	0.52±0.09	2.59	0.06
HDL (mmol/L)	1.08±0.09	1.05±0.09	0.56	0.58
LDL (mmol/L)	2.65±0.18	1.04±0.44	7.52	0.00
AIP	-0.15±0.18	-0.34±0.09	2.71	0.05
CAST 1	3.84±0.32	2.16±0.53	5.27	0.00
CAST II	2.44±0.33	0.94±0.47	5.01	0.00
Total Protein (mmol/L)	72.20±5.36	75.4±9.07	0.67	0.51
Albumin (mmol/L)	42.00±1.87	41.4±5.32	0.24	0.81

HDL – High Density Lipoprotein LDL – Low Density Lipoprotein
 AIP – Atherogenic Index of Plasma CAST I – Castelli Risk Index I
 CAST II – Castelli Risk Index II P<0.05 – Significant

Table 2 shows that Total cholesterol, Low Density Lipoprotein, Atherogenic index of plasma, CAST I and II were significantly reduced ($P<0.05$) when the test group was compared to the control after 7 days of consumption of *Bryophyllum pinnatum*. Triglycerides, High Density Lipoprotein, Total protein and Albumin did not show any significant difference ($P>0.05$) when test group was compared to the control after 7 days of consumption of *Bryophyllum pinnatum*.

Table 3 shows that, Total cholesterol, Triglycerides, High Density Lipoprotein, Low Density Lipoprotein, Atherogenic Index of

Plasma, Castelli I and II, Total protein and Albumin did not show any significant difference when the test group were compared to the control group after 14 days of consumption of *Bryophyllum pinnatum*. $P>0.05$.

Table 4 shows that, Total cholesterol, Triglycerides, High Density Lipoprotein, Low Density Lipoprotein, Atherogenic Index of Plasma, Castelli I and II, Total protein and Albumin did not show any significant difference after one day of consumption was compared to 7 days of consumption of *Bryophyllum pinnatum*. $P>0.05$.

Table 3. Lipid Concentrations, Atherogenic Index, Castelli Risk Index I and II in Apparently Healthy Individuals after 14 days of Consumption of *Bryophyllum pinnatum* and Control n=15

Parameter	Control Mean±SD n=15	Test (after14 days) mean± SD n = 15	T-test	P-value
Total cholesterol(mmol/L)	4.13±0.08	3.47±0.75	1.92	0.09
Triglycerides(mmol/L)	0.87±0.33	0.69±0.20	0.99	0.35
HDL (mmol/L)	1.08±0.09	0.95±0.14	1.52	0.16
LDL (mmol/L)	2.65±0.18	2.22±0.74	1.14	0.31
AIP	-0.15±0.18	-0.15±0.18	0.28	0.78
CAST I	3.84±0.32	3.74±1.8	0.19	0.85
CAST II	2.44±0.33	2.42±0.98	0.10	0.91
Total Protein (mmol/L)	72.20±5.36	70.80±3.03	0.51	0.63
Albumin (mmol/L)	42.00±1.87	42.40±3.65	0.21	0.83

HDL – High Density Lipoprotein LDL– Low Density Lipoprotein
AIP– Atherogenic Index of Plasma CAST I – Castelli Risk Index 1
CAST II – Castelli Risk Index II $P<0.05$ – Significant

Table 4. Lipid Concentrations, Atherogenic Index, Castelli Risk Index I and II in Apparently Healthy Individuals after 1 day of Consumption of *Bryophyllum pinnatum* and 7 days. n= 15

Parameter	After 1 day Mean±SD n=15	After 7days mean ±SD n = 15	T-test	P-value
Total cholesterol(mmol/L)	3.10±1.07	2.43±0.57	1.64	0.17
Triglycerides (mmol/L)	0.65±0.18	0.52±0.09	1.49	0.13
HDL (mmol/L)	1.02±0.16	1.05±0.09	0.95	0.13
LDL (mmol/L)	1.78±1.11	1.04±0.44	1.84	0.13
AIP	-0.20±0.13	-0.34±0.09	1.94	0.08
CAST I	3.13±1.35	2.16±0.53	1.40	0.17
CAST II	1.83±1.32	0.94±0.47	1.41	0.19
Total Protein (mmol/L)	74.80±5.07	75.40±9.07	0.15	0.88
Albumin (mmol/L)	40.20±1.48	41.40±5.32	0.42	0.69

HDL – High Density Lipoprotein LDL – Low Density Lipoprotein
AIP – Atherogenic Index of Plasma CAST 1 – Castelli Risk Index 1
CAST II – Castelli Risk Index II $P<0.05$ – Significant

Table 5. Lipid concentrations, atherogenic index, castelli risk index I and II in Apparently Healthy Individuals after 7 Days of Consumption of *Bryophyllum pinnatum* and 14 days. n= 15

Parameter	After 7 days Mean±SD n=15	After 14days mean+ SD n= 15	T-test	P-value
Total cholesterol(mmol/L)	2.43± 0.57	3.47± 0.75	0.97	0.38
Triglycerides (mmol/L)	0.52± 0.09	0.69± 0.20	1.72	0.16
HDL (mmol/L)	1.05± 0.09	0.95 ±0.16	1.59	0.18
LDL (mmol/L)	1.04 ±0.44	2.22±0.4	3.42	0.02
AIP	-0.34± 0.09	-0.15 ±0.18	2.37	0.05
CAST 1	2.16 ±0.53	3.74 ±1.8	3.94	0.01
CAST II	0.94± 0.47	2.42± 0.98	5.99	0.00
Total Protein(mmol/L)	75.40± 9.07	70.80± 3.03	1.19	0.29
Albumin (mmol/L)	41.40 ± 5.32	42.40 ±3.65	0.33	0.75

HDL – High Density Lipoprotein LDL – Low Density Lipoprotein
 AIP – Atherogenic Index of Plasma CAST I– Castelli Risk Index I
 CAST II – Castelli Risk Index II P<0.05 – Significant

Table 5 shows that, Low density lipoprotein(LDL) was significantly increased in test group after 14 days of consumption of *Bryophyllum pinnatum* was compared to 7 days of consumption. Atherogenic index of plasma, Castelli I and II (CAST I and II) were also significantly increased in the test group after 14days of consumption of *Bryophyllum pinnatum* was compared to 7 days of consumption. Total cholesterol (T.C),Triglycerides (T.G), High density lipoprotein (HDL),Total protein (T/P)and Albumin did not shows any significant difference when the test group after 14 days of consumption of *Bryophyllum pinnatum* were compared to 7 days of consumption.

4. DISCUSSION

This study assessed lipid concentrations, AtherogenicIndex, Castelli Risk Index I and II in apparently healthy individuals after consumption of 1.32g/180ml of *Bryophyllum pinnatum* leaf extract.Results of this study showed no significant difference in levels of lipid parameters, Atherogenic Index of Plasma, Castelli Risk Index I and II, Total protein and Albumin after one day of consumption of *Bryophyllum pinnatum* leaf extract was compared to results before consumption. This could explain why the leave have been used as food source as it is shown to possess some levels of carbohydrate, proteins, fats and oil [17].

However, comparism after seven days consumption showed significant reduction in lipid parameters, Atherogenic Index of Plasma, Castelli Risk Index I and II. This would suggest

that short term consumption of *Bryophyllum pinnatum* leaf extract would reduce cardiovascular risk indices in humans. Studies by Kalio et al. [26] on herbal plant suggest results contrary to the findings of this study and concluded that herbal plants such as *Costus afer* when consumed do not affect lipid parameters and does not predispose consumers to cardiovascular risk. Reduced Low density lipoprotein observed in the study after 7 days consumption suggest that short term consumption of *Bryophyllum pinnatum* lowers bad cholesterol level (LDL) in the body, Low density lipoprotein cholesterol is an important indicator of plaque buildup in the arteries which predicts atherosclerosis and cardiovascular disease, hence short term consumption *Bryophyllum pinnatum* leaf extract can aid in reducing the risk of cardiovascular disease. *Bryophyllum pinnatum* leaf extract has been shown to possess anti-inflammatory properties [19] and contains flavonoids and Ascorbic acid which are good antioxidants [20] capable of preventing pathological consequences through their neuroprotective and anticonvulsant properties. This could also explain the ability of the leave extract in reducing low density lipoprotein levels. Also, the reduce Atherogenic Index of Plasma level observed after seven days consumption is also suggestive of the ability of the leave extract in reducing cardiovascular disease. Atherogenic Index of Plasma is a marker of future cardiovascular disease and a predictor of anterogenicity [27,28]. Atherogenic Index of Plasma reflect the lipoprotein composition in the plasma and is an independent risk factor for coronary disease.

Furthermore, results of 14 days of consumption of *Bryophyllum pinnatum* when compared to 7 days of consumption of *Bryophyllum pinnatum* showed increased low density lipoprotein cholesterol, AIP and CAST I and II after 14 days consumption. This would suggest that continuous long term consumption would further predispose consumers to increase concentrations of cardiovascular risk indices in humans. Atherogenic Risk Index (AIP) is a strong prediction of infarction and can be used alone for cardiac risk estimation. It is used by some practitioners as a significant predictor of Atherosclerosis [29]. Castelli Risk Index which is of two types, Castelli risk index I and II. Castelli Risk Index is also known as cardiac risk ratio (CRI). The ratios have been studied as markers of Lipid Atherogenic. These are calculated fractions which can be used in clinical setting to assess the risk of cardiovascular disease beyond the routinely done Lipid profile [25].

This study also showed that Low Density Lipoprotein was significantly higher after 14 days of consumption of *Bryophyllum pinnatum* was compared to 7 days of consumption. Increased levels of Low Density Lipoprotein is linked to an increased risk of heart and blood vessel disease including coronary artery disease, heart attack and death. Low Density Lipoprotein is a combination of fat and protein found in the blood. It is called bad cholesterol because it picks cholesterol from the blood and take it to the cells and build up walls in the arteries. These fatty deposits form plaque that lines up in the arteries can cause blockage. Thus build up is known as Atherosclerosis [22]. LDL moves cholesterol to vascular cells and can be use to determine deposition of intracellular lipids [30]. Increase Low density lipoprotein observed in this study suggest after 14 days consumption suggest that *Bryophyllum pinnatum* consumption may predispose consumers to increase risk of heart and blood vessel disease [31].

5. CONCLUSION

This study showed that long term consumption of *Bryophyllum pinnatum* could predispose consumers to increase levels of cardiovascular risk indices. Consequently, continuous long term consumption should be discouraged to prevent risk of developing cardiovascular problems.

CONSENT

As per international standard or university standard, Participants' written consent

has been collected and preserved by the author(s).

ETHICAL APPROVAL

Ethical approval was gotten from Rivers State college of Health Science and Management Technology research board.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Yadav NP, Dixit VK. The patoprotective activity of leaves of *Kalarichoepinnata*. Pers. Journal of Ethnopharmacology. 2013;86:197-202.
2. Smith GF, Figueiredo E, Vanwyk AE. *Kalanchoe*(Crussulaceae) in South Africa. Academic Press, Elsevier. 2019;i-328.
3. Gill LS. Ethno-medical uses of plants in Nigeria. University of Benin Press. 2017;46. Gupta R, Lohani M, Arora S. Anti-inflammatory activity of the leaf extract/fractions of *Bryophyllum pinnatum* salivsyn. International Journal of Pharmaceutical Sciences Review and Research. 2011; 3(1):16-18.
4. Silva D, Pal S, Chaudhari Nag AK. Neuro psychopharmacological profile of the methanolic fraction of *Bryophyllum pinnatum* leaf extract. Journal of Pharmaceutical Pharmacol. 2015;51: 313-318.
5. Dalzeil JM. The useful plants of west tropical Africa. London: Crown Agents for the colonies. 2017;28-29.
6. Naude TW. The occurrence and significance of South African cardiac glycosides. J. S. Afr. Biol. Soc. 2017;18:7.
7. Araújo ERD, Xavier-Santos JB, da Silva VC, de Lima JBF, Schlamb J, Fernandes-Pedrosa MDF, Zucolotto SM. Gel formulated with *Bryophyllum pinnatum* leaf extract promotes skin wound healing in vivo by increasing VEGF expression: A novel potential active ingredient for pharmaceuticals. Frontiers in Pharmacology. 2023;13;5546.
8. Oliver-Bever. Medicinal plants in tropical west Africa III Antinfection therapy with higher plants. J. Ethnopharmacology. 2013;9:1-83.

9. Pal S, Chaudhari Nag AK. Studies on the anti-ulcer activity of a *Bryophyllum pinnatum* leaf extract in experimental animals. *J. Ethnopharmacol.* 2015;33:97-102.
10. Ojewole JAO. Antihypertension properties of *Bryophyllum pinnatum* (Lam) (oken) leaf extracts. *Am J. Hypert.* 2015;15(4): A34-A39.
11. Kirtikar KR, Basu BD. Indian medicinal plants, periodical experts. Delhi. 2: 2nd ed. 2015;999.
12. Sujatha R, Kavitha S. Atherogenic indices in patients with stroke: A retrospective study. *Iran J Neurol.* 2017;16:78-82.
13. Lin C, Rong L. Ethnobotanical studies on medicinal plants used by the red headed Yao people in Jinping Yunnan Province, China. *Journal of Ethnopharmacology.* 2014;90:389-395.
14. Mirzayeva N, Forst S, Passweg D, Geissbühler V, Simões-Wüst AP, Betschart C. *Bryophyllum pinnatum* and Improvement of Nocturia and Sleep Quality in Women: A Multicentre, Nonrandomised Prospective Trial. *Evidence-Based Complementary and Alternative Medicine;* 2023.
15. Okwu DE, Nnamdi FU. Two novel flavonoids from *Bryophyllum pinnatum* and their antimicrobial activity. *Journal of Chemical and Pharmaceutical Research.* 2014;3(2):1-10.
16. Chennkappan K, Kadarkarai M. In vitro antimalarial activity of traditionally used western chats plants from India and their interactions with chloroquine against GQ resistant *Plasmodium falciparum*. *Parasitology Res.* 2019;10.
17. Nwali BU, Okaka CNA, Offor EC, Aja P, Mand Nwachi UE. Proximate and mineral compositions of *Bryophyllum pinnatum* leaves. *American Journal of Phytomedicine and Clinical Therapeutics.* 2014;2(3)286-289.
18. Nayak A, Berry B, Tassetto M, Kunitomi M, Acevedo A, Deng C, Krutchinsky A, Gross J, Antoniewski C, Andino R. Cricket paralysis virus antagonizes Argonaute 2 to modulate antiviral defense in *Drosophila*. *Nat. Struct. Mol. Biol.* 2017;17(5):547—554.
19. Ojewole JA. Antinociceptive, anti-inflammatory and antidiabetic effects of *Bryophyllum pinnatum* (crassulaceae) leaf aqueous extract. *Journal of Ethanopharmacology.* 2005;99:13-19.
20. Raymond Iduojemu Ozolua, Sylvester Eshiotsemeldogun, Glory Eshiagiamhe Tafamel. Acute and sub-acute toxicological assessment of aqueous leaf extract of *Bryophyllum pinnatum* (Lam.) in Sprague-Dawley Rats *American Journal of Pharmacology and Toxicology.* 2010;5(3):145-151
21. Pagana KD, Pagana TJ, Pagana TL. *Mosby's diagnostic & laboratory test reference* (14). Elsevier; 2019.
22. Catapano AL, Pirillo A, Norota GT. High density lipoprotein levels. *Cardiovascular Disease Risk.* 2019;115(1):6-7.
23. Ochei J, Kolhatkar A. *Medical laboratory science. Theory and Practice* (18). New Delhi, Tata McGraw Hill. 2017;157-198.
24. Kanthe PS, Patil BS, Bagali Sh, Deshpande A, Shaikh G, Aithala M. Atherogenic index as a predictor of cardiovascular risk among women with different grades of obesity. *IJCRIMPH.* 2012;4(10):1767–1774.
25. Oguejifor OC, Onwukwe CH, Odenogbo CU. Dylipidemia Nigeria: Prevelance and pattern. *Ann African Medicals.* 2012;197-2020.
26. Kalio,Ibiene Sarah, Okon, Abigail Effiong, Iyama, Mina Josephine. Cardiovascular risk indices in apparently healthy individuals after 14 days of consumption of costusafer stem extract. *Journal of Advances in Medical and Pharmaceutical Sciences.* 2022;24(5):33-40.
27. Dobiášová M, Frohlich J, Šedová M, et al. Cholesterol esterification and atherogenic index of plasma correlate with lipoprotein size and findings on coronary angiography. *J Lipid Res.* 2011;52:566–571.
28. Manoj Kumar Choudhary, Arttu Eräranta, Jenni Koskela, Antti J. Tikkakoski, Pasi I. Nevalainen, Mika Kähönen, Jukka Mustonen, Ilkka Pörsti. Atherogenic index of plasma is related to arterial stiffness but not to blood pressure in normotensive and never-treated hypertensive subjects. *Blood Pressure.* 2019;28:3:157-167.
29. Dabiaswu M. Cholesterol estimation and antherogenic size and findings on coronary angiography. *Journal of Lipid.* 2011;566-577.
30. Venugopal SK, Jialal I. *Biochemistry, low density lipoprotein in stat pearls.* Statpearls publishing treasure island, FL, USA; 2019.

31. Madsen CM, Varbo A, Nordestgaard BG. Extreme high high-density lipoprotein cholesterol is paradoxically associated with high mortality in men and women: two prospective cohort studies. Eur Heart J. 2017;38:2478–2486.

© 2023 Kalio et al.; This is an Open Access article distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/4.0>), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Peer-review history:

*The peer review history for this paper can be accessed here:
<https://www.sdiarticle5.com/review-history/98680>*