SCIENCE FORUM (JOURNAL OF PURE AND APPLIED SCIENCES) 22 (2022) 234 – 238

http://dx.doi.org/10.5455/sf.39911

Science Forum (Journal of Pure and Applied Sciences)

journal homepage: www.atbuscienceforum.com

Antioxidant potential, phytochemicals, and minerals content of the root extract of *Physalis angulata*

Abubakar Bawa[1], Abdulqadir Yunusa[1], Misbahu Sambo[2*]

[1] *Department of Science Laboratory Technology, Federal Polytechnic, Mubi, Nigeria*

[2] *Department of Biochemistry, Abubakar Tafawa Balewa University, Bauchi, Nigeria*

ABSTRACT

The continuous increase in the shift of interest from synthetic drugs to medicinal plants source of drugs necessitates the screening of traditional plants (grown in Northeastern Nigeria) for their antioxidant potential, phytochemicals, and minerals content. This is an attempt to pave way for the scientific identification of plants with proven medicinal values. Therefore, the aim of this research was to determine the antioxidant potential, phytochemicals, and minerals content of the root extract of *Physalis angulata,* which is a herb commonly found even along road sides in the rural areas of northeastern Nigeria. The antioxidant potential, phytochemicals, and minerals content were determined using standard methods. The results of the qualitative phytochemical analysis revealed the presence of alkaloids, terpenoids, saponins, glycosides, and flavonoids. Quantitatively, the amount of the aforementioned phytochemicals was found to be 14.96% ± 0.86% (alkaloids), 13.79% ± 0.04% (terpenoids), 12.78% ± 2.4% (saponins), 0.05% ± 0.03% (glycosides), and 0.05% ± 0.00% (flavonoids). The result of this research also showed that the extract contains magnesium (1,101.50 ± 2.12 ppm), sodium (407.20 ± 0.42 ppm), calcium (76.96 ± 0.79 ppm), zinc (4.95 ± 0.07 ppm), potassium (2.05 ± 0.07 ppm), manganese (1.84 ± 0.05 ppm), copper (1.10 ± 0.14 ppm), cobalt (0.63 ± 0.04 ppm), and selenium (0.20 ± 0.01 ppm). The result of the *in vitro* antioxidant activity (AOA) of the terpenoid fraction showed that there was a dose-dependent increase in the AOA as the concentration of the terpenoid increased from 20 to 1,000 μg/ml. These results suggest that the extract may exert all the activities associated with the phytochemicals it contains; it may also serve as a source of minerals – which are essential for maintenance and perpetuation of life – found in it; and it may also serve as an antioxidant. However, it is suggested that *in vivo* experiments be conducted to test for the activities that the root extract is assumed to possess due to the phytoconstituents it contains (as revealed by this research).

ARTICLE INFO

Article history:
Received 05 December 2021
Received in revised form 28 December 2021
Accepted 29 December 2021
Published 27 April 2022
Available online 27 April 2022

KEYWORDS

Physalis angulata
Phytochemicals
Minerals
Drug
Antioxidant

1. Introduction

The use of plants as food and medicine has been with man since from the beginning. Therefore, plants have been the earliest source of food and medicine for man. Although modern science has tried producing drugs for the treatment of many diseases, a lot of these drugs have significant side effects and sometimes may even complicate rather than alleviate the disease condition. Furthermore, a significant number of these

*** Corresponding author** Misbahu Sambo ✉ misbahusambo@gmail.com ✉ Department of Biochemistry, Abubakar Tafawa Balewa University, Bauchi, Nigeria.

synthesized drugs are expensive (Smolinski et al., 2003). These and many other reasons shifted the interest of researchers to alternative drugs – drugs from plants, which are the earliest (Nuhu, 2001). As such, so many plants are investigated by different researchers for their possible therapeutic effects. It has been found that plant extract, either as pure compounds or as a standardized extract, has provided unlimited opportunities for new drugs' discoveries (Cos et al., 2006). Although most products made from medicinal plants may not have been tested for their safety and efficacy, and products that were marketed in developed economies and provided in the undeveloped world by traditional healers sometimes contain dangerous contaminants – heavy metals inclusive – still maximum benefit could be derived from plant-based drugs if systematic research methodology is employed in evaluating them (Ekor, 2013).

Physalis angulata is a plant that is traditionally used to treat infectious diseases. It belongs to the family Solanaceae, widely distributed throughout the tropical and subtropical regions of the world. It is distributed as a weed in gardens, waste lands, along roads, in the forest, and in cultivated fields (Smith, 1991). It is used as herbal medicine for the treatment of various human ailments like malaria, hepatitis, asthma, dermatitis, and rheumatism (Rengifo-Salgado and Vargas-Arana, 2013; Soares et al., 2003). Infusions of *P. angulata* have been used to treat earache and postpartum infection (Ismail and Alam, 2001). All these medicinal benefits derived from *P. angulata* may be due to a wide array of phytochemicals which it contains. Therefore, this research aimed at determining the antioxidant potential, phytochemicals, and minerals content of the root extract of *P. angulata*.

2. Materials and Method

2.1. Collection and preparation of plant material

Fresh roots of *P. angulate* were collected from Yola South local government area of Adamawa State, Nigeria. The plant material was identified and authenticated by Mr. Usman Gala of the Botany Department, Ahmadu Bello University, Zaria, Nigeria. The plant was assigned the voucher number: ABU2051. The root sample was washed and cut into smaller pieces and dried under direct sunlight. The sample was later pulverized to coarse powder using a hammer mill (Gallenkamp, USA). A known weight (6.952 kg) of the air-dried root powder was extracted with analytical grade ethanol in a Soxhlet at 65°C. The mixture was vacuum-filtered through Whatman No. 1 filter paper and concentrated using a vacuum rotary evaporator (Eyla N-1000, Japan). The extractive yield was calculated using the following relationship:

Yield (%) = [Weight of extract (g)/Weight of plant material (g)] ×100

2.2. Qualitative and quantitative phytochemical screening of the extract

The extract was subjected to qualitative screening using standard phytochemical methods as outlined by Harborne (1998), Trease and Evans (1998), and Siddiqui and Ali (1997). The quantitative phytochemical analysis of the dried and powdered *P. angulate* was determined using standard methods described by Boham and Kocipai (1994), AOAC (2003), Harborne (1998), Obadoni and Ochuko (2001), and Nabavi et al. (2008).

2.3. Minerals analysis of P. angulate root extract

The minerals content, namely sodium, calcium, cobalt, selenium, cadmium, chromium, arsenic, zinc, potassium, magnesium, copper, and manganese, were estimated by the use of atomic absorption spectrophotometer according to the method of AOAC (1990).

2.4 Determination of total antioxidant activity (AOA) using phosphomolybdate assay

The total antioxidant capacity of the terpenoid fraction was determined by phosphomolybdate method using butylated hydroxytoluene (BHT) as the standard compound, as described by Jayaprakasha et al. (2002). The total antioxidant capacity was expressed as μg equivalents of BHT by using the standard BHT graph.

3. Results

The results of both the qualitative and quantitative phytochemical analyses of the root extract of the plant are shown in Table 1. The results for the qualitative analysis showed the presence of alkaloids, terpenoids, saponins, glycosides, and flavonoids. While tannins, steroids, phenols, and resins are absent. The results of the quantitative analysis of phytochemical contents of the root extract of *P. angulata* is also shown in Table 1. The concentration of the phytochemicals from the highest to the lowest is as follows: alkaloids (14.96% ± 0.83%), terpenoids (13.79% ± 0.04%), saponins (12.78% ± 2.4%), flavonoids (0.05% ± 0.00%), and glycosides (0.05% ± 0.03%).

Table 2 shows the minerals content of the root extract of *P. angulata*. It contains high amounts of magnesium (1,101.50 ± 2.12 ppm), sodium

Table 1. *Phytochemical constituents of P. angulata root extract.*

Constituents	Qualitative	Quantitative (%composition)
Alkaloids	++	14.96 ± 0.83
Terpenoids	++	13.79 ± 0.04
Saponins	++	12.78 ± 2.40
Glycosides	+	0.05 ± 0.03
Flavonoids	+	0.05 ± 0.00
Tannins	ND	-
Steroids	ND	-
Phenols	ND	-
Resins	ND	-

ND = Not detected.
n = 3.
++ = Present in high concentration.
+ = Present in moderate concentration.

Table 2. Mineral contents of the root extract of *P. angulate.*

S/N	Mineral	Concentration (ppm)
1	Magnesium	1,101.50 ± 2.12
2	Sodium	407.20 ± 0.42
3	Calcium	76.96 ± 0.79
4	Zinc	4.95 ± 0.07
5	Potassium	2.05 ± 0.07
6	Manganese	1.84 ± 0.05
7	Copper	1.10 ± 0.14
8	Cobalt	0.63 ± 0.04
9	Selenium	0.20 ± 0.01
10	Cadmium	ND
11	Chromium	ND
12	Arsenic	ND

ND = Not detected.
Values are expressed as mean ± SD.
n = 3.

(407.20 ± 0.42 ppm), and calcium (76.96 ± 0.79 ppm). While zinc (4.95 ± 0.07 ppm), potassium (2.05 ± 0.07 ppm), manganese (1.84 ± 0.05 ppm), copper (1.10 ± 0.14 ppm), cobalt (0.63 ± 0.04 ppm), and selenium (0.20 ± 0.01 ppm) are present in lower quantities. Cadmium, arsenic, and chromium were not detected.

The *in vitro* AOA of terpenoids fraction using phosphomolybdate assay indicated that there was a dose-dependent increase in the *in vitro* AOA as the concentrations of the terpenoids increased from 20 to 1,000 μg/ml, as shown in Table 3.

Table 3. *In vitro* AOA (phosphomolybdate assay) of terpenoids fraction.

S/N	Concentration of terpenoids (μg)	AOA
1	1,000	755.67 ± 109.43
2	500	753.54 ± 24.01
3	100	688.12 ± 60.21
4	50	672.00 ± 35.92
5	20	644.88 ± 278.92

Values are expressed as mean ± SD.
n = 3.

4. Discussion

The amount of phytochemicals found in the root extract of *P. angulata* were quantitatively determined using standard procedures. The results revealed the phytochemicals content of the root extract to be alkaloids (14.96% ± 0.96%), flavonoid (0.05% ± 0.00%), saponins (12.78% ± 2.40%), glycosides (0.05% ± 0.03%), and terpenoids (13.79% ± 0.04%). Flavonoids have been reported to partake in the reduction of ischemia-reperfusion injury by interfering with inducible nitric oxide synthase activity. Saponins possess a variety of biological activities such as antioxidant, immunostimulant, antihepatotoxic, anticarcinogenic, antidiarrheal, antiulcerogenic, hypocholesterolemic, anticoagulant, hepatoprotective, hypoglycemic, neuroprotective, and anti-inflammatory activities. Saponins also inhibit both dental caries and platelet aggregation and they are useful in diabetic retinopathy and reproduction. Many saponins are known to be antimicrobial and inhibit mold formation. They are also known to protect plants from insects. They may be considered a defense system and have been included in a large group of protective molecules found in plants named phytoanticipins or phytoprotectants (Negi et al., 2013). Therefore, the extract may exert all the aforementioned activities because it contains a reasonable amount of saponins. Terpenoids have been identified to possess AOA against reactive oxygen species (Grassmann, 2005).

The evaluation of minerals content of *P. angulata* root extract showed that it contains magnesium (1,101.50 ± 2.12), sodium (407.20 ± 0.42), calcium (76.96 ± 0.79), zinc (4.95 ± 0.07), potassium (2.05 ± 0.07), manganese (1.84 ± 0.05), copper (1.10 ± 0.14), cobalt (0.63 ± 0.04), and selenium (0.20 ± 0.01), while cadmium, chromium, and arsenic were absent. A number of researches have suggested that all essential and trace elements play a vital role in medicine and therapy in health and disease (Prasad, 2008; Sahito et al., 2003). The significant roles many of these minerals played in enhancing health cannot be over emphasized. So also, the negative impact of their deficiency to the system cannot be over looked. For example, selenium deficiency has been reported to cause asthma, while its existence helps to utilize vitamin E (Sahito et al., 2013). The intracellular level of calcium ions aids excitation–contraction in muscles, excitation–secretion coupling in glands, and excitation–release coupling in nerves. Together with phosphorus, magnesium, and other ions, calcium is involved in blood formation. Magnesium functions in bone formation, blood clotting, and transduction are well established. It also helps in healthy lungs function by acting as a bronchodilator and stops bronchial routes from going into tremor. Calcium plays an important role in the production of energy needed for muscles' contraction (Fleck, 1976). Iron and zinc are cofactors needed for the synthesis and proper functioning of catalase and superoxide dismutase (Jimoh et al., 2009). Zinc is also essential for growth and development. It is also needed for the function of the cells of the immune system (Ghani et al., 2012). Although minerals have their positive sides, beyond the required amount, they may cause unwanted reactions in the body. For example, redox active transition metals have the ability to induce and initiate lipid peroxidation through the production of oxygen radicals, mainly hydroxyl radical through Fenton's/Haber–Weiss reactions (Jomova and Valko, 2011; Valko et al., 2007). Transition metals such as copper (Boveris et al., 2012), chromium (Parveen, 2009), cadmium (Karaca and Eraslan, 2013), and nickel (Amudha and Pari, 2011) have been reported to induce lipid peroxidation *in vivo* in the mammalian model.

Phosphomolybdenum assay has been routinely used to evaluate the antioxidant capacity of extracts (Prieto et al., 1999). In this research, the AOA of the terpenoid fraction of the root extract of *P. angulata* has been determined using the mentioned method. The assay is simple and independent of other antioxidant measurements commonly employed. The assay revealed that the 1,000 μg/ml terpenoid fraction showed the highest phosphomolybdenum reduction (755.67 ± 109.43). Therefore, the AOA of the root extract of *P. angulata* cannot be ruled out. Body cells and tissues are continuously threatened by the damage caused by free radicals and reactive oxygen species, which are produced during normal oxygen metabolism or are induced by exogenous damage (de Groot., 1994; Nijveldt et al., 2001). The mechanisms and the sequence of events by which free radicals interfere with cellular functions are not fully understood, but one of the most important events seems to be lipid peroxidation, which results in cellular membrane damage (Nijveldt et al., 2001). This cellular damage causes a shift in the net charge of the cell, changing the osmotic pressure, leading to swelling and eventually cell death. Free radicals can attract various inflammatory mediators, contributing to a general inflammatory response and tissue damage. Antioxidants help to relieve oxidative stress, which could be by preventing free radicals from damaging biomolecules, such as proteins, DNA, and lipids (Sahidi and Naczk, 2004). And it could be by the ability of the antioxidant to chelate/deactivate transition metals, which possess the ability to catalyze hydroperoxide decomposition and Fenton-type reactions. As many researchers have reported the adverse effects of synthetic antioxidants, such as toxicity and carcinogenicity, relying on natural sources of antioxidants, such as terpenoids, from the root of *P. angulata* as substitutes to the artificial ones may be one of the many options.

5. Conclusion

The present study has shown that *P. angulata* root extract contains a reasonable amount of alkaloids, terpenoids, and saponins. Thus, it may exert all the activities associated with these phytochemicals. The extract also contains high amount of Mg, Na, and Ca, and may therefore serve as a source of these minerals which play essential roles for the maintenance and perpetuation of life. The study has also revealed *in vitro* AOA of the terpenoids fraction of the extract, and may therefore be used as an antioxidant.

Conflict of interest

There is no conflict of interest among the authors.

Author contribution

Each author has contributed significantly toward the realization of this research.

References

Amudha K, Pari L. Beneficial role of naringin, a flavonoid on nickel induced nephrotoxicity in rats. Chem Biol Interact 2011; 193(1):57–64.

AOAC. Official methods of analysis. 17th edition, Association of Official Analytical Chemists, VA, Washington DC, USA, pp 408–26, 2003.

Boham, B. A. and Kocipai, A. R. (1994) "Flavonoids and condensed tannins from the leaves of Hawaiian vaccinium vaticulatum and V. calycinium" Pacific Sci, 48: 458–63.

Boveris, A., Musacco-Sebio, R. Ferrarotti, N., Saporito-Magrina, C., Torti, H., Massot, F. and Repetto, M. G. (2012) "The acute toxicity of iron and copper: biomolecule oxidation and oxidative damage in rat liver" Journal of Inorganic Biochemistry, 116, 63-69.

Cos, P., Vlietinck, A. J., Berghe, D. V. and Maes, L. (2006) "Anti-infective potential of natural products: How to develop stronger invitro proof-of-concept" Journal of Ethnopharmacology, 106, 290–302, Elsevier.

de Groot, H. (1994) "Reactive oxygen species in tissue injury" Hepato-Gastroebterology, 41: 328–32.

Ekor M. The growing use of herbal medicine: issues relating to adverse reactions and challenges in monitoring safety. Front Pharmacol 2013; 4:77.

Fleck H. Introduction to nutrition. 3rd edition, Macmillan, New York, NY, pp 11–29, 1976.

Ghani A, Ali Z, Ishtia M, Maqbool M, Parveen, S. Estimation of macro and micro nutrients in some important medicinal plants of Soon valley district Khushab, Pakistan. Afr J Biotechnol 2012; 11(78):14386–91.

Grassmann J. Terpenoids as plant antioxidants. Vita Hormon 2005; 72:505–35.

Harborne JB. Phytochemical methods: a guide to modern technique of plant analysis. Champman and Hall, London, UK, pp 21–72, 1998.

Ismail N, Alam M. A novel cytotoxic flavonoid glycoside from Physalis angulata. Fitoterapia 2001; 72(6):676–9.

Jayaprakasha GK, Jena BS, Negi PS, Sakariah KK. Evaluation of antioxidant activities and antimutagenicity of turmeric oil: a byproduct from curcumin production. Z Naturforsch 2002; 57:828–35.

Jimoh FO, Babalola SA, Yakubu MT. Assessment of the antioxidant potential of Cnidoscolous chayamansa". Pharma Biol 2009; 47(9):903–9.

Jomova K, Valko M. Advances in metal-induced oxidative stress and human disease. Toxicology 2011; 283(3):65–87.

Karaca, S. and Eraslan, G. (2013) "The effect of flaxseed oil and cadmium-induced oxidative stress in rats" Biogical Trace Elements Research, 155 (3), 423–30.

Nabavi SM, Ebrahimzadeh MA, Nabavi SF, Hamidinia A, Bekhradnia AR. Determination of antioxidant activity, phenol and flavonoids content of Parrotiapersica Mey. Pharmacologyonline 2008; 2:560–7.

Negi JS, Negi PS, Pant GJ, Rawat MSM, Negi SK. Naturally occurring saponins: chemistry and biology. J Poison Med Plant Res 2013; 1(1):1–6.

Nijveldt RJ, van Nood E, van Hoorn DEC, Boelens PG, van Norren K, van Leeuwen PAM. Flavonoids: a review of probable mechanisms of action and potential applications. Am J Clin Nutr 2001; 74:418–25.

Nuhu H. Pharmacognosy in A.B.U graphic media production, Supreme press LTD, Zaria, Nigeria, 2001.

Obadoni BO, Ochuko PO. Phytochemical studies and comparative efficacy of the extracts of some haemostatic plants in Edo and Delta States of Nigeria. Global J Pure Appl Sci 2001; 8:203–8.

Prasad, A. S. (2008) "Zinc in human health: effect of zinc on immune cells" Mol Med, 14 (5-6), 353–57.

Perveen, T., Haider, S., Kanwal, S. and Haleem, D. J. (2009) "Repeated administration of Nigella sativa decreases 5-HT Turnover and produces Anxiolytic effects in rats" Pakistan journal of Pharmaceutical Sciences, 22, 139-144.

Prieto P, Pineda M, Anguilar M. Spectrophotometric quantitation of antioxidant capacity through the formation of a phosphomolybdenum complex: Specific application to the determination of vitamin E. Ann Biochem, 1999; 269:337–41.

Rengifo-Salgado E, Vargas-Arana G. Physalis angulata L. (BolsaMullaca): a review of its traditional uses, chemistry and pharmacology. BoletínLatinoamericano y del Caribe de PlantasMedicinales y Aromáticas 2013; 12(5):431–45.

Sahidi F, Naczk M. Extraction and analysis of phenolics in food. J Chromat A 2004; 1054(1-2):95–111.

Sahito SR, Memon MA, Kazi TG, Kazi GH. Evaluation of mineral contents in medicinal plant Azadirachtaindica (Neem). J Chem Sci 2003; 25:139–43.

Siddiqui AA, Ali M. Practical pharmaceutical chemistry. 1st edition, CBS Publishers and Distributors, New Delhi, India, pp 126–31, 1997.

Smith, A. C. (1991) "Flora vitiensis nova: a new Flora of Fiji (Spermatophytes only). Volume 5: Angiospermae: Dicotyledons, families 170-186, Monocotyledones, Family 32. Pp 626.

Smolinski MS, Hamburg MA, Lederberg J. Microbial threats to health: emergence, detection, and response. Institute of Medicine, National Academic Press, Washington, DC, pp 203–10, 2003.

Soares JR, Dinis TCP, Cunha AP, Almeida LM. Antioxidant activities of some extracts of Thymus zygi. Free Rad Res 1997; 26:469–78.

Trease GE, Evans WC. Pharmacognosy. 15th edition, Saunder Publishers, London, UK, pp 42–4; 221–9; 246–9; 404; 306; 331–2; 391–3, 2002.

Valko M, Leibfritz D, Moncol J, Cronin M, Mazur M, Telser J. Free radicals and antioxidants in normal physiological functions and human disease. Int J Biochem Cell Biol 2007; 39(1):44–84.