EUROPEAN JOURNAL OF BIOMEDICAL AND PHARMACEUTICAL SCIENCES
http://www.ejbps.com

ISSN 2349-8870
Coden USA: EJBPBO
Volume: 13
Issue: 4
Year: 2026

POTENTIAL ANTIOXIDANT ACTIVITY OF THE EXTRACTS AND THEIR ACTIVE COMPONENTS OF PHYSALISPERUVIANA L. (CAPE GOOSEBERRY) AND PHYLLANTHUS (AMALA)

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DOI: https://doi.org/10.5281/zenodo.19413503

How to cite this Article: *Anil Kumar. (2026). Potential Antioxidant Activity Of The Extracts And Their Active Components Of Physalisperuviana L. (Cape Gooseberry) And Phyllanthus (Amala). European Journal of Biomedical and Pharmaceutical Sciences, 13(4), 305–314.

Article Received on 05/03/2026 **Article Revised on 25/03/2026** **Article Published on 04/04/2026**

ABSTRACT

The extraction of secondary metabolites was carried out by using water, a mix of methanol and water (8:2) with NaF, as well as methanol, ethanol, and acetone (all mixed with water in a 7:3 ratio) from various parts (like leaves, flowers, stems, and roots) of *Physalisperuviana L.(Cape Gooseberry) and Phyllanthus emblicand (Amala)* with the help of decoction and maceration methods. This paper states that methanol provides the best results for decoction, while acetone worked best for maceration. The total polyphenol content (TPC) achieved through decoction showed the highest TPC levels, and MeOH with NaF was found to be the most effective solution for extracting TPC. Maceration proved better for extracting flavonoids, with ethanol and acetone being the most effective solvents. In general, the highest levels of TPC and flavonoids were obtained from leaves and fruits of *Physalisperuviana L.* (Cape Gooseberry) and *Phyllanthus (Amala)* regardless of the solvent or extraction method applied. Furthermore, the roots of *Physalisperuviana L.(Cape Gooseberry) and Phyllanthus emblicand (Amala)* showed important levels of these compounds in consonance with the total antioxidant activity (TAA) evaluated in the different organs of the plant in the these species. In this study, the solvents and extraction methods applied were tools that determined significantly the level of extraction of bioactive compounds, showing a different impact on plant organs for each medicinal species studied.

KEYWORDS: maceration, decoction, TPC, flavonoids, bioactive molecule, antioxidant activity.

INTRODUCTION

Polyphenols are natural compounds that are widely found in plants and their importance continues to grow, in particular because of their impact on organoleptic and health benefits.[1,2] Throughout history, humans have encountered a range of diseases,[3,4] discomforts, and challenges, prompting various responses to address them. One of the many strategies employed to tackle health issues is the application of medicinal plants for the treatment of different diseases.[5,6] While significant advancements in major therapeutic options have been achieved, there is a growing inclination towards herbal medicine because of rising worries about the increasing toxicity linked to conventional therapies.[7-9] Recently, the utilization of medicinal plants has been recognized as both complementary and alternative therapies, often in conjunction with other forms of treatment.[10]

The diseases are primarily associated with the generation of free radicals.[11] Free radicals play important role in aerobic life and metabolic activities.[12] They are essential to various biochemical processes and involved in the caution of numerous diseases such as cancer,[13] Alzheimer's disease, [Parkinson's disease,[14] inflammatory disorders,[15] lipid peroxidation,[16] DNA damage,[17] stroke,[18] cardiovascular ailments,[19] protein oxidation,[20] and diabetes.[21-22] Bioactive compounds, including flavonoids, phenols, anthocyanins, ascorbic acid, amides, alkaloids, tannins, saponins and glycosides, from diff erent part of medicinal species play an important role in human health, due to their biological activity.[23]

Antioxidants safeguard cells from harm caused by free radicals. Research indicates that they can slow down or

halt the oxidation of other molecules.[24] These substances can stop chain reactions and block oxidation by eliminating radical intermediates and undergoing oxidation themselves.[25] The body is equipped with various compounds capable of preventing free radicals from forming or minimizing their damage. These antioxidants can be derived from both within the body and from external sources.[26] Internally produced antioxidants come from the action of body enzymes such as superoxide dismutase (SOD), catalase (Cat), and glutathione peroxidase.[27] On the other hand, external sources include foods rich in vitamins A, E (alpha-tocopherol),[28] C (ascorbic acid),[29] minerals, and polyphenols,[30-32] which are mainly found in plants. Plants are rich in numerous antioxidants that help protect against diseases linked to free radicals.[33] Most of these antioxidant compounds are produced in plants as secondary metabolites. The term phytochemicals refers to "plant chemicals." They are the non-nutritive chemical elements in plants that offer various health benefits and disease-preventing properties.[34] Though the nutrients they provide are not essential for life, these chemicals are generated by plants to thrive, which in turn give health advantages to humans when eaten.[35] There are more than a thousand recognized phytochemicals categorized as either primary or secondary components based on their function in plant metabolism.[36-38]

Physalis peruviana L. is a plant of the family Solanaceae and the genus Physalis, which has about 100 species.[39] It is commonly referred to as the gooseberry.[40] *Physalis peruviana* is a medicinal plant widely used in traditional medicine to treat diseases such as malaria, asthma, hepatitis, dermatitis, cancer and rheumatism. It has antispasmodic, diuretic, antiseptic, sedative, analgesic, antioxidant, antifungal, antibacterial, anti-inflammatory, cataract-cleansing, antidiabetic and antiparasitic properties.[41-46] It has been described as a good source of nutrients and bioactive compounds, β-carotene and vitamins A and C, and minerals including K, Mg and Cu, with moderate fibre content, phenolic compounds and low levels of calories.[47-48]

The cape gooseberry, known scientifically as Physalis peruviana L., is a fruit crop that grows annually and is part of the Solanaceae family. This plant is either herbaceous or has soft wood, typically growing to a height of 2 to 3 feet. Cape gooseberry is widely cultivated in tropical and subtropical areas of world. The small fruit measures between 1 to 3.5 cm in diameter and is a yellow-orange berry surrounded by a large, growing epicalyx. Its shape is similar to that of a tomato, but it offers a sweeter flavor, a more pleasant aroma, and contains more pectin. In Hawaii, it is often referred to as Poha or Poha berry, while in South Africa, it's known as Golden berry. In India, it goes by various names, including Rashbhari, Makoi, Tepari, Husk cherry, and Peruvian ground cherry. The term "cape gooseberry" likely originates from the “Cape of Good Hope” in South Africa, where it was first commercially cultivated. People enjoy the ripe fruit fresh and use it to create high-quality jellies, sauces, and notably, jams, which have earned it the nickname “Jam fruit of India.”

Figure: Fruit and Plant of Cape Gooseberry.

The Cape gooseberry, scientifically known as Physalis peruviana L., is part of the Solanaceae family. This family includes various economically significant crops such as potatoes, tomatoes, eggplants, and chilies, all belonging to different genera. Key characteristics of the Solanaceae family include a taproot system, stems that can be upright or climbing, and leaves that are arranged alternately, either simple or pinnately compound, without stipules. Their leaves feature reticulate venation, and the gynoecium is bicarpellary and syncarpous, with a superior ovary exhibiting axile placentation. The Solanaceae family contains 102 genera and approximately 2,500 species, many of which are important for food and medicinal uses. Within the genus Physalis, there are 80 species, some of which hold significant value. Specifically, the species alkekengi and peruviana yield edible fruits popularly referred to as winter cherry and cape gooseberry (49-50). CP is a fruit that has garnered increasing interest in recent years due to its rich nutritional profile and possible health benefits.[51] It has historically been used to address digestive issues like indigestion and gastric acidity, and to bolster the immune system. In Indonesia, this fruit is often utilized for managing diabetes mellitus and related

ailments,[52] while in China, its anticancer, detoxifying, and anti-inflammatory properties are valued.[53] In Latin America, CP has a tradition of being used to alleviate various conditions, including asthma, dermatitis, fever, ulcers, and inflammation, in addition to helping lower blood cholesterol.[54-56] The growing interest in this topic has been supported by preclinical studies that show various forms of the fruit—like fresh pulp, juice, freeze-dried pomace, and methanolic extracts—exhibit antioxidant, anti-inflammatory, hypoglycemic, and hypolipidemic properties.[57-60] These effects largely stem from their influence on metabolic and cellular pathways related to oxidative stress and insulin resistance. Nevertheless, translating these results to clinical practice is still constrained, as only two studies involving humans have been carried out so far. Both of these studies yielded mixed results and faced considerable methodological shortcomings.[61-62]

Phyllanthus emblica Linn., which belongs to the Euphorbiaceae family, is commonly found in various tropical and subtropical regions.[63] According to the two major classical texts of Ayurveda, the Sushruta Samhita and Charaka Samhita, P. emblica is esteemed as "the finest of the sour fruits" and "the top rejuvenating substance." This fruit plays a crucial role in essential medicinal formulations like Triphala and Chyawanprash, a tonic that supports overall mental and physical wellbeing for individuals of all ages.[64] The pharmacological benefits of P. emblica are diverse, including anti-cancer, anti-inflammatory, antioxidant, anti-diabetic, neuroprotective, and hepatoprotective effects, among others. Nonetheless, much of the research on the pharmacological effects of P. emblica tends to focus on Triphala, which is an Ayurvedic remedy made from equal amounts of three medicinal fruits: P. emblica, Terminalia chebula, and Terminalia belerica.[65-67]

Phyllemblin" is the active chemical identified by Indian scientists as having a substantial pharmacological impact in amla. The fruit is abundant in quercetin, phyllaemblic compounds, gallic acid, tannins, flavonoids, pectin, and vitamin C, in addition to a range of other polyphenolic compounds. Terpenoids, alkaloids, flavonoids, tannins, and other phytochemical components have been shown to have positive biological properties.[14,15] The fruits, leaves, and bark all have a high tannin content. The root contains lupeol and ellagic acid, whereas the bark contains leucodelphinidin. The seeds yield a steady (16%) oil with a brownish-yellow tint. Its components are linolenic (8.8%), linoleic (44.0%), oleic (28.4%), stearic (2.15%), palmitic (3.0%), and myristic (1.0%) fatty acids.[68] This plant contains hydrolysable tannins such as eblicanin A, eblicanin B, punigluconin, and pedunculagin.[69] Flavonoids include Kaempferol 3 O alpha L (6"methyl) rhamnopyranoside and Kaempferol 3 O alpha L (6"ethyl) amnopyranoside." alkaloids, including phytollantine, phytollantidineGallic acid, ellagic acid, 1-Ogalloyl-beta-D-glucose, 3,6-di-O-galloyl-D-glucose, chebulinic acid, quercetin, chebulagic acid, corilagin, and isostrictinnin were isolated from Phyllanthusemblica fruits. A new acylated glucoside was isolated from the methanolic extract of P.emblica leaves.[70] The molecules luteolin 4'Oneohesperiodoside, gallic acid, methyl gallate, 1, 2, 3, 4, and 6 penta-Ogalloylglucose were combined to form apigenin7-O-(6"-butyryl-beta)- glucopyranoside.[71] P. emblica seeds have phosphatides, fixed oil, and a trace amount of essential oil. Moreover, the leaves include chebulagic, ellagic, gallic, and chebulinic acids. Phyllaemblic acid, a new highly oxygenated norbisabolane, was isolated from P. emblica roots and its structure was fully characterised using chemical and spectroscopic methods. Ellagic acid and lupeol are detected in P.emblica roots.[20]

Fruit:- Protein 0.5%, fat 0.1%, mineral matter 0.7%, fibre 3.4%, carbohydrates 14.1%, nicotionic acid (0.2 mg/100g), gallic acid, phyllem-belin, phyllembelic acid, emblico Kellagic acid, pectin 725-277, SOD 482,[69-72] 14 units/g, putranjivain, and quercctin, were all present in the mixture.[73] **Seeds**:- The seeds of the Indian gooseberry contain a fixed oil, phosphatides, and an essential oil. The seeds yields a fixed oil (16%) that is brownish yellow. Linolenic acid (8.8%), linoleic (44.0%), oleic (28.4%), stearic (2.15%), palmitic (3.0%), and myristic acid were also present. There are proteolytic and lipolytic chemicals present.[75]

Leaves:- The bark and leaves have a high concentration of tannins. The leaves contain the alkaloids phyllantidine and phyllantine, gallic acid, ellagic acid, chebulic, chebulagic, and chebulinic acids, as well as the gallotannin am lie acid.[76]

The study of these plants and the chemicals obtained from them presents an alternative way for discovering natural products, making it a potentially valuable field for exploring functional ingredients. This method of

processing is quite sustainable for industrial manufacturing since there is a reliable market for the end products in the food and pharmaceutical sectors, along with inexpensive raw materials. In this context, while cultivating passion fruit, cape gooseberry, or amala, certain plant parts are often discarded as waste; however, they could actually serve as a income source.

Our research aims to identify the most effective method for extracting total polyphenols and flavonoids from various parts of the tropical plants mentioned earlier. We will employ different extraction solvents and to determine their promising antioxidant properties.

EXPERIMENTAL

MATERIALS AND METHODS

Plant Material

Physalisperuviana L. (Cape Gooseberry) and *Phyllanthus (Amala)* were harvested from September 2025 to Feburay 2026. These plant species were harvested early in the morning with pruning shears and were tagged and transported in plastic bags. Leaves, flowers, stems and roots were separated, then dried at room temperature in darkness for 21 days and crushed using a grinder. Then samples were packaged in sealed polyethylene bags and transported to Lab.

Chemicals and Reagents

Thepolyphenolic standards (gallic acid, hydrated quercetin-3-rutinoside), H_2O_2, ABTS peroxidase and trolox were provided by Sigma-Aldrich. The reagents like aluminium tri chloride, acetate of sodium) were provided by Sigma-Aldrich, and the other solvents were obtained from E. Merck, India.

Procedure

Extraction by maceration: Using the maceration method outlined by Romani et al.,[77] 10 to 30 g of each of the three plants' crushed parts (leaves, flowers, stems, and roots) were macerated in order to extract the total polyphenols of the various plant parts.

10 to 30 g of each of the crushed plant parts (leaves, flowers, stems, and roots) were macerated for 2.5 hours in triplicate at room temperature in 100 mL of aqueous solutions of the solvents (methanol, ethanol, and acetone) diluted 7:3 in water, water and MeOH/water (8:2) containing 2 mM NaF. The filtrates were collected and centrifuged at 4000 rpm at 4 °C for 20 minutes after being filtered through a muslin cloth. They were then kept at −80 °C until needed.

Extraction by decoction: We used the procedure outlined by Chavan et al.[78] to extract bioactive components by decoction. 40 mL of various extraction solvents, such as methanol, ethanol, acetone (diluted 7:3 in water), and MeOH/water (8:2), including 2 mM NaF, were mixed with 1 g of the powders of the various plant components. Before being filtered through a muslin cloth, each combination was cooked in triplicate within hermetically sealed flasks for 30 minutes in a water bath. After recovering and centrifuging the filtrates at 4000 rpm for 20 minutes at 4 °C, they were kept at -80 °C until the extracted sample was analysed.

Yield of Extraction

The formula given by Falleh et al.[78] was used to determine the yield of the two extraction techniques for the three plants: Y (%) = 100 Mext/Mech, where Y is the extraction yield in percentage, Mext is the mass of the extract after the extraction solvent has evaporated (using a rotary evaporator) in milligrams, and Mech is the mass of the plant sample in milligrams.

Calculating Total Flavonoids and Polyphenols

Total polyphenols: The Folin-Ciocalteu (FC) technique was used to measure total polyphenols,[79-80] for analysis, 200 µL of each extract was extracted in duplicate and combined with 300 µL of 50 mM phosphate buffer solution, 2.5 mL of FC reagent, and 2 mL of Na_2CO3 at 1 N. After vortexing the mixture, it was kept in a water bath at 50 °C for five minutes. The phosphate buffer solution was used in place of the extract to create the blank. A UV-1700 spectrophotometer (Shimadzu) was used to detect the absorbance at 760 nm. Using the gallic acid calibration curve as a guide, the results were reported as mg gallic acid equivalent/g of dry vegetable material. Every sample (n = 12) was examined twice.

The flavonoid test was carried out using the procedure described by Woisky and Salatino.[81] A total of 1500 µL was combined in duplicate with 500 µL of each extract to be examined. 2.8 mL of distilled water, 100 µL of 1 M sodium acetate, 100 µL of $AlCl_3$ at 10% (m/v), and 95% methanol. After vortexing the entire mixture, it was incubated at room temperature in a dark environment for half an hour. A UV-1700 spectrophotometer (Shimadzu) was used to measure the absorbance at 415 nm after the extract was replaced with 95% methanol to create the blank. Using the quercetin-3-rutinoside calibration curve as a guide, the data were reported in mg equivalents of quercetin-3-rutinoside/100 g of dry matter. Every sample was examined twice (n = 12). Since these techniques are the most widely used to quantify these substances with good specificity and without the need for extra equipment, their selection allowed for comparison with other investigations.

TAA, or total antioxidant activity

The ABTS test was used to determine antiradical activity using a slightly modified version of the procedure outlined by Cano et al.[82] 0.5 g of plant tissue (leaves, flowers, stems, and roots of the three plants) was combined with 10 mL of 50 mM phosphate buffer solution and 6 mL of ethyl acetate in three repetitions. The mixture was homogenized for one minute before being centrifuged at 10,000 rpm for twenty minutes at 4 °C. The various plant sections were divided into hydrophilic and lipophilic phases.

Antioxidant activity in the hydrophilic phase (H-TAA) was determined by mixing 890µL of 50m Mglycine buffer solution with 30µL of 10m MABTS solution, 30µL of 1m MH2O2, and 25µL of 10µ Mperoxidase. Instead of using a sample, the absorbance of this mixture was measured at 730 nm against a blank made from the glycine solution buffer. After adding 25µL of each water-soluble phase to the previous mixture in duplicate (n = 6), the absorbance was measured at 730nm once again after a minute. Using the trolox calibration curve as a guide, the results were reported as mg trolox equivalent/100 g of dry vegetable material.[75]

The antioxidant activity in the lipophilic phase (L-TAA) was determined by mixing 30µL of 10m MABTS solution with 30µL of 1 mMH2O2, 25µL of 10µmperoxidase, and 850µL of ethanol. This mixture's absorbance was measured at 730nm in comparison to an ethanol blank. After adding 25µL of each soluble lipid phase in duplicate (n = 6) to the previous mixture, the absorbance was measured at 730nm once again after one minute. Using the trolox calibration curve as a guide, the results were reported in mgtrolox equivalent/100 g of dry vegetable material.[83]

CONCLUSIONS

This study is the first to provide information on these species of medicinal herbs in relation to the various plant sections. An essential step in assessing bioactive substances and functional qualities is the extraction of flavonoids and total phenolic compounds. To maintain the biological characteristics of these bioactive compounds, the right solvent and extraction method must be chosen. According to this study, the best technique for extracting the total polyphenols was decoction with methanol: water (8:2) adding 2 mM NaF. However, maceration with this solvent, along with ethanol and acetone, proved to be an effective method for extracting flavonoids, particularly from the leaves and flowers of cape Gooseberry and Amala. This study highlights the challenge of identifying a single extraction method appropriate for every aspect of the However, maceration with this solvent, along with ethanol and acetone, proved to be an effective method for extracting flavonoids, particularly from the leaves of cape gooseberry and amala. This study highlights the challenges of identifying a single extraction method appropriate for every region of the plant, demonstrating notable variations among the three species examined. In all of them, the findings demonstrated that, when compared to other plant parts, the leaves and roots have greater concentrations of bioactive chemicals, boosting their overall antioxidant activity. In conclusion, the knowledge gained from this study and the various plant parts' therapeutic potential expands the potential application of these medicinal plants in the prevention or treatment of numerous illnesses impacting human health.

Extraction Yield by Maceration

The results of the maceration extraction yield (Table1) show that acetone is the best extraction solvent, with an average of 17.53 ± 0.27 % for *Physalisperuviana L.* (Cape Gooseberry) and 17.28 ± 0.15 % for *Phyllanthus (Amala)* followed by water, with averages of 16.47 ± 0.27%, 16.77 ± 0.14 % and 18.32±0.19% for respectively. The highest extraction in ***Physalisperuviana L.*** was found in the leaves for *Physalisperuviana L.* (Cape Gooseberry) and *Phyllanthus(Amala)* all solvents used ($p<0.05$).

Table 1: Extraction yield(%DM) of the different parts of Plants extracted by Decoction and Maceration.

Extraction Method	Extraction Solvents	CapeGooseberry(*PhysalisperuvianaL.*)			
		Leaves	Flower	Stem	Roots
Decoction	CH_3OH(70%)	17.53±0.27l,m	15.12±0.19q	17.10±0.36l,m	16.76±0.83i–k
	C_2H_5OH(70%)	11.90±0.67s	14.02±0.2o,p	15.04±0.21o,p	13.81±0.17r
	H_2O	17.87±0.94i–k	18.28±0.69g–i	17.96±0.82l,m	17.34±0.13i–k
	CH_3COCH_3(70%)	19.33±0.20e,f	20.99±0.525e,f	19.53±0.1c–e	20.15±0.29a,b
	CH_3OH, NaF(80%)	16.65±1.07m–p	16.66±0.82l–n	17.93±0.29h–k	18.01±0.23g–
Maceration	CH_3OH(70%)	18.53±0.36f,g	20.32±0.35a–c	21.31±0.5d,e	21.66±0.33a
	C_2H_5OH(70%)	16.22±0.15m,n	20.07±0.14b–e	20.38±0.11g,h	20.60±0.44b–d
	H_2O	16.22±0.3l–n	16.90±0.65k,j	17.70±0.33k,l	17.53±0.34j,k
	CH_3COCH_3(70%)	16.45±0.88m,n	13.06±0.46r	15.42±0.25p,q	16.71±0.08s
	CH_3OH, NaF(80%)	16.2±0.73m,n	16.09±0.32m–o	17.68±0.16m,n	15.90±0.32o,

Extraction Method	Extraction Solvents	*Phyllanthus(Amala)*			
		Leaves	Flower	Stem	Roots
Decoction	CH_3OH(70%)	17.25±0.14l,m	15.02±0.19q	17.20±0.16l,m	18.76±0.83i–k
	C_2H_5OH(70%)	11.90±0.67s	16.02±0.2o,p	16.04±0.21o,p	12.81±0.17r
	H_2O	18.87±0.91i–k	19.28±0.39g–i	17.76±0.87l,m	18.74±0.83i–k
	CH_3COCH_3(70%)	20.33±0.00e,f	20.99±1.25e,f	20.90±0.1c–e	21.59±0.29a,b
	CH_3OH, NaF(80%)	16.96±1.07m–p	17.66±0.82l–n	18.93±0.29h–k	19.01±0.23g–
Maceration	CH_3OH(70%)	19.53±0.36f,g	21.32±0.35a–c	20.31±0.5d,e	22.36±0.13a
	C_2H_5OH(70%)	17.22±0.15m,n	21.07±0.14b–e	19.38±0.11g,h	21.60±0.64b–d

	H_2O	17.22±0.3l–n	17.90±0.65k,j	17.85±0.33k,l	18.23±0.34j,k
	CH_3COCH_3(70%)	17.45±0.88m,n	13.06±0.46r	15.62±0.25p,q	16.41±0.08s
	CH_3OH, NaF(80%)	17.2±0.73m,n	17.09±0.32m–o	17.08±0.16m,n	16.20±0.32o,

Table 2: Total Polyphenol(TPP) content (mgeqGA/100gDM) in the different parts of Plants.

Extraction Method	Extraction Solvents	CapeGooseberry(*PhysalisperuvianaL.*)			
		Leaves	Flower	Stem	Roots
Decoction	CH_3OH(70%)	1429.13±55.62g,h	1261.73±47.89j–m	1233.47±74.25l,m	1372.6±60.81h,i
	C_2H_5OH(70%)	1505.21±65.65c–e	1166.08±47.89n	1259.56±75.26k–m	1437.82±67.12f,g
	H_2O	1324.78±57.84i,j	1083.47±43.18o	1198.69±57.4m,n	1137.82±56.07n,o
	CH_3COCH_3(70%)	1476.95±58.7d–g	1274.78±47.62j–l	1290±56.07j–l	1316.08±57.4i–k
	CH_3OH, NaF(80%)	1976.95±62.04a	1498.69±28.73c–f	1518.26±68.1c,d	1466.08±49.69d–g
Maceration	CH_3OH(70%)	1234.13±26.41l,m	924.34±24.33r,s	974.34±19.28p–s	958.04±24.17p–s
	C_2H_5OH(70%)	1373.26±32.02h,i	964.56±24.69p–s	1447.17±19.24e–g	1447.17±19.24e–g
	H_2O	1229.78±35.56l,m	787.39±28.51t	918.91±12.98s	947.17±28.92q–s
	CH_3COCH_3(70%)	1362.39±47.41i	938.47±23.38q–s	984.13±9.64p–r	1289.56±31.15j–l
	CH_3OH, NaF(80%)	1597.17±41.45b	1020±27.26p	997.17±22.83p,q	1551.52±26.88b,c

Extraction Method	Extraction Solvents	*Phyllanthus(Amala)*			
		Leaves	Flower	Stem	Roots
Decoction	CH_3OH(70%)	1266.08±44.33e	818.26±27.03r	887.826±36.54q	1159.56±37.82g,h
	C_2H_5OH(70%)	1335.65±48.67d	1131.3±40.47h	1131.3±40.47h	1168.26±30.43g,h
	H_2O	1163.91±46.76g,h	716.08±35.05s	840±37.56r	966.08±32.14n–p
	CH_3COCH_3(70%)	1340±45.73d	892.17±31.75q	1016.08±36.46k–m	1026.95±27.03j–l
	CH_3OH, NaF(80%)	1637.82±47.29b	1013.91±31.75l,m	1172.6±37.82g,h	1398.69±36.46c
Maceration	CH_3OH(70%)	1198.26±36.89f,g	921.08±24.94p,q	963.47±23.81n–p	1045±34.48i–k
	C_2H_5OH(70%)	1403.69±22.83c	950.43±29.05o,p	1002.6±24.84i–k	1061.3±33.01i–k
	H_2O	1074.34±22.02i	920±31.75p,q	738.47±35.03s	900.43±25.72q
	CH_3COCH_3(70%)	1374.34±27.61c,d	1009.13±25.22l–n	1009.13±25.22l–n	1045±33.93i–k
	CH_3OH, NaF(80%)	1824.34±27.72a	1068.91±27.81i,j	1268.91±21.41e	1243.91±27.15e,f

[Different letters in the same column for each plant indicate significant difference at a $p < 0.05$ level level of probability data are the mean ± standard deviation (SD]

Total Antioxidant activity

In the sample of plants, totalantioxidantactivity (TAA) was measured in the hydrophilic (H-TAA) and lipophilic (L-TAA) fractions. The results showed that the H-TAA fractions ofcape gooseberry and amala obtained the highest levels of H-TAA in the leaves and roots. These levels were significantly higher (<0.05 p) in the roots of cape gooseberry (979.54±42.43 and 823.62±22.06mg eqtrolox 100g DM, respectively) than in other parts of the plant. The leaves and flowers of cape gooseberry showed the highest level of H-TAA between all the species studied in this research .On the other hand, for L-TAA, cape gooseberry and amala is both had a higher balance of lipophilic antioxidants in the stem sand roots, in comparison with amala. In this sense, the lowestlevels of L-TAA were found in cape gooseberry, regardless the part of the plant evaluated.

ACKNOWLEDGEMENT

The author wish to express their sincere thanks to Principal, Sahu Jain College, najibabad for providing necessary facilities for the work. Our sincere thanks to Prof. R.N. Goel, former Head, Department of Chemistry, IIT, Roorkee for arranging and helping in the study of plants and special thanks to Director and Dean, Centre for Aromatic Plants, Dehradun (Uttarakhand) for providing technical assistance and equipments for study.

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