BIBECHANA
Vol. 20, No. 1, April 2023, 103–112

ISSN 2091-0762 (Print), 2382-5340 (Online)
Journal homepage: http://nepjol.info/index.php/BIBECHANA
Publisher:Dept. of Phys., Mahendra Morang A. M. Campus (Tribhuvan University)Biratnagar

Analysis of phytochemicals and biological activities of rhizome of *Curcuma longa*, aerial parts of *Centella asiatica*, and corn silk of *Zea mays*

Ayusha Hyaunmikha, Bimala Subba*
Central Department of Chemistry, Tribhuvan University Kirtipur, Kathmandu, Nepal
*Corresponding author. Email: bimalasubba@gmail.com

Abstract

Nepal is a storehouse of medicinal plants. Medicinal plants like the rhizome of Curcuma longa, the aerial part of Centella asiatica, and corn silk of Zea mays were used traditionally as medicine for diseases like inflammation, hepatic disorders, cough, etc. In this study, these selected plants were subjected to the analysis of phytochemical constituents, and biological activities following standard methods. Phytochemical analysis of the methanolic extract of these selected plants revealed the presence of different chemical constituents such as polyphenols, flavonoids, glycosides, quinones, saponins, and tannins. C. longa rhizomes also showed the strongest DPPH radical scavenging activity with IC_{50} of 55.06 µg/mL which was very close to standard ascorbic acid (49.09 µg/mL) than that of the aerial part of C. asiatica (72.56 µg/mL) and corn silk of Z. mays (131.96 µg/mL). Total phenolic and total flavonoid content was found highest in C. longa with the values of 195.95 ± 0.899 mg GEA/g and 56.45 ± 4.056 mg QE/g respectively. The phenolic and flavonoid content of methanolic extract of aerial parts of C. asiatica was found to be 110.78 ± 1.984 mg GEA/g and 30.00 ± 2.358 mg QE/g and corn silk of Z. mays were found to be 65.92 ± 1.244 mg GEA/g and 18.50 ± 1.424 mg QE/g respectively. The methanolic extract of rhizomes of C. longa exhibited high α-amylase inhibitory activity with IC_{50} values of 382.30 µg/mL than that of C. asiatica with IC_{50} value of 520.48 µg/mL and Z. mays with IC_{50} value 593.09 µg/mL.

Keywords
Curcuma longa, Centella asiatica, Zea mays, phytochemical, antioxidant, anti-diabetic.

Article information
Manuscript received: March 9, 2023; Accepted: April 4, 2023
DOI https://doi.org/10.3126/bibechana.v20i1.52006

1 Introduction

Nepal has a huge number of medicinal plants and significant biodiversity, making it a perfect place to find novel medicines. According to World Health Organization (W.H.O.) research from 2008, traditional medicine is the major source of primary healthcare for the majority of people in the Asian region [1]. Plants have played a significant role in maintaining human health and improving the quality of human life. As plants contain therapeutic components, they have been used for ages to treat human illnesses [2].

Curcuma Longa is a perennial herb grown in trop-

ical southeast Asia [3]. It is commonly known as turmeric in English and Besar in Nepali. Mainly rhizome of *C. Longa* has great medicinal value. In addition to flavoring and coloring food, *C. longa* rhizome is used for a variety of other uses [4]. Rhizome is used in the treatment of various diseases like diabetes, inflammation, Alzheimer, analgesic, biliary disorders, anorexia, cough, hepatic disorders, and sinusitis [5, 6]. Biological activities of *C. longa* include those that are anti-bacterial, anti-inflammatory, anti-oxidant, anti-coagulant, and anti-diabetic, according to research by Bhat et al. (2015) [7].

Centella asiatica is a perennial, prostrate, stoloniferous creeper herb that can have an average length of 15 cm. It is also known as "gotu kola" in many other regions of the world and "ghotapre" in Nepali. Its common names include "madhukaparni" in Sanskrit, "Brahmi" in Hindi. It grows in tropical and subtropical regions and grows widely in different habitats. In Nepal, it is found at a height of 96-2200 m above sea level [8]. Many pharmacological effects of *C. asiatica* are thought to exist, including immunomodulatory, memory-improving, cardioprotective, anti-cancer, antibacterial, anti-inflammatory, antidiabetic, and antioxidant characteristics [8, 9].

Zea mays is the second most significant crop grown in Nepal [10]. *Z. mays* presents with a long and yellowish stigma known as corn silk is mostly used in clinical practice to treat gonorrhea, prostatitis, urethritis, cystitis, nephritis, and urinary stones [11]. According to B. Thoudam et al 2011, the methanolic extract of corn silk had the highest level of antioxidant activity (85.2 mg/mL), while the ethyl acetate extract had the lowest (45.5 mg/mL) [2]. Plants in different geographical areas show different biological activities. The extraction process as well as the methodology also impact the result of the research.

A literature survey revealed that not much work has been reported on the biological activities of the rhizome of C. longa, the aerial part of *C. asiatica*, and corn silk of *Z. mays* in Nepal. Plants differ as per climate which results in different physiological metabolites. So, we intend to choose these three plants for analysis in this study.

2 Material and Methods

2.1 Materials

The plant samples (rhizome of Turmeric, aerial part of the Ghodtapre, and Corn silk of maize) were collected from Bhaktapur and Kathmandu valley based on traditional medicinal value from March to July 2018. The plants were identified by literatures and compared with the voucher specimens deposited at National Herbarium and Plant Laboratories, Godavari, Kathmandu.

2.2 Extraction

The gathered rhizome of *C. longa*, the aerial part of *C. asiatica*, and corn silk of *Z. mays* were rinsed with distilled water, shaded dried, powered being stored in a clean plastic bag until needed. Cold percolation was used for the extraction of methanolic samples of selected plants. About 100 g shade dried ground powder of rhizome of *C. longa*, the aerial part of *C. asiatica*, and corn silk of *Z. mays* were kept in a conical flask separately soaked in methanol. The sample was allowed to stand at room temperature for a few days before being filtered and concentrated with a rotatory evaporator. The concentrated filtrate was air-dried to obtain a solid or semisolid residue. The same process was repeated for all other selected plants. After that, the extracts were kept in air-tight vials and stored in a room at cold and dry place.

2.3 Phytochemical screening

The phytochemical constituent of the selected plant extract was determined using standard protocol [12]. The presence of different phytochemicals was analyzed using different specific reagents.

2.4 Antioxidant activity

DPPH free radical scavenging activity assay was carried out. The ability of the rhizome of *C. longa*, the aerial part of *C. asiatica*, and corn silk of *Z. mays* extracts to scavenge DPPH free radicals was estimated using protocol [13]. In brief, the stock solution of each extract was prepared in methanol (10 mg/mL). By serial dilution of the stock solution, the plant samples at various concentrations (10–100 μg/mL) were added to a 100 μM solution of DPPH in methanol. The absorbance of each solution was determined at 517 nm after 30 min of incubation at 37 °C using a UV-visible spectrophotometer. The measurement was performed in triplicates.

The efficiency of the DPPH free radical scavenging activity was determined by using the following equation:

$$\% \text{ scavenging} = \frac{\text{Ac} - \text{As}}{\text{Ac}} \times 100\ \%$$

where, As is Absorbance of sample solution, Ac is Absorbance of control (DPPH solution + methanol). The IC_{50} value is the effective sample concentration required to neutralize 50% of the DPPH free radicals.

2.5 Determination of Total Phenol Content (TPC)

The total phenolic content of all extracts was determined using the Folin-phenol reagent as described by the standard protocol [12]. The plant samples at various concentrations of 0.125, 0.25, 0.5, and 1.0 mg/mL, were prepared by serial dilution of stock solution of plants 10 mg/mL. These diluted solutions were then incubated for 30 minutes with 10% FCR and 7% Na_2CO_3, and absorbance was measured at 760 nm about a blank for each concentration. Gallic acid was used as a reference compound. The measurement was performed in triplicates.

2.6 Determination of Total Flavonoid Content (TFC)

Using the aluminum chloride colorimetric method with quercetin as a reference, the TFC of each extract was calculated [14]. The plant samples at concentrations of 0.125–1.0 mg/mL, were prepared by serial dilution of stock solution. The absorbance of each quantity of extract was measured at 510 nm against a blank. The measurement was performed in triplicates.

2.7 α-amylase inhibition assay

To determine the antidiabetic potential of selected plants, an α-amylase inhibition assay was carried out using a standard protocol with slight modification [13]. The stock solution of each plant extract was prepared in DMSO (1 mg/mL). Six distinct concentrations of each extract, 1000 μg/mL, 640 μg/mL, 320 μg/mL, 160 μg/mL, 80 μg/mL, and 40 μg/mL were made by serial dilution of the resulting stock solution. Similar methods were created for the commonly used acarbose as a standard compound. The blue starch iodine complex, which was detected at 630 nm, was used to identify the undigested starch as a result of enzyme inhibition. The measurement was performed in triplicates.

3 Results and Discussion

3.1 Phytochemical analysis

The micro-chemical analysis of a crude extract of the rhizome of *C. longa*, the aerial part of *C. asiatica*, and corn silk of *Z. mays* in methanol extract depicted the presence of a class phytochemical as shown in Table 1.

Table 1: Result of Phytochemical screening of the rhizome of *C. longa*, the aerial part of *C. asiatica*, and corn silk of *Z. mays*

S. N.	Phytochemicals	*Curcuma longa*	*Centella asiatica*	*Zea mays*
1.	Alkaloids	+	+	+
2.	Flavonoids	+	+	+
3.	Reducing sugar	+	+	+
4.	Terpenoids	+	+	+
5.	Saponins	−	+	−
6.	Phenolic compounds	+	+	+
7.	Tannis	+	+	+
8.	Glycosides	+	+	+
9.	Coumarins	−	+	+
10.	Sterols	+	−	+

(+) means presence, and (−) means absence

The crude extract of the rhizome of *C. longa*, the aerial part of *C. asiatica*, and corn silk of *Z. mays* in methanol extract revealed the existence of a class of phytochemicals in the phytochemical study as indicated in Table 1. The appearance of certain hues as viewed by a microscope confirmed the existence of phytochemical. Literature reveals that the methanolic extract of *C. longa* consists of bioactive compounds like tannin, glycosides, flavonoid alkaloid saponin, steroids, glycosides, carbohydrates, proteins, starch, and amino acid [15, 16]. Similarly, *C. asiatica* methanolic extract comprise bioactive compounds like alkaloids, tannin, flavonoids, phenolics, saponin, glycosides, terpenoids, and steroids [17]. And methanolic extract of corn silk of *Z. mays* contained alkaloids, tannin, flavonoids, phenolics, glycosides, terpenoids, and steroids [2]. The result of preliminary phytochemical screening for the same samples may show some variation due to different environmental factors, methods of collection of samples, time of collection, time for grinding, percolation, lab setup, and chemical grades.

3.2 Antioxidant activity

The DPPH radical assay was carried out for all extracts by using Ascorbic acid as standard according to the standard procedure and absorbance was recorded at 517 nm by a spectrophotometer (Table 2).

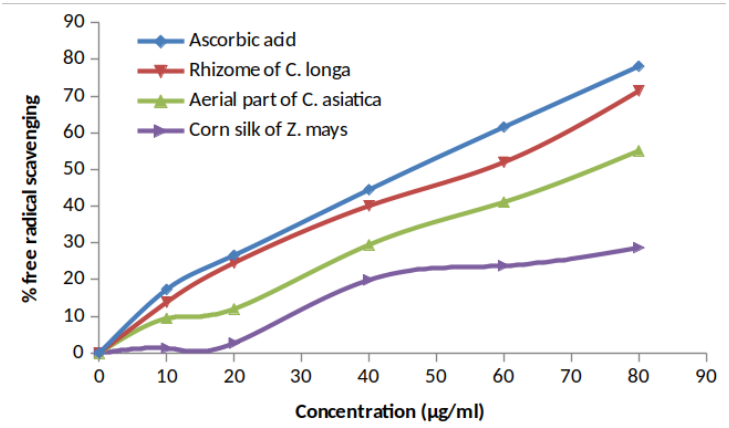

Figure 1: A plot of free radical scavenging of methanolic extracts and concentrations of plants, and ascorbic acid

Table 2: Absorbance of DPPH radical in different concentrations of Ascorbic acid

S.N.	Concentration (μg/mL)	Absorbance
1	10	0.639
2	20	0.567
3	40	0.429
4	60	0.297
5	80	0.169
6	100	0.061

(Each value is a mean of triplicate data)

The decrease in absorbance was due to a decrease in the concentration of DPPH free radicals since there is a transfer of hydrogen radicals from ascorbic acid to DPPH free radicals to form stable DPPH-H molecule resulting in decolorization from violet to pale yellow. The plant extracts showed antioxidant properties in the preliminary tests therefore further test of all those extracts were carried out. The control used involved DPPH and methanol omitting the sample extracts.

Accordingly, the % radical scavenging of each plant extract at different concentrations was calculated and listed in Table 3.

The IC_{50} values of methanolic extracts of *C. longa*, *C. asiatica*, and *Z. mays* were found as 55.06 μg/mL, 72.56 μg/mL, and 131.96 μg/mL respectively (Figures 1 and 2). Since these values are lower than 100 μg/mL and comparable with IC_{50} values of the standard; ascorbic acid (49.09 μg/mL), these extracts show remarkable antioxidant activity may be due to the presence of a phenolic group.

Table 3: Percentage of radical scavenging with different concentrations of plants extracts

Concentration (mg/mL)	Rhizome of *C. longa*	Aerial part of *C. asiatica*	Corn silk of *Z. mays*	Ascorbic acid
10	13.84	9.44	1.29	17.33
20	24.58	12.03	2.71	26.65
40	40.10	29.49	19.92	44.51
60	52.00	41.13	23.80	61.57
80	71.41	55.11	28.71	78.13

The IC_{50} values of methanolic extracts of *C. longa*, was found as 55.06 μg/mL. Since these values are lower than 100 μg/mL and comparable with IC_{50} values of the standard; ascorbic acid (49.09 μg/mL), these extracts shows remarkable antioxidant activity. This result is in agreement with the literature study which showed that the highest DPPH scavenging activities were shown by the

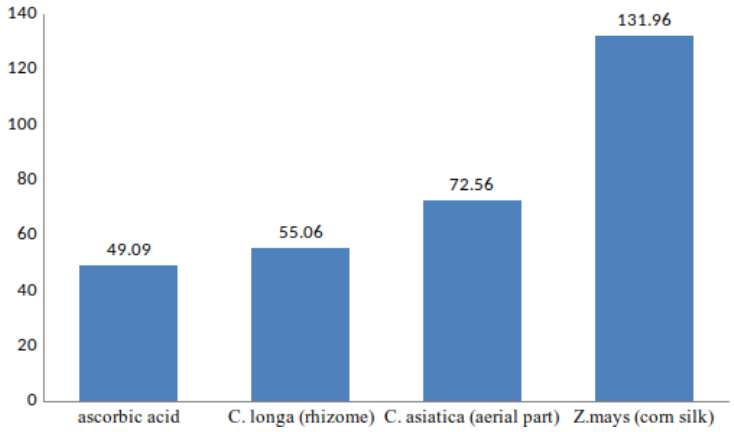

Figure 2: Bar graph showing IC_{50} values of various methanolic plant extracts

methanolic extract of *C. longa*. These scavenging activities of the extract could be related to the lipid–oxidation process, thus contributing to their electron transfer/ hydrogen donating ability [18]. The ethanolic extract of *C. asiatica* stem extract showed greater free radical scavenging than leaves extract [19]. But in this present study aerial part (stem + leaves) exhibited an anti-oxidant capacity less than *C. longa* but greater than *Z. mays*.

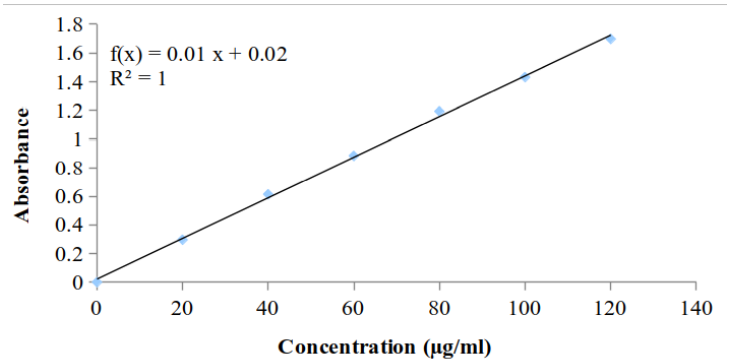

Figure 3: Calibration curve of Gallic acid

The literature revealed that the methanolic extract of corn silk of Z. mays showed strong antioxidant activity at 85.2 mg/mL which may be due to the presence of phenolic and flavonoid constituents [2]. But the study showed the lower antioxidant capacity of corn silk which may be due to variations in environment, time of collection and methodology.

3.3 Total Phenolic Content (TPC)

The total phenolic compound present in the methanolic extract of two different plants was evaluated by using the Folin-cocalteu reagent (FCR) according to the standard procedure given involving the gallic acid as standard. The absorbance graph for standard gallic acid is shown in Figure 3. TPC values of methanolic extracts of *C. longa* rhizome, *C. asiatica* aerial parts, and *Z. mays* corn silk were determined using a calibration curve and absorbance which are shown in the Figure 4.

From the result obtained from TPC, it has been found that phenolic compounds are a class of antioxidant that acts as the free radical terminator. The highest value of rhizome of C. longa methanolic extract (TPC 195.95 ± 0.89) showed high antioxidant activity than the methanolic extract of *C. asiatica*, and *Z. mays* (Figure 4). This result is in agreement with the literature study which showed that the highest TPC was shown by methanolic extract of rhizome of *C. longa* (260 ± 0.025 mg/g) [20]. The literature reviewed that the methanolic extract of *C. longa* was reported to be TPC of 39.38 mg GAE/g. The study value is slightly lower than the reported value of literature review which could be due to variations in environmental conditions or may be due to the presence of other secondary metabolites or may be due to differences in

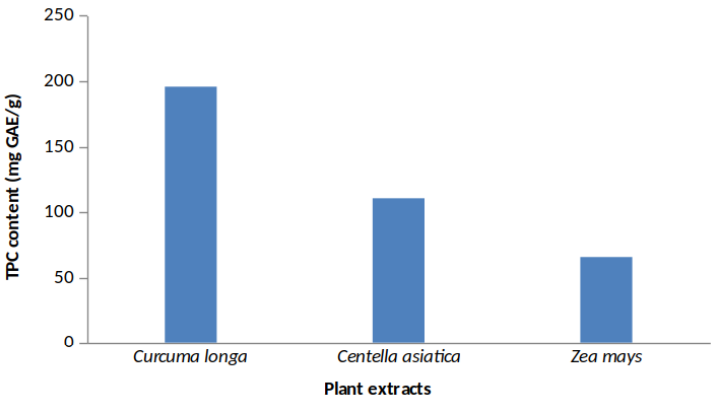

Figure 4: TPC values of three plant samples

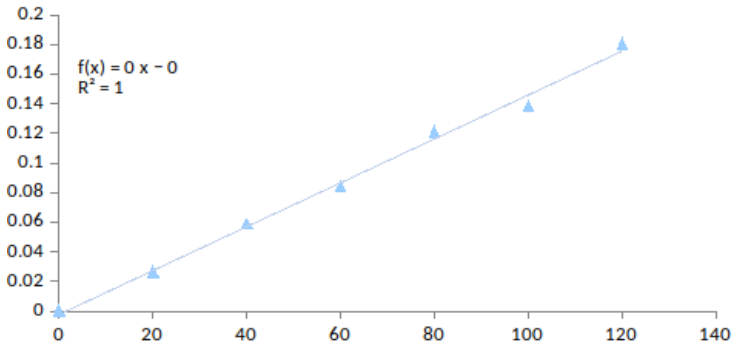

Figure 5: Calibration curve of quercetin

extraction methodology [18]. The therapeutic properties of *C. asiatica* may potentially be attributed to the presence of phenolic compounds as research in the literature revealed that phenolic compounds are the major contributors to the antioxidant activity in plants and that these compounds are also effective hydrogen donors, making them good antioxidants [21]. It was discovered that the TPC of the corn silk extract in this investigation (TPC 272.81 mg GAE/100mg) was lower than the corn silk extracts reported by literature studies. This difference in TPC could be attributed to an environmental variable [22].

3.4 Total Flavonoid Content (TFC)

According to the standard protocol and using quercetin as the reference standard, the total flavonoid compound found in the methanolic extract of selected plants was calculated. The absorbance vs concentration curve for the standard is shown in Figure 5.

TFC values of methanolic extracts of *C. longa* rhizome, *C. asiatica* aerial parts, and *Z. mays* corn silk were determined using a calibration curve and absorbance which are shown in Table 5.

From the result obtained from TFC, it has been found that phenolic compounds are a class of antioxidant that acts as the free radical terminator. The highest value of rhizome of *C. longa* methanolic extract (TFC 56.45 ± 4.05) showed high antioxidant activity than the methanolic extract of *C. asiatica*, and *Z. mays* (Figure 6).

The literature revealed that the methanolic extract of *C. longa* indicated the most abundant flavonoid content which supports to have several biological activities such as antimicrobial and protective compounds against plant disease [18]. Methanolic extract of the rhizome *C. longa* contained TFC (79.36 ± 0.01), which is slightly higher than the value of this study [20]. This may be due to variations in the time of collection and environment. The presence of rutin, catechin, and quercetin in the *C. asiatica* leaf, root, and petiole resulted in a higher concentration of flavonoids, according to the literature [23].

Higher TFC in methanolic extract contributed to a strong scavenging activity which is thought to give higher antioxidant activity. Methanolic extract of corn silk showed higher TFC than water extract [22]. But in this study, the methanol extract of corn silk of *Z. mays* showed lower TFC. The difference in result may be due to variations in altitude, and in time of collection of samples.

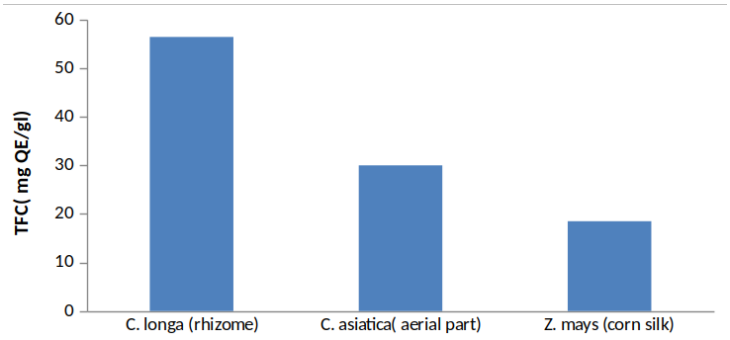

Figure 6: Total flavonoid content of different methanolic plant extracts

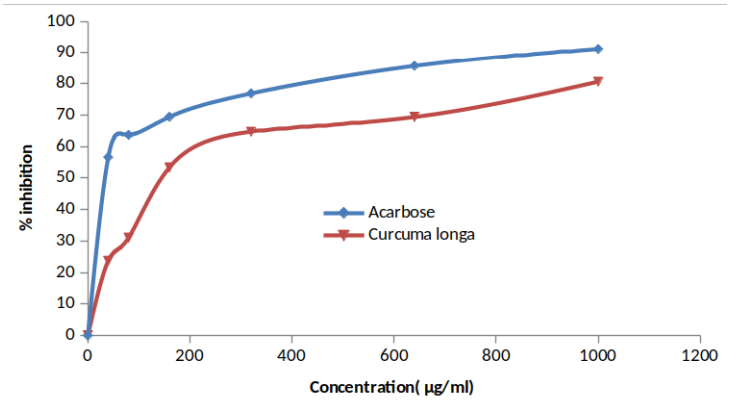

Figure 7: Comparison of α-amylase inhibition % between Acarbose and methanol extract of *C. longa*

3.5 α-Amylase inhibition activity

The anti-diabetic properties of methanolic extract of *C. longa*, *C. asiatica*, and *Z. mays* were measured by taking acarbose as standard, and IC_{50} values were also calculated. To assess the anti-diabetic potential of chosen samples, a starch-iodine assay for α-amylase inhibition was performed. Percentage inhibition of α-amylase by different concentrations of plant extracts and Acarbose were calculated and these data were tabulated below Table 4.

The above result in table 4 demonstrated that selected plant extracts show amylase inhibition activity and there is concentration-dependent increase in inhibition percentage. *C. longa* extract had higher % inhibition of 80.62 at 1000 μg/mL than the *C. asiatica* and *Z.myas*. Acarbose as standard drug had % inhibition of 91.23 at 1000 μg/mL.

IC_{50} values were calculated using graph obtained by plotting % inhibition against concentration and results are shown in Table 7.

Thus, the methanolic extract of *C. longa* showed a lower IC_{50} value than that of *C. asiatica* and *Z. mays*. The IC_{50} value of the standard was found as 85.43 μg/mL. The IC_{50} value of *C. longa* was found as 382.30 μg/mL which showed a higher antidiabetic property than that of *C. asiatica* and *Z. mays*.

The literature revealed that some bioactive compounds such as flavonoids, phenolic acid, and steroids are known to be bioactive antidiabetic principles. *C. longa* having terpenes, alkaloids, flavonoids, phenols, and sterols showed potent inhibitory activity towards alpha/beta-glucosidase [4].

In the previous study, the triterpenes compound is responsible for the biological activity of *C. asiatica*, and asiaticoside one of triterpene showed an activity as an antidiabetic agent [24]. The literature revealed that *C. asiatica* leaves possess significant antidiabetic activity [25]. But the research did not show the antidiabetic activity of the aerial part *C. asiatica* this may be due to variations in environment and time of collection.

The methanolic extract of corn silk of *Z. mays* showed lower antidiabetic activity than other plant extracts. This result correlates well with the fact that it possessed lower antioxidant capacity and lower phenolics. However, the percentage inhibition (64.94 $\pm$ 0.26) was not bad at 1000 μg/mL concentration. This may be due to the availability of phytochemicals like alkaloids, tannins, flavonoids,

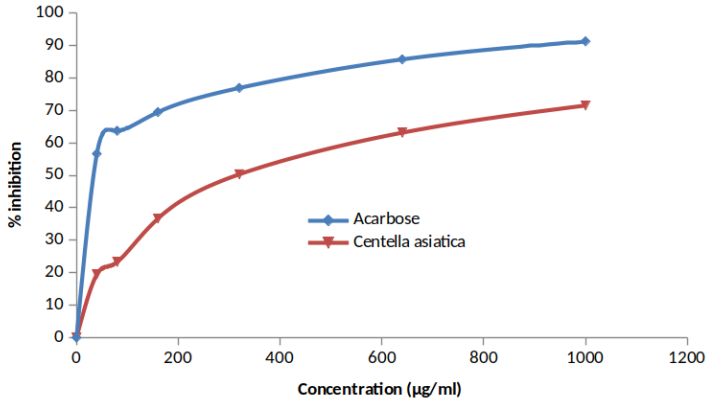

Figure 8: Comparison of α-amylase inhibition % between Acarbose and methanol extract of *C. asiatica*

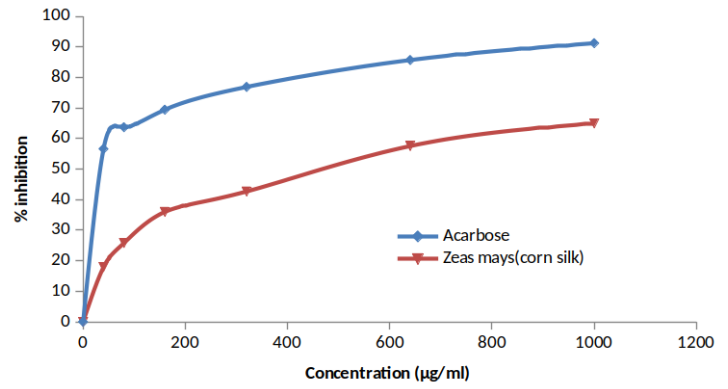

Figure 9: Comparison of α-amylase inhibition % between Acarbose and methanol extract of *Z. mays*

phenolics, glycosides, terpenoid, and steroids which could be responsible for the antidiabetic potential of corn silk. The literature revealed that hexane and methanolic extract of corn silk inhibited the α-glucosidase with IC_{50} value ranges of 31.6 ± 0.4 μg/mL to 35.7 ± 0.6 μg/mL [26].

4 Conclusion

The methanolic extracts of the three chosen plants were subjected to phytochemical analysis in this study, which revealed several chemical constituents, including polyphenols, flavonoids, glycosides, saponins, and tannins. Thus, it can be concluded that the selected plants are rich in secondary metabolites. The methanolic extract of rhizome of *C. longa* demonstrated the strongest DPPH radical scavenging action with an IC_{50} value of 55.06 μg/mL which is similar to standard ascorbic acid (49.09 μg/mL). The outcome showed that the highest total phenolic content was in *C. longa* (195.95 ± 0.899 mg GAE/g) extract followed by the aerial part of C. asiatica (110.78 ± 1.984 mg GAE/g extract). The extract which showed the lowest content of total phenol was *Z. mays* (65.92 ± 1.244 mg GAE/g). The total flavonoid content (56.45 ± 4.056 mg QE/g) was highest in the extract of *C. longa* among other plant extracts. Among the se-

Table 4: α-amylase inhibition % by different concentrations of plant extracts and acarbose

Concentration (mg/mL)	Acarbose	*C. longa* (rhizome)(in %)	*C. asiatica* (aerial part) inhibition	*Z. mays* (corn silk)
1000	91.23 ± 0.31	80.62 ± 1.04	71.47 ± 0.55	64.94 ±0.26
640	85.69 ± 0.23	69.39 ± 0.02	63.12 ± 0.16	57.55 ± 0.21
320	76.89 ± 0.34	64.74 ± 1.35	50.3 ± 0.45	42.67 ± 0.09
160	69.43 ± 0.65	53.41 ± 0.50	36.63 ± 1.03	36 ± 0.25
80	63.69 ± 0.54	31.11 ± 0.84	23.30 ± 0.53	25.82 ± 0.40
40	56.60 ± 0.31	23.75 ± 0.50	19.49 ± 1.20	17.94 ± 0.16

(Each value is a mean of triplicate data)

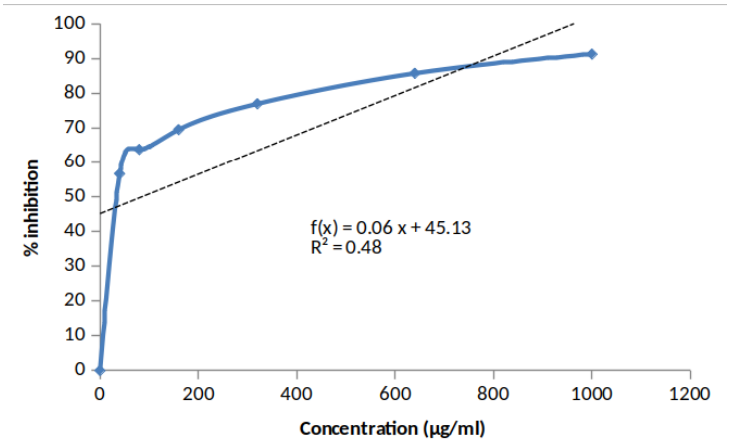

Figure 10: Inhibition % vs Concentration graph for Acarbose

Table 5: Comparison of IC_{50} values of plant extracts with the standard for α-amylase inhibition

S.N.	Sample	IC_{50} (μg/mL)
1	Acarbose	85.43
2	*C. longa*	382.30
3	*C. asiatica*	520.48
4	*Z. mays*	593.09

lected plants, the methanolic extract of the rhizome of *C. longa* exhibited high α-amylase inhibitory activity with an IC_{50} value of 382.30μg/mL. As a result, the rhizome of *C. longa* demonstrated significant biological activities, although they cannot be used directly for medicinal purposes. For their in-vivo application as well as to characterize and isolate the unknown component to introduce their pharmacological qualities, additional comprehensive phytochemical and pharmacological research along with the mechanism of action are essential.

Conflict of interest

The authors do not have any conflict of interest pertinent to this work.

References

[1] Chunmei Li and Myeong-Hyeon Wang. In vitro biological evaluation of 100 selected methanol extracts from the traditional medicinal plants of asia. *Nutrition Research and Practice*, 8(2):151–157, 2014.

[2] Bhaigyabati Thoudam, T Kirithika, J Ramya, K Usha, et al. Phytochemical constituents and antioxidant activity of various extracts of corn silk (zea mays l). *Research Journal of Pharmaceutical, Biological and Chemical Sciences*, 2(4):986–993, 2011.

[3] Swatilekha Mohanta, P. K. Swain, P. Sial, and G. R. Rout. Morphological and molecular screening of turmeric (Curcuma longa L.) cultivars for resistance against parasitic nematode, Meloidogyne incognita. *Journal of Plant Pathology & Microbiology*, 6(5):1, 2015.

[4] Wahyu Widowati, Teresa Liliana Wargasetia, Ervi Afifah, Tjandrawati Mozef, Hanna Sari Widya Kusuma, Hayatun Nufus, Seila Arumwardana, Annisa Amalia, and Rizal Rizal. Antioxidant and antidiabetic potential of curcuma longa and its compounds. *Asian Journal of Agriculture and Biology*, 6(2):149–161, 2018.

[5] Jesmin Akter, Md Amzad Hossain, Kensaku Takara, Md Zahorul Islam, and De-Xing Hou. Antioxidant activity of different species and varieties of turmeric (curcuma spp): Isolation of active compounds. *Comparative Biochemistry and Physiology Part C: Toxicology & Pharmacology*, 215:9–17, 2019.

[6] Suresh V Nampoothiri, PC Lekshmi, VV Venugopalan, and A Nirmala Menon. Antidiabetic and antioxidant potentials of spent turmeric oleoresin, a by-product from curcumin production industry. *Asian pacific journal of Tropical Disease*, 2:169–172, 2012.

[7] Suman Vikas Bhat, Tawheed Amin, and Saima Nazir. Biological activities of turmeric (curcuma longa linn.)-an overview. *BMR Microbiol*, 1(1):1–5, 2015.

[8] Anjana Devkota, Stefano Dall'Acqua, Pramod Kumar Jha, and Gabbriel Innocenti. Variation in the active constituent contents in centella asiatica grown in different habitats in nepal. *Botanica Orientalis: Journal of Plant Science*, 7:43–47, 2010.

[9] Rasangani Sabaragamuwa, Conrad O Perera, and Bruno Fedrizzi. Centella asiatica (gotu kola) as a neuroprotectant and its potential role in healthy ageing. *Trends in Food Science & Technology*, 79:88–97, 2018.

[10] Shiva Chandra Dhakal, Punya Prasad Regmi, Resham Bahadur Thapa, Shrawan Kumar Sah, and Dilli Bahadur Khatri-Chhetri. Productivity and profitability of maize-pumpkin mix cropping in chitwan, nepal. *Journal of Maize Research and Development*, 1(1):112–122, 2015.

[11] Shun-Cheng Ren, Qing-Qing Qiao, and Xiao-Lin Ding. Antioxidative activity of five flavones glycosides from corn silk (stigma maydis). *Czech Journal of Food Sciences*, 31(2):148–155, 2013.

[12] Dae-Ok Kim, Seung Weon Jeong, and Chang Y Lee. Antioxidant capacity of phenolic phytochemicals from various cultivars of plums. *Food chemistry*, 81(3):321–326, 2003.

[13] S Paulsamy, K Karthika, et al. Screening of in vitro antioxidant activity of methanolic leaf and root extracts of hypochaeris radicata l.(asteraceae). *Journal of Applied Pharmaceutical Science*, 2(7):149–154, 2012.

[14] Pallab Kalita, Barman K Tapan, Tapas K Pal, and Ramen Kalita. Estimation of total flavonoids content (tfc) and anti oxidant activities of methanolic whole plant extract of biophytum sensitivum linn. *Journal of Drug delivery and Therapeutics*, 3(4):33–37, 2013.

[15] RS Sawant and AG Godghate. Qualitative phytochemical screening of rhizomes of curcuma longa linn. *International Journal of Science, Environment and Technology*, 2(4):634–641, 2013.

[16] H Rajesh, SN Rao, R Megha, K Prathima, E Rejeesh, and R Chandrashekar. Phytochemical analysis of methanolic extract of curcuma longa linn rhizome. *International Journal of Universal Pharmacy and Bio Sciences*, 2(2):39–45, 2013.

[17] S Saranya, Aswathy V Nair, P Prathapan, AS Neethu, and Neethu S Kumar. Phytochemical analysis of centella asiatica l. leaf extracts. *Int. J. Adv. Res*, 5(6):1828–1832, 2017.

[18] Alafiatayo A Akinola, Syahida Ahmad, and Mahmood Maziah. Total anti-oxidant capacity, flavonoid, phenolic acid and polyphenol content in ten selected species of zingiberaceae rhizomes. *African Journal of Traditional, Complementary and Alternative Medicines*, 11(3):7–13, 2014.

[19] Shakil Ahmed Polash, Tanushree Saha, Md Sharif Hossain, and Satya Ranjan Sarker. Phytochemical contents, antioxidant and antibacterial activity of the ethanolic extracts of centella asiatica (l.) urb. leaf and stem. *Jahangirnagar University Journal of Biological Sciences*, 6(1):51–57, 2017.

[20] Rajeshwari Sahu and Jyoti Saxena. Screening of total phenolic and flavonoid content in conventional and non-conventional species of curcuma. *Journal of Pharmacognosy and phytochemistry*, 2(1):176–179, 2013.

[21] MK Zainol, A Abd-Hamid, S Yusof, and R Muse. Antioxidative activity and total phenolic compounds of leaf, root and petiole of four accessions of centella asiatica (l.) urban. *Food chemistry*, 81(4):575–581, 2003.

[22] A R Nurhanan, W Rosli, and S Mohsin. Total polyphenol content and free radical scavenging activity of cornsilk (zea mays hairs). *Sains Malays*, 41(10):1217–1221, 2012.

[23] MK Mohd Zainol, A Abdul-Hamid, F Abu Bakar, and S Pak Dek. Effect of different drying methods on the degradation of selected flavonoids in centella asiatica. *International Food Research Journal*, 16(4):531–537, 2009.

[24] EKA Fitrianda, Elin Yulinah Sukandar, Elfahmi Elfahmi, and I Ketut Adnyana. Antidiabetic activity of extract, fractions, and asiaticoside compound isolated from centella asiatica linn. leaves in alloxan-induced diabetic mice. *Asian Journal of Pharmaceutical and Clinical Research*, pages 268–272, 2017.

[25] PK Chauhan, IP Pandey, and Vinod Kumar Dhatwalia. Evaluation of the anti-diabetic effect of ethanolic and methanolic extracts of centella asiatica leaves extract on alloxan induced diabetic rats. *Adv Biol Res*, 4(1):27–30, 2010.

[26] E Adewole, A Ojo, AO Omoaghe, LA Enly, GS Njateng, Z Sumera, and I Jamshed. Antidiabetic potential of corn silk extracts, identification and drug properties of bioactive compounds. *Trends Med*, 18(6):1–7, 2018.