

Review Article

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Corrosion Inhibition by Flower Extracts - At a Glance

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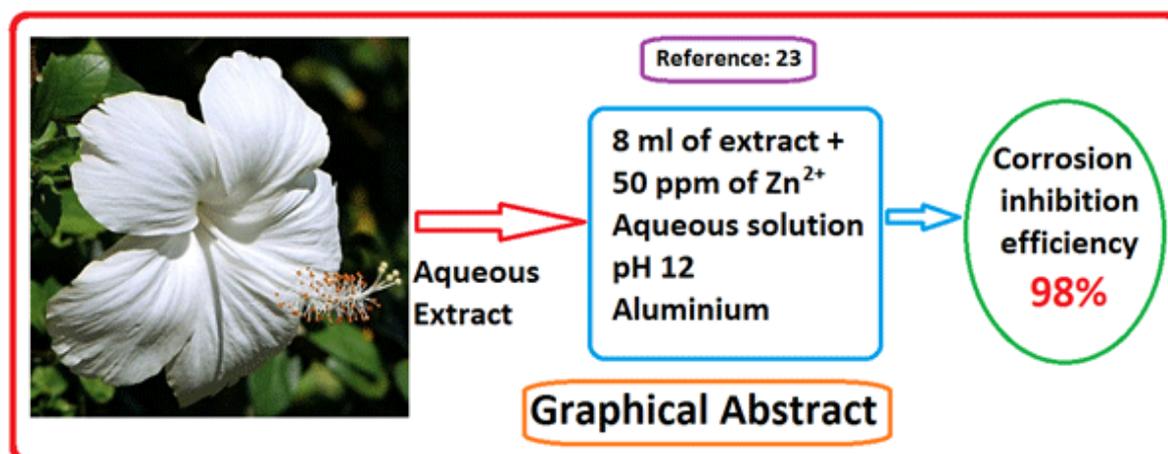
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Abstract

Flower extract are ecofriendly corrosion inhibitors. They have been used to control corrosion of mild steel, copper and aluminium in various media. The mechanistic aspects have been investigated by electrochemical studies such as polarisation study and AC impedance spectra. The protective film has been analysed by FTIR, SEM, EDX and AFM. The adsorption isotherms being obeyed are Langmuir, Temkin and Freundlich adsorption isotherms. The flowers extract primarily function as mixed type of inhibitors. The active principles mainly present in colored flowers are anthocyanins, and carotenoids. They contain polar groups such as hydroxyl, methoxy and ether. These ingredients coordinate with the metal ions on the metal surface through oxygen atom, benzene ring and conjugated double bonds. The protective film formed on the metal surface controls the corrosion process.

Keywords: Corrosion Inhibition; Flower Extract; AFM; SEM; FTIR; Isotherms; Green Inhibitors



Introduction

Metals when they come in contact with water and air, they undergo decay. This process is called corrosion. Corrosion is a natural spontaneous process. It is a thermodynamically favourable process. Because of corrosion, there is collapse of bridges, industrial equipments, aeroplanes and ships. This leads to loss of life and shut down of industries. There are many ways to control corrosion process. One such method is use of inhibitors. Among the various types of inhibitors, extracts of plant materials are preferred since they are easily available, nontoxic and less expensive. In the present work the use of flower extracts as corrosion inhibitors is discussed.

Colors of flowers

Flowers have showy colors to attract pollinators such as bees, Hummingbirds, Butterflies, moths and bats. Each pollinator is attracted by specific color. For example, bright blue and violet colors attract bees. Red, pink, fuchsia or purple flowers attract Hummingbirds. Yellow, orange, pink and red colors attract Butterflies. The color of the flowers are due to chemical compounds such as anthocyanin's (red, pink, blue and purple) (Figure 1, Table 1) and carotenoids (Figure 2) (yellow, red and orange). The general structure of anthocyanin is shown in Figure 1. It contains glucose unit in position 3 and 5. When the glucose unit is removed then anthocyanidine is produced. It is also called aglycon. When R1 and R2 are replaced by H, OH and OCH₃, various ananthocyanins are produced.

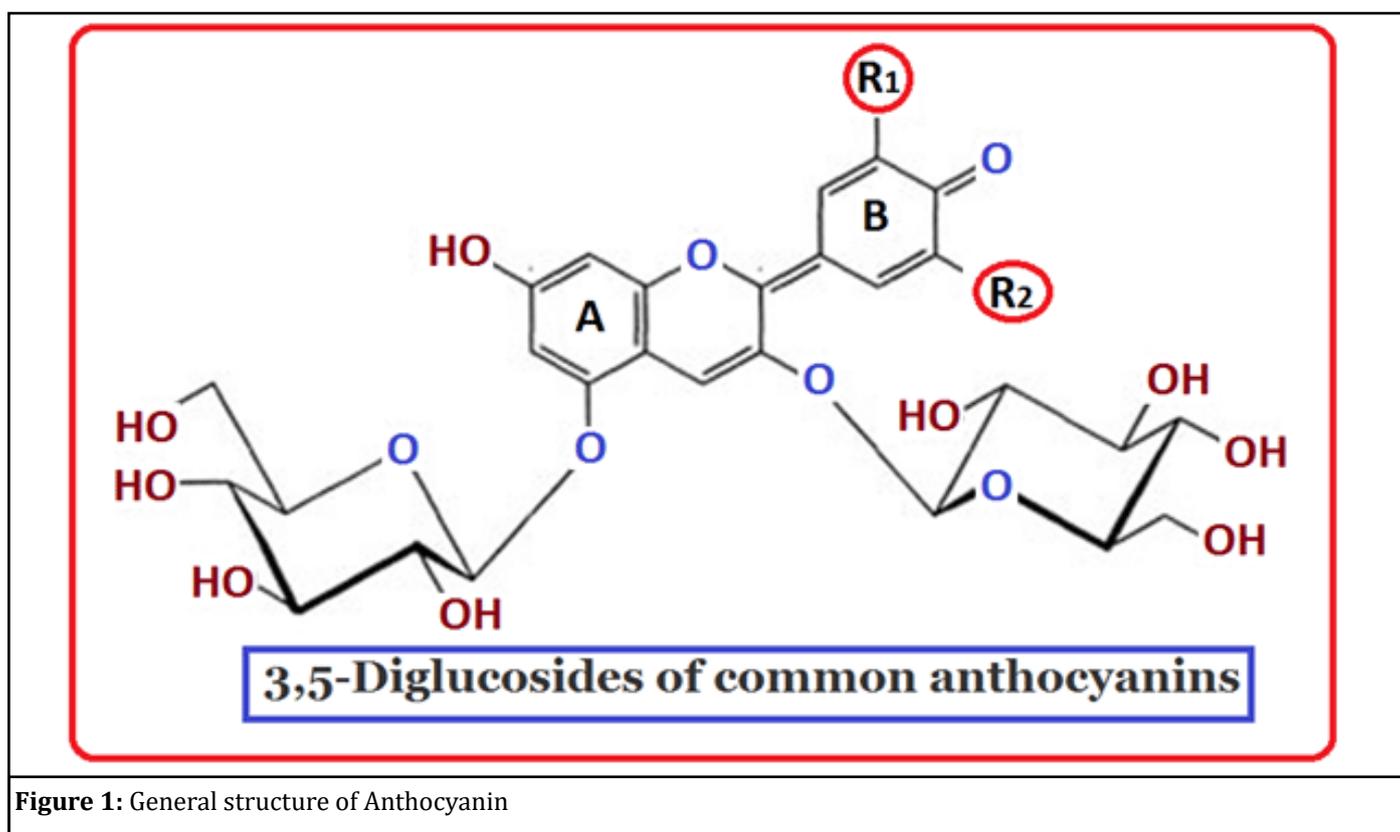


Figure 1: General structure of Anthocyanin

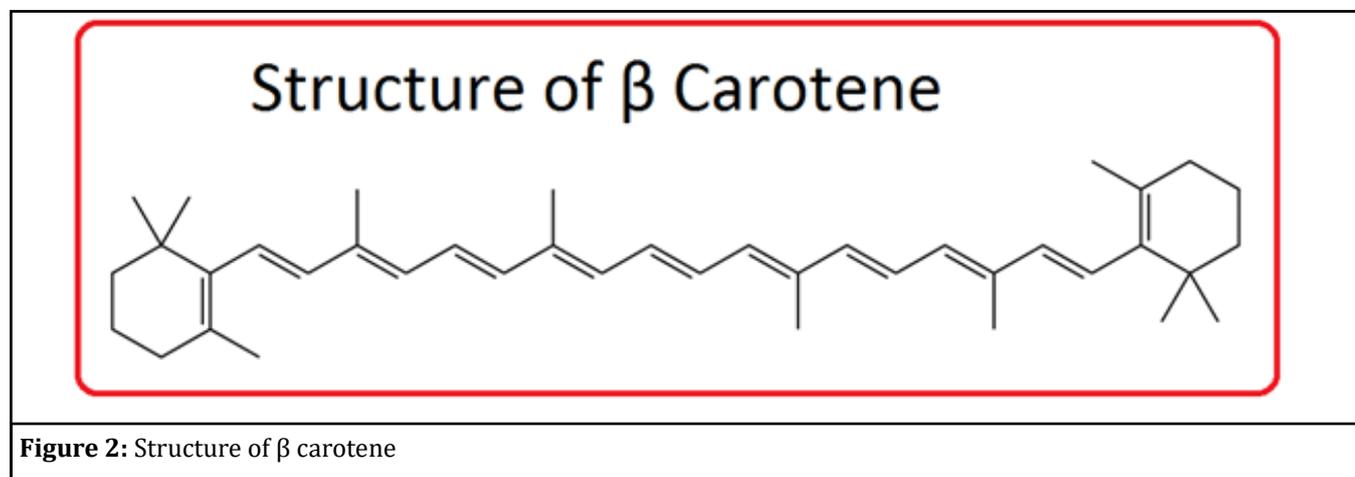


Figure 2: Structure of β carotene

Table I: Various anthocyanins

S No	R ₁	R ₂	Anthocyanin	Anthocyanidin (Aglycon)
1	H	H	Pelargonin	Pelargonidin
2	OH	H	Cyanin	Cyanidin
3	OCH ₃	H	Peonin	Peonidin
4	OH	OH	Deophin	Deophidin
5	OCH ₃	OH	Petunin	Petunidin
6	OCH ₃	OCH ₃	Malvin	Malvidin

Use of flower extracts as corrosion inhibitors

Introduction

Many researchers have recently focused on corrosion prevention methods using green inhibitors. However, the use of green inhibitors has proven to be the easiest and cheapest method for corrosion protection and prevention due to their low toxicity, easy availability and economical preparation. The study is conducted by some techniques such as weight loss method, electrochemical studies etc.

Metals and alloys

Flower extracts have been used to control corrosion of various metals and alloys [1-25]. For example the extracts have been used to control corrosion of mild steel [1,2,4-7], Aluminium [3,21,23] and copper [8].

Medium

The corrosion resistance of steel has been investigated in various medium such as acidic medium [1,3-7,14-20], alkaline medium [2], sea water [8], chloride medium [24] and industrial cooling water systems [25].

Flower extracts

Various types of flower extracts have been used as corrosion inhibitors. For example extracts of Rosa damascena flower [1], Primrose flower [2], Areca flower [3], Primula vulgaris flower [4], Borage flower [5] have been used as corrosion inhibitors.

Methods

Corrosion inhibition efficiencies have been evaluated by weight loss method [9,10,22,24,25]. Mechanistic aspects of corrosion inhibition have been studied by electrochemical studies [5,6,9,11,14,15,19,23-25] such as polarization study and AC impedance spectra. Cyclic Voltammetry [12] has also been employed.

Surface morphology of protective film

Corrosion inhibition is due to the formation of protective film formed on the metal surface. The protective film has been analysed by surface analysis techniques such as FTIR spectroscopy [2,5,6,11], X-ray analysis [2], Contact angle measurement [2,5], SEM [3,5,13], UV-Visible spectroscopy [4,5], Raman spectroscopy [12], EDAX [10] and AFM [3,5,24].

Adsorption isotherm

The film formation on the metal surface takes place after

adsorption of inhibitor molecules on the metal surface obeys various isotherm such as Langmuir adsorption isotherm [1,3,5,6, 10,13,14,16, 17], Temkin adsorption isotherm [6, 18-20], Freundlich adsorption isotherms [22].

Findings

Inhibition of corrosion of mild steel in various media in presence of various types of flower extracts has been investigated by many techniques. The important findings are listed below. The inhibitors function as mixed type of inhibitors [9,10,15,20] under the given experimental conditions. In electrochemical studies,

when corrosion inhibition takes place linear polarization value increases, Corrosion current value decreases, Charge transfer value increases and Double layer capacitance value decreases [5,6,9,11,14,15,19,23-25].

Recent research on use of flower extracts as corrosion inhibitors

Many research activities have been carried out on the inhibition of corrosion by flower extracts. They are summarized in the following Table1.

Table1: Flower extracts as corrosion inhibitors

S.No	Metal	Medium	Inhibitor	Method	Findings	Ref
1	Mild Steel	1 M HCl	Rosa damascena flower extract	PPS , SEM and AFM	Inhibition efficiency 90%, Langmuir isotherm	1
2	Mild Steel	Saline solutions	Primrose flower (PPE) extract and zinc cations	FT-IR, SEM, UV-Vis, GIXRD, AFM, CA, EIS, PPS	Inhibition efficiency 95.3%	2
3	Aluminum	0.5 M HCl	Areca flower extract	Weight loss, EIS, SEM and AFM	Langmuir adsorption model	3
4.	Mild Steel	1 M HCl	Primula vulgaris flower extract	FT-IR, UV-Vis, SEM, CA, EIS and PDS	Inhibition capacity 95.5% at 1000 ppm PVFE	4
5.	Mild Steel	1 M HCl	Borage flower extract	PPL, EIS, AFM , SEM FT-IR, UV-Vis and contact angle measurement	Langmuir isotherm, 91% efficiency at 800 ppm after 5 h	5
6.	Mild Steel	1M HCl	Tithonia diversifolia flower extract	Weight loss, EIS, PPL, FT-IR and OES	Langmuir and Temkin adsorption isotherms	6
7.	Mild Steel	Acid medium	Dipteracanthus prostratus (POIR) and Tithonia diversifolia flower extract	Thermal & dielectric spectroscopic method	Corrosion inhibition	7
8.	Copper	Natural sea water	Ziziphus lotus	Weight loss, polarization study, SEM	93% inhibition efficiency	8
9	Mild Steel	1M HCl	Olive inflorescence flower extract	Weight loss, PPL, EIS and IR	Mixed inhibitor	9
10	Mild Steel	1.0 M phosphoric acid	Borage flowers aqueous extract	HE, ML, PDP, SEM and EDX	Langmuir and thermodynamic-kinetic adsorption isotherms, Mixed-type inhibitor	10
11	Mild Steel	1 N HCl	Gloriosa superba Linn. extract	ML, PPL, EIS, FTIR and SEM	Temkin adsorption isotherm, 99.80 % at 15 ppm	11
12	Reinforcing steel	3.5% NaCl	Tagetes erecta extract	In situ and ex situ Raman spectroscopy, CV, OCP and EIS	Raman method	12
13	Mild Steel	0.5 M H ₂ SO ₄	Bombax ceiba flower extract	PPL, SEM and ML	Langmuir adsorption isotherm, Mixed-type behaviour, Inhibition efficiency 90.84 %	13
14	Mild Steel	1M HCl	Opuntia Ficus Indica methanolic flowers extract	ML, PPL and EIS	Langmuir's adsorption isotherm	14

15	Mild Steel	1M HCl	Canna Indica flower extract	ML, PPL and EIS	Mixed type inhibitor	15
16	Mild Steel	0.5M H ₂ SO ₄	Tagetes erecta extract	Gravimetric, PPL and EIS	Langmuir adsorption isotherm, Mixed inhibitor	16
17	Mild Steel	0.5 M H ₂ SO ₄	Anacyclus pyrethrum L. extracts	PPL and EIS	Langmuir adsorption isotherm	17
18	Mild Steel	1 N H ₂ SO ₄	Musa acuminata flower extract	ML, PPL, SEM	Temkin adsorption isotherm, Maximum efficiency of 95.01% for 5 hours	18
19	Mild Steel	1 N HCl	Musa acuminata flower extract	ML, PPL and EIS	Langmuir and Temkin adsorption isotherms, mixed type inhibitor	19
20	Mild Steel	1M HCl	Cocos Nucifera Flower extract	ML, PPL, Tafel, lpr,eis,	Langmuir and Temkin type isotherms, Inhibition efficiency 97.3%, mixed type inhibitor	20
21	Mild Steel and Aluminium	2M HCl	Nerium oleander and Tecoma stans Air dried flowers	Chromatography and Spectral studies	Corrosion inhibition. Antibacterial and antifungal activity against different organisms	21
22	Mild Steel	1 M HCl	Cassia Auriculata flowers extract	ML, electrochemical studies	Langmuir, Temkin, Freundlich and thermodynamic model, Mixed type inhibitor, inhibition efficiency 74.7%	22
23	Aluminium	pH 12	Hibiscus rosa-sinensis	ML, PPL,EIS and FTIR	Inhibition efficiency 98%	23
24	Carbon steel	60 ppm of Cl-	Hibiscus rosa-sinensis Linn flower extract	ML, PPL,EIS, UV-vis, FT-IR and AFM	Mixed type inhibitor	24
25	Mild Steel	Industrial cooling systems	Eucalyptus (leaves), Hibiscus (flower), and Agaricus extracts	Weight loss and Polarization methods	Langmuir and Freundlich adsorption isotherms, Mixed inhibitors	25

Table 2: Uses of flower extracts

S.No	Name of the Flower	Medicinal Uses	Ref
1	Rosa damascena flower extract	Treatment of abdominal and chest pains, strengthening the heart, menstrual bleeding, digestive problems and constipation	26
2	Primrose flower (PPE) extract	During pregnancy for preventing high blood pressure (pre-eclampsia), shortening labor, starting labor, and preventing late deliveries, premenstrual syndrome (PMS), breast pain, and symptoms of menopause such as hot flashes	27
3	Areca flower extract	Relieves hunger, abdominal discomfort and weariness, veterinary medicine to expel tapeworms, used against anaemia, fits, leucoderma, leprosy, obesity and worms	28
4.	Primula vulgaris flower extract	Spasms, cramps, paralysis and rheumatic pains	29
5.	Borage flower extract	Fever, cough, and depression, hormone problem, blood purification, to increase urine flow, to prevent inflammation of the lungs, as a sedative, and to promote sweating	30
6.	Tithonia diversifolia flower extract	Treatment of constipation, stomach pains, indigestion, sore throat and liver pains	31
7.	Dipteracanthus prostratus (POIR) neem leaves and Tithonia diversifolia flower extract	Treatment of constipation, stomach pains, indigestion, sore throat and liver pains	32
8.	Ziziphus lotus	Improving muscular strength and weight, for preventing liver and bladder diseases and stress ulcers, and as a sedative. It is also used to reduce constipation	33

9	Olive inflorescence flower extract	Reduces symptoms of constipation such as bloating, stomach pain, lower the total cholesterol, low-density lipoprotein and reduce levels of bilirubin	34
10	Gloriosa superba Linn. extract	In intermittent fevers, wounds. Antifertility purpose, Gonorrhoea, Leprosy, Piles, Debility, dyspepsia, flatulence, haemorrhoids, helminthiasis, inflammations, in promoting labor pain and expulsion of the placenta	35
11	Tagetes erecta extract	To treat boils, carbuncles and earaches, treat colds, mumps, skin diseases, conjunctivitis and sore eyes	36
12	Bombax ceiba flower extract	Treatment of cholera, tubercular fistula, coughs, urinary complaints, nocturnal pollution, abdominal pain due to dysentery, and impotency	37
13	Opuntia Ficus Indica methanolic flower extract	Treatment of chronic diseases, particularly diabetes, obesity, cardiovascular diseases, and cancer	38
14	Canna Indica flower extract	Treatment of gonorrhoea and amenorrhoea	39
15	Anacyclus pyrethrum L. extracts	To treat antidiabetic, antioxidant, treating asthma, cardiac diseases, and throat problems, remove laziness, nerves weakness, carminative, stomache, arthritis, sciatica, diuretic, tooth and gum problems, aphrodisiacs, hiccoughs, epilepsy, headache, pains, muscle relaxant, worm infestation, anti-rheumatism, anticonvulsant, brain tonic, common cold and other human related disorders	40
16	Musa acuminata flower extract	Treatment of diseases like diabetes, hypertension, cancer, ulcers, diarrhoea, urolithiasis, Alzheimer's and infections. Other medicinal uses are in surgical dressing, pain relief, food and pharmaceuticals, nano medicine, pollution control, apoptosis and cell cycle	41
17	Cocos Nucifera Flower extract	To treat rheumatism and back pains or as an ointment to maintain smooth, soft skin, sick new born infants and women who have just given birth	42
18	Nerium oleander and Tecoma stans Air dried flowers	Treatment of heart conditions, asthma, epilepsy, cancer, painful menstrual periods, leprosy, malaria, ringworm, indigestion, and venereal disease; and to cause abortions	43
19	Cassia Auriculata flowers extract	Good for skin, reduces obesity, constipation, regulates, menstrual Cycle, antidiabetic and anthelmintic Properties	44
20	Hibiscus rosa-sinensis	To treat heart and nerve diseases, and as a diuretic to increase urine production, to treat constipation, cancer, liver disease, and cold symptoms	45
21	Eucalyptus (leaves), Hibiscus (flower), and Agaricus extracts	To relieve a sore throat, sinusitis, and bronchitis	46

Uses of flower extracts

For several centuries, medical practitioners have lengthily mentioned the therapeutic properties of certain flora. Extra than simply spanning time, this information additionally spans many cultures around the world. One of the finest blessings is that plants and plants offer absolutely herbal medicinal homes, frequently without the frightening side outcomes that current pills and medicines bring on. Furthermore, treatments crafted from plants can be a good deal less expensive than tablets marketed by using pharmaceutical companies. There are many uses from the flower extracts. They are summarized in the following Table 2.

Conclusions

A review of use of flower extracts as corrosion inhibitors have discussed. The various aspects presented are as follows:

- Flower extract are ecofriendly corrosion inhibitors.
- They have been used to control corrosion of mild steel, copper and aluminium in various media.
- The mechanistic aspects have been investigated by electrochemical studies such as polarization study and AC impedance spectra.
- The protective film has been analysed by FTIR, SEM, EDX and AFM.
- The adsorption isotherms isotherms being obeyed are Langmuir, Temkin and Freundlich adsorption isotherms.
- The flowers extract primarily function as mixed type of inhibitors.
- The flowers have medicinal values apart from fragrance.

Mechanism of corrosion inhibition

- ❖ The active principles mainly present in colored flowers are anthocyanins, and carotenoids.
- ❖ They contain polar groups such as hydroxyl, methoxy and ether.
- ❖ These ingredients coordinate with the metal ions on the metal surface through oxygen atom, benzene ring and conjugated double bonds.
- ❖ The protective film formed on the metal surface controls the corrosion process.

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