# NON-TOXIC GREEN CORROSION INHIBITORS- A REVIEW

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**Abstract-** This review article summarizes the research work done on the use of natural compounds as non-toxic green corrosion inhibitors.Corrosion control of metals is very important. Natural extract have been widely used to protect the metal from corrosion. The use of inhibitors is one of the best options of protecting metals and alloys against corrosion. Plant extracts are environmentally friendly, inexpensive, readily available and also renewable. Development of green chemistry and green chemical technologies offers novel synthetic methods for ionic liquids, which are considered as new corrosion green inhibitors.

## 1. INTRODUCTION

Corrosion is the destruction and deterioration of metals as a result of reaction with environment[1](Fontana and Greene 1987). It is slow but spontaneous process.Corrosion can cause disastrous damage to metal and alloy structures causing economic consequences in terms of repair, replacement, product losses, safety and environmental pollution. Due to these harmful effects, corrosion is an undesirable phenomenon that ought to be prevented.To protect metals or alloys from corrosion, approaches such as isolating the structure from aggressive media (using coatings or film-forming chemicals) or compensating for the loss of electrons (corrosion is an oxidation process) from the corroded structure (e.g. cathodic protection by impressed current or by using active sacrificial anodes) are employed. From 1960's onward, a large number of synthetic organic compounds have been studied as anticorrosive materials in which heteroatoms such as C, N, O, and S were identified to be the prime reason for its corrosion inhibition ability.However, most of these inhibitors were expensive, harmful to humankind, and nonbiodegradable[2]. So,more attention was given towards the development of naturally derived environmentally benign organic corrosion inhibitors. Apparently, every plant contains several active phytochemicals, and they are the ideal to replace traditional toxic inhibitors[3]. In this review article we discuss some plant extract as corrosion inhibitors for steel and aluminium.

## 2. PLANT EXTRACTS AS CORROSION INHIBITOR FOR STEEL

Plants and their part have been used by human beings for their basic needs such as production of food-stuffs, shelters, clothing, fertilizers, flavors and fragrances, medicines and also as corrosion inhibitors. The use of natural products as corrosion inhibitors can be traced back to the 1930's when plant extracts of Chelidonium majus (Celandine) and other plants were used for the first time in $H_2SO_4$ pickling baths (Sanyal, 1981). After then, interest in using natural products as corrosion inhibitors increased.

M.S. Al-Otaibi etal4, in 2014 reported the corrosion inhibitive effect of eight plants namely Lycium shawii (L.S.), Teucrium oliverianum (T.O.),Ochradenus baccatus(O.B.),Anvillea garcinii(A.G.), Cassia italica (C.I.), Artemisia sieberi (A.S.), Carthamus tinctorius (C.T.) and Tripleurospermum auriculatum (T.A.) grown in Saudi Arabia. They evaluate corrosion inhibition of these plants on mild steel in 0.5 M HCl solution using Open Circuit Potential(OCP),Tafel plots and Electrochemical Impedance Spectroscopy (EIS) methods.

A comparative study was done by M. Shyamala and P. K. Kasthuri in 2011[5] on the inhibitory effects of plant extracts, Ocimum sanctum, Aegle marmelos, and Solanum trilobatum, on the corrosion of mild steel in 1N HCl medium using weightloss method, electrochemical methods, and hydrogen permeation method. On comparison, it was found that the maximum inhibition was shown by Ocimum sanctum with 99.6% inhibition efficiency at 6.0% v/v concentration of the extract

Anjali Peter etal[6] studied the anticorrosive efficacy of Guar Gum with mild steel in acidic medium. Gums have been found to be good corrosion inhibitors due to their functional group; they form complexes with metal ions and on the metal surfaces. Most gums have -COOH functional groups, which can increase the contribution of electron or charge transfer and hence facilitate inhibition through adsorption. According to Ayssar et al.[7] (2010), the aqueous neem leaves extract was found to be an excellent potential corrosion inhibitor for carbon steel in 1.0 M HCl.

Rocha et al.[8] observed the combined effect of mango and orange peel extracts for corrosion inhibition on carbon steel in the acidic medium over a concentration range of 200–600 ppm. They concluded that polar heterosides and hydroxyl groups are the leading cause of inhibition property. Anticorrosive property6 of Mangifera indica L. Leaf Extract was studied for the prevention of commercial steel in 3.5 wt % NaCl environment. Corrosion prevention occurs by forming an insoluble organometallic complex between metal ions and functional groups in the antioxidants at the metal–electrolyte interface..Corrosion prevention occurs by forming an insoluble organometallic complex between metal ions and functional groups in the antioxidants at the metal–electrolyte interface.

Saleh and his co-workers[9] performed an exhaustive work with Opuntia ficus indica, as a steel corrosion inhibitor. The aqueous extract of the inhibitor is found as a cathodic-type which is get absorbed over the electrode surface in physical nature and follows unimolecular Langmuir adsorption. They were also studied with aloe vera leaves and

fruits peels of mango, orange and pomegranate fruits on the corrosion of MS, Al, Zn and Cu in both HCl and $H_2SO_4$ acid solutions.

Sangeetha et al.2012[10] Banana peel extract (constituent of this extract is bananadine (3Z,7Z,10Z)-1-oxa-6-azacyclododeca-3,7,10-triene) was reported as a good corrosion inhibitor with Zn in distilled water for carbon steel corrosion by the weight loss, thermometric , FTIR, and AFM analysis. Obtained results show that percentage inhibition efficiency first decrease with the addition of Zn but after increasing Zn concentration it increased.

Gupta and Jain in 2014[11] reported the Corrosion inhibition by Aloe barbadensis (aloe vera) extract as green inhibitor for mild steel in $HNO_3$.Aloe vera plant belongs to the family of Liliacea.The constituents of gel are polysaccharides, glycoproteins, vitamins, mineral, and enzymes. Obtained results show its synergistic type effect, and percentage inhibition efficiency was decrease with rise in temperature and increase with increasing extract concentration[11.]

Desai et al[12]., reported Hibiscus rosa-sinensis leaves extract as a good corrosion inhibitor for mild steel in HCl medium by the use of weight loss and EIS techniques. Obtained results show that the percentage inhibition efficiency was increased with the increasing temperature and concentration and show mixed-type inhibitor effect, and adsorption process was spontaneous and followed the Langmuir, Flory-Huggins and Freundlich adsorption isotherms.16

Noor 2007[13] Extract of fenugreek leaves reported as a good inhibitor for mild steel in HCl and $H_2SO_4$ solution but more efficient in HCl solution. Inhibition efficiency was decrease with rise in temperature but increase with increasing inhibitor concentration in HCl while both temperature and concentration increased the inhibition efficiency for mild steel in $H_2SO_4$ solution. Langmuir adsorption isotherm followed in HCl medium and Temkin followed in $H_2SO_4$ medium.

Yamuna and Athony 2014[14] 18 C. sinensis leaf extract reported as a corrosion inhibitor in aqueous medium by the use of weight loss, UV, and FT-IT methods. Obtained results show that inhibition efficiency increase with increasing inhibitor concentration but decrease with rise in temperature

Nwankwo[15] and his coworkers studied the use of Amaranthus cordatus as the corrosion inhibitor for conventional mild steel in 0.5 M and 1.0 M of both H2SO4 and NaCl. The result showed that the rates of corrosion of the mild steel increased with an increase in concentration of the acid or base and also decreased with increasing volume of Amaranthus cordatus.

Norzila etal., studied the effect of Piper nigrum extract on corrosion of mild steel

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Rehan in 2003[16] reported that Phoenix dactylifera as a good corrosion inhibitor for Al in NaOH solution by weight loss and PDP method. His results showed that the inhibition efficiency increase with increasing temperature and concentration

Abd-El-Nabey et al.[17] 2012 The extracts of Damsissa, Corchours oitorius reported as a good inhibitor for the corrosion of aluminum in aqueous sodium carbonate by the use of gasometry, potentiodynamic polarization, and electrochemical impedance spectroscopy (EIS).

Avwiri and Igho 2003[18] Vernonia amygdalina reported as a fine corrosion inhibitor for aluminum in HCl and HNO3 medium by the use of weight loss method. But its inhibition performance was much better in $HNO_3$ solution as compare to HCl medium.

Nnanna et al. 2012[19] The inhibition effect of Newbouldia laevis leaves extract reported as a good inhibitor on the corrosion of aluminum HCl and $H_2SO_4$ solutions by the use of gravimetric technique. Obtained results show that N. laevis inhibitor effect was more efficient in HCl than $H_2SO_4$.

Umoren et al. 2012[20] Coconut coir dust extract reported as a good inhibitor for aluminum corrosion in 1 M HCl medium by the use of weight loss and hydrogen evolution method. It was exhibited that percentage IE efficiency increased with increasing temperature and concentration. Obtained results show the Langmuir adsorption performance.

## CONCLUSION

The literature revealed that natural plant extracts are effective green corrosion inhibitors against various metals and alloys.Green inhibitors are excellent inhibitors under a variety of corrosive environments for most of the metals. This article has shown that the usage of such eco-friendly corrosion inhibitors is the only way onward in the search for safer and environmentally secure protection against metal corrosion. The non-toxicity and biodegradability are the major advantages for these inhibitors.

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