coatings

# Green Corrosion Inhibition of Mild Steel by Hydrazone Derivatives in 1.0 M HCl

**Abdelkarim Chaouiki [1], Maryam Chafiq [1], Hassane Lgaz [2,*], Mustafa R. Al-Hadeethi [3], Ismat H. Ali [4], Sheerin Masroor [5] and Ill-Min Chung [2,*]**

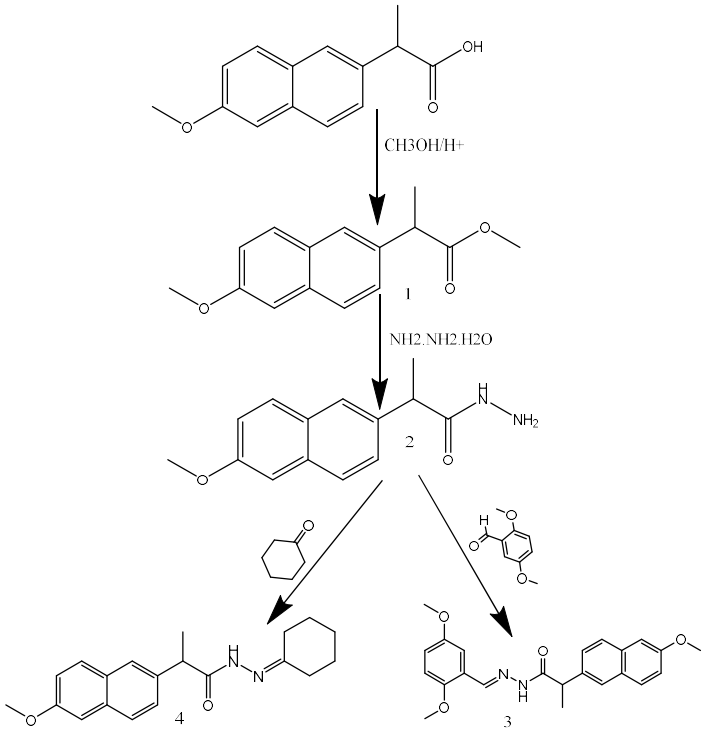
[1] Laboratory of Applied Chemistry and Environment, ENSA, University Ibn Zohr, PO Box 1136, Agadir 80000, Morocco; abdelkarim.chaouiki@uit.ac.ma (A.C.); maryam.chafiq@edu.uiz.ac.ma (M.C.)
[2] Department of Crop Science, College of Sanghur Life Science, Konkuk University, Seoul 05029, Korea
[3] Department of Chemistry, College of Education, Kirkuk University, Kirkuk 36001, Iraq; mustfaa70@yahoo.com
[4] Department of Chemistry, College of Science, King Khalid University, P. O. Box 9004, 61413 Abha, Saudi Arabia; ismathassanali@gmail.com
[5] Departement of Chemistry, Anugrah Narayan College, Patliputra University, Patna 800013, Bihar, India; masroor.sheerin@gmail.com
* Correspondence: hlgaz@konkuk.ac.kr (H.L.); imcim@konkuk.ac.kr (I.-M.C.)

**Preparation of hydrazone derivatives:**

**Synthesis of methyl 2-(6-methoxynaphthalen-2-yl)propanoate (1):** A mixture of (11.5 g, 0.05 mmol) Naproxen and excess of absolute methanol with a catalytic amount of $H_2SO_4$ was refluxed for 8 h. The mixture was poured into crushed ice and neutralized with $NaHCO_3$; the precipitated ester was collected and washed with water twice to remove the ions then recrystallized from ethanol to afford the ester as white crystal with melting point (m.p) =89–91 °C. Fourier-transform infrared (IR) (KBr): (C=O ester 1739 $cm^{-1}$), (C–H aliphatic 2975 $cm^{-1}$), (=C–H aromatic 3061 $cm^{-1}$).

**Synthesis of 2-(6-methoxynaphthalen-2-yl)propanehydrazide (2):** A mixture of Naproxen methyl ester (1) 1 mmol and hydrazine hydrate 5 mmol was refluxed for 20 h. The reaction mixture was cooled and the separated solid was collected and recrystallized from ethanol to obtain the hydrazide with m.p = 138–140 °C. IR (KBr): (C=O amide 1635 $cm^{-1}$), (C–H aliphatic 2931 $cm^{-1}$), (=C–H aromatic 2999 $cm^{-1}$).

**General procedure for synthesis of hydrazones (3,4):** A mixture of an equimolar ratio of appropriate aldehyde (0.01 mmol) and naproxen acid hydrazide (0.01 mol) with catalytic amount of glacial acetic acid was refluxed in 20 mL of absolute ethanol for 6 h. The mixture was cooled, and the solvent was evaporated. The solid precipitate was collected and recrystallized from ethanol/dioxan and ethanol, respectively, to give the hydrazones.




**Scheme 1.** General procedure for the synthesis of hydrazones (3,4).

(E)-N'-(2,5-dimethoxybenzylidene)-2-(6-methoxynaphthalen-2-yl)propanehydrazide (3): m.p = 204-206 $^{0}$C. IR (KBr): (C=O amide 1641 cm$^{-1}$), (N–H 3317 cm$^{-1}$), (–C=N 1605 cm$^{-1}$). $^{1}$H NMR (400MHz, DMSO): δ = 1.4 (d, 3H, $CH_3$), 3.4 (q, 1H, C–H), 3.8 (s, 3H, $OCH_3$), 3.6 (s, 3H, $OCH_3$), 3.8 (s, 3H, $OCH_3$), 8.3 (s, 1H, –CH=N–), 10.3 (s, 1H, –NH), 7.1–8.0 (m, 9H, aromatic protons). $^{13}$C-NMR δ = 19 ($CH_3$), 44 (C–H aliphatic), 55($OCH_3$), 106–156 (16aromatic carbons), 162(C=N), 172 (C=O amide).

N'-cyclohexylidene-2-(6-methoxynaphthalen-2-yl)propanehydrazide (4): m.p = 144–147 °C. IR (KBr): (C=O amide 1672 cm$^{-1}$), (N–H 3182 cm$^{-1}$), (–C=N 1608 cm$^{-1}$), (C-H aliphatic 2867–2952 cm$^{-1}$). $^{1}$H NMR (400MHz, DMSO): δ = 1.4 (d, 3H, $CH_3$), 3.4 (q, 1H, C–H), 3.8 (s, 3H, $OCH_3$), 1.5–2.3 (m, 10H, cyclic aliphatic protons), 10.1 (s, 1H, –NH), 7.1–7.8 (m, 6H, aromatic protons). $^{13}$C-NMR δ =18 ($CH_3$), 44 (C–H aliphatic), 55 ($OCH_3$), 25–33 (5 cyclic aliphatic carbons), 106–155 (10aromatic carbons), 160 (C=N), 172 (C=O amide).