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THE UTILITY OF MICHAEL CONDENSATION FOR THE SYNTHESIS OF MACROMOLECULE SURFACTANTS FROM AZO-NAPHTHOLS AS POSSIBLE ANTIMICROBIALS

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ABSTRACT

((*E*)-4-(pyridin-3-yldiazenyl)naphthalen-1-ol) and (4-((*E*)–pyridin-3-yldiazenyl)–8-((*Z*)-pyridin-3-yldiazenyl)naphthalene-1,5-diol) (**IIIa, b**) were prepared. Condensation of (**IIIa, b**) with 2-(pyridin-4-ylmethylene) malononitrile (**V**) under Michael reaction conditions gave the corresponding bezo[h]chromene and dihydrochromene[8,7-h] chromene derivatives (**VIa, b**). The cationic derivatives for **(IIIa, b**) and **(VIa, b)** were obtained by quaternization as (**IVa,b**) and (**VIIa,b**). The structures obtained were confirmed form IR, ^{1}HNMR and mass spectra studies. The antimicrobial activities were also studied and have been found that; the cationic dyes (**IVa,b**) and (**VIIa**) exhibit promising results against *Candida albicans*.

Keywords: Pyridinyldiazenylnaphthols, cationic azo dyes, antimicrobial activity.

1. INTRODUCTION

Azo compounds are regarded as important and vital compounds in the industry of color and pigments [1], food colorant, pesticides [2], lubricating oil improvers [3], and in the medicinal and pharmaceuticals such in HIV inhibitors of the viral replication [4]. Medicinal importance of azo compounds is also well documented because of their use as antineoplastic, antidiabetics, antiseptics [5, 6], antibacterial [7] and antitumor [8]. In several numbers of biological reactions such as inhibition of DNA, RNA and protein synthesis, carcinogenes and nitrogen fixation [9, 10], the involvement of azo dyes is known. In pharmaceutical and medicinal fields, azo compounds are becoming important [11], and it has been proposed that the biological activities expressed by some Schiff bases [12, 13], might be due to azo-imine linkage which are responsible for antibacterial and pesticidal activities of different types of compounds. Electrochemical measurements showed that azo dye, 4-(phenyldiazenyl)phenyl-2-furoate(ppf), acts as corrosion inhibitor of carbon steel in saline water (SW), by suppressing simultaneously the cathodic and anodic processes via adsorption on the carbon steel surfaces [14]. Keeping in view the above-mentioned importance of azo dyes, it was conceivable to develop synthesis of macromolecule surfactant from azo naphthol. Herein, the authors have prepared some new naphthol dye and their derivatives in the form of macromolecule surfactants and study their ^{1}HNMR, IR and mass spectroscopy. Their antimicrobial activities were also studied.

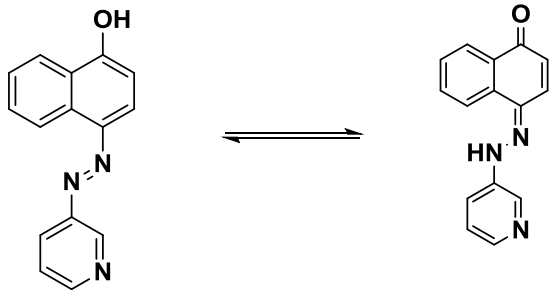
2. Material and Experimental work

2.1. General Procedure of azo-naphthols

The azo-naphthols (**IIIa, b**) were synthesized by diazotization of 3-aminopyredine with nitrosyl chloride and subsequent coupling with naphthalen-1-ol and naphthalene-1,5-diol respectively. Thus, (3.79 g, 0.055mol) $NaNO_2$ was added to (6 ml) HCl**,** cooled to 0^oC and (4.32g, 0.05mol) 3-aminopyredine was stirred. The clear diazonium solution obtained was added under stirring at (0-5^oC) to solution of coupling naphthols (0.05 mol of naphthalen-1-ol and 0.0025 mol naphthalen-1,5-diol) in 10% aq. NaOH (20 ml). The residue formed was filtered off, washed with water and dried to give the corresponding azo-naphthols.

2.1.1. ((*E*)-4-(pyridin-3-yldiazenyl)-naphthalene-1-ol) (IIIa), recrystallized twice from hot ethanol, yield (85%) as red solid. Mp: (209-210 °C) (lit 209.5-210 °C) [15-17].

(IIIa), IR *(*ν_{max}, cm^{-1}): 3435.1, 3211, 3153.7, 3046.9, 1628.4, 1556.0 (vs).



^{1}HNMR (DMSO-d_6): (δ, ppm): 7.014, 6.993 (1H, d, *J*=8.4 Hz), 7.63, 7.612, 7.594 (2H, t, *J*=7.2 Hz); 7.757, 7739,7.20 (1H, t, *J*=7.2 Hz), 8.025, 8.003 (1H, d, *J*=8.8 Hz), 8.238, 8.219 (2H, d, *J*=7.6 Hz), 8.637 (1H,s), 8.66,8.847 (1H, d, *J*=7.6 Hz) and 9.107 (1H, s, 2-Py)

UV c.f (Table 1, fig. 1) λ max (279, 427 and 565nm)

2.1.2. (4-((*E*)–pyridin-3-yldiazenyl)–8-((*Z*)-pyridin-3-yldiazenyl)naphthalene-1,5-diol) (IIIb), recrystallized from hot ethanol, yield (85%) as dark brown solid. Mp: > 300 °C**.**

IIIb; IR (ν_{max}, cm^{-1}): 3441.1, 3337.8, 3043, 1596.3, 1558.7 (vs). ^{1}HNMR(DMSO-d_6): (δ, ppm): 6.891, 6.914 (1H, d, *J*=7.2 Hz), 7.168, 7.7187 (1H, d, *J*=7.6 Hz), 7.421, 7.441, 7.461 (2H, dd, J_1=J_2= 8Hz), 7.568, 7.579 (2H, d, *J*=4.4 Hz) (7.681, 7.701,7.734)(1H, dd, J_1=8 and J_2= 13.2Hz), 7.811(1H, s),8.199, 8.222(1H, d, *J*=9.2 Hz), 8.5(1H, s),8.772, 8.808(1H, d, *J*=14.4 Hz), 8.882, 8.898(1H, d, *J*=6.4 Hz), 9.008(1H, s), 11.843(1H, s)

UV c.f (Table 1, fig. 1) λ max (266, 367, 476 and 584 nm)

2.1.3. Synthesis of 2-(Pyridin-4-ylmethylene)malononitrile (V)

Solution of 4-pyridinecarboxyaldehyde (5 g, 0.047 mol) in 50 ml (EtOH: H_2O) was stirred at room temperature, and then followed by adding malononitrile solution (3.08 g, 0.047 mol) for (15 min.). The mixture was reflux until precipitation complete (time reaction is 1hr). The corresponding solid product filtrated off; Mp: 100-101°C [18].

V: IR (ν_{max}, cm^{-1}): 3426(br), 3046.44, 2952, 2930.59, 2232.08, 2191.8, 1609.08 and 1546.82

^{1}HNMR (DMSO-*d6*), 400 MHz: (δ, ppm): 7.55(1H, s, PyCH=), 8.474 – 8.747(4H, m, Py-H)

Ms (m/z, %): 155(M^+, (10.79), 103, (11.12), 78(78.56), 77(24.41), 52(35.91), 51(100), c.f scheme 6

2.1.4. Synthesis of ((E)–2–amino–6-(pyridin-3-yldiazenyl)–4-(pyridin-4-yl)-4H-benzo[h]chromene-3-carbonitrile (VIa).

To solution of 2-(pyridin-4-ylmethylene)malononitrile (1.55 g, 0.01 mol) in EtOH (30 ml) was treated with (*E*)-4-(pyridin-3-yldiazenyl)naphthalen-1-ol (2.49 g, 0.01 mol) followed by few drops of piperidine (0.5 ml) . The reaction mixture was heated until precipitation (the reaction time 6hrs). The solid product which formed was collected by filtration and recrystallized from EtOH to produce the expected yield as dark red. Mp: 170 °C

VIa: IR (ν_{max}, cm^{-1}): (3380.3(br), 3059.6, 2934.7, 2193.3(CN), 1628.2(shoulder), 1595.7(s), 1473.01(N=N) OR 3345.98, 3247.79, 3062.69, 2193.7, 1626.53, 1596.49(vs), 1546.22, 1487.08, 1454, 1411.87.

^{1}HNMR (DMSO-*d6*) 400 MHz: (δ, ppm): 6.998(C-H), 7.074-7.125(2H, NH_2), 7.253-9.179(Ar-H + py-H) (complex pattern)

Ms (m/z, %): 404(M^+, 8.96), 298(100), 43(91.68) (Scheme 7)

UV c.f (Table 1, fig. 1) λ max (278 and 426 nm)

2.1.5. Synthesis of 3,9–diamino–5-((*E*)-pyridin-3-yldiazenyl)–11-((*Z*)–pyridin–3-yl-diazenyl)-1,7–di(pyridin–4-yl)-1,7–dihydrochromeno[8,7-h]chromene-2,8-dicarboni- trile (VIb)

To a solution of 2-(pyridin-4-ylmethylene) malononitrile (3.1 g, 0.02 mol) in EtOH (30 ml) was treated with 4-((*E*)-pyridin-3-yldiazenyl)-8-((*Z*)-pyridin-3-yldiazenyl) naphthalene-1,5-diol (3.7 g, 0.01 mol) followed by few drops of piperidine (0.5 ml) . The reaction mixture was heated until precipitation (the reaction time 6hrs). The solid product which formed was collected by filtration and recrystallized from EtOH to produce the expected yield. Mp: >300°C

VIb: IR (ν_{max}, cm^{-1}): 3430.1(br), 3173(s), 3054, 2192.2, 1592.2 (vs), 1466.05, 1416.5

^{1}HNMR (DMSO-*d6)* 400 MHz: (δ, ppm): 6.4(s, 2H, 2C-H), 6.925(br, 4H, $2NH_2$), 6.972, 6.99, 7.011(2d, J_1=8.8Hz, J_2= 7.08Hz), 7.2(br), 7.182(br), 7.272(br), 7.378-8.803(set of multiplets), 9.06(s). 9.12(s)

Ms (m/z, %): 680[(14.25, M^+), (90.6, M^{+1}), (20.27, M^{+2})], 468(16.85), 425(22.91), 343(100), 215(19.64), 137(59.89) (Scheme 8)

UV c.f (Table 1, fig. 1) λ max (273, 347, 434 and 570 nm)

2.2. Quaternary salt (surfactants)

2.2.1. Synthesis of (*E*)–1–dodecyl–3-((4-hydroxynaphthalen-1-yl)diaze nyl) pyridin-1-ium bromide (IVa).

A mixture of (*E*)-4-(pyridin-3-yldiazenyl)naphthalen-1-ol (2.49 g, 0.01 mol) and 1-bromododecane (2.49 g, 0.01 mol) in ethanol was refluxed for 48 h to produce the quaternary product. The mixture was allowed to cool and the obtained red solid precipitate was further purified by diethyl ether, dioxane then recrystallized from ethanol.

IVa: IR (ν_{max}, cm^{-1}): 3420.1(br), 3208.77, 3119.59, 2924.04, 2852.96, 1632.35(m), 1548.75 (vs)

^{1}HNMR (DMSO-*d6*) 400 MHz: (δ, ppm): 0.7947(3H, CH_3), 1,165(20H, $10CH_2$), 4.6908(2H, $^+$ N-CH_2), 6.0808, 7.1281, 7.257, 7.383, 7.5684, 7.6957, 8.0174, 8.2452, 8.6196 and 9.0945(11H, Ar-H, OH).

Ms (m/z, %): 498(M^{+1})(12.6), 284(100), 170(5.47), 143(22.42), 115(44.3), 114(44.3), 89(8.75), 78(73.99), 64(75.29), 43(47.51), 40(54.96). (Scheme 5)

UV c.f (Table 1, fig. 1) λ max (260 and 412 nm)

2.2.2. Synthesis of 3-((*E*)-(4,8-dihydroxy-5-((*Z*)-(1-dodecyl-pyridin-1-iumbromide-3-yl)diazenyl)naphthalen-1-yl)diazenyl)–1-dodecylpyridin-1-ium bromide (IVb).

A mixture of 4-((*E*)-pyridin-3-yldiazenyl)-8-((*Z*)-pyridin-3-yldiazenyl) naphthalene-1,5-diol (3.7 g, 0.01 mol) and 1-bromododecane (4.98g, 0.02 mol) in ethanol was refluxed for 48 h to produce the quaternary product. The mixture was allowed to cool and the obtained solid precipitate was further purified by diethyl ether, dioxane then recrystallized from ethanol.

IVb: IR (ν_{max}, cm^{-1}): 3384.62, 3187.09, 3057.95, 2924.30 (vs), 2853.54(aliph C-H), 1629.1, 1592.09, 1458. 57(s)

^{1}HNMR (DMSO-d_6)400 MHz: (δ, ppm): 0.8436, 0.8608(d, 6H, 2 CH_3, *J*=6.88 Hz), 1.0826, 1,0651(4H, d, $2CH_2$, *J*=7 Hz), 1.2417(m, 32H, 16 CH_2), 4.4347, 4.4171, 4.3994(2d, 4H,2 $^+$ N-CH_2, J_1=7.04 and J_2= 7.08Hz), 7.0198(1H, s), 7.1476(1H, s), 7.315((1H, s), 7.4986, 7.5358(2H, d, *J*=14.88 Hz), 8.033(1H, s), 8.1088(1H, s), 8.1659, 8.1519(2H, d, *J*=5.6 Hz), 8.975(1H, s), 9.3249, 9.3122 (2H, d, *J*=6.88 Hz), 9.7318(1H, s), 10.732(1H, s).

UV c.f (Table 1, fig. 1) λ max (268, 440 and 563 nm)

2.2.3. Synthesis of (*E*)–3-((2-amino-3-cyano-4-(1-dodecyl- pyridin-1-ium-4-yl) -4H- benzo [h] chromen -6-yl) diazenyl) -1-dodecyl pyridin–1-ium bromide (VIIa).

A mixture of (*E*)-2-amino-6-(pyridin-3-yldiazenyl)-4-(pyridin-4-yl)-4H-benzo[h] chromene-3-carbonitrile (4.04 g, 0.01 mol) and 1-bromododecane (4.98 g, 0.02 mol) in ethanol was refluxed for 72 hrs. To produce the quaternary product the mixture was allowed to cool and the obtained solid precipitate was further purified by diethyl ether, dioxane then recrystallized from ethanol.

VIIa: IR (ν_{max}, cm^{-1}): 3415.79, 3183.14(vs), 3038.4(w), 2924.43(vs), 2853.49(s), 2195.78 (CN), 1632.32, 1594.51, 1553.33, 1498.81

^{1}HNMR (DMSO-d_6)400 MHz: (δ, ppm): 0.861, 0.8454(6H, d, *J*= 6.24Hz), 1.0754, 1.092,1.1097(4H, 2d, J_1=6.88Hz , J_2= 6.8Hz),1.2458(32H, m, $16CH_2$), 1.768,1.7857, 1.8024(4H, t, *J*=7.08Hz, $2CH_2$), 4.419, 4.4368(4H, d, *J*= 7.2Hz, $2N^+$-CH_2), 4.7107(1H, s, H-4), 6.6449, 6.6607(2H,br, NH_2), 7.036(1H, s, H-5 Ar), 7.1511-7.1641(2H, d, *J*= 5.2Hz, H-8,9 Ar), 7.29(1H, s,H-4, Py), 7.6396 – 7.8046(5H, m, CH-7,10 Ar + 3CH,3,5,5-Py), 8.0337 – 8.352(4H, m,C-H,2,6Py).

UV c.f (Table 1, fig. 1) λ max (272 and 437 nm)

2.2.4. Synthesis of 4,4'-(3,9–diamino-2,8–dicyano–5-((*Z*)-(1-dodecylpyridin-1–ium–3-yl)diazenyl)–11-((*E*)-(1-dodecylpyridin-1-ium–4-yl)diazenyl)-1,7-dihydrochromeno[8,7-h]-1,7-diyl)bis(1-dodecylpyridin-1-ium)bromide (VIIb).

A mixture of 3,9–diamino–5-((*E*)–pyridine–3-yldiazenyl)-11-((*Z*)-pyridin-3-yldiazenyl)-1,7-di(pyridin-4-yl)-1,7–dihydro chromeno[8,7-h]chromene-2,8-dicarbonitrile (6.8 g, 0.01 mol) and 1-bromododecane (9.96 g, 0.04mol) in ethanol was refluxed for 96 hrs. To produce the quaternary product the mixture was allowed to cool and the obtained solid precipitate was further purified by diethyl ether, dioxane then recrystallized from ethanol.

VIIb: IR (v_{max}, cm^{-1}): 3385.03, 2955.42, 2924.46, 2853.58, 2194.4(CN), 1633.09, 1588.34, 1462.97

^{1}HNMR (DMSO-*d6*) 400 MHz: (δ, ppm): 0.851(12H, s, $4CH_3$), 1.2358, 1.6639 – 1.9194 (88H, 2m, $44CH_2$), 4.4103 and 4.6304(2H, 2s,C-H,1,7), 6.8761(4H,s, $2NH_2$),7.0663, 7.1945(2H, 2s, H-6,12, Ar), 7.3217 – 8.9236(16H, m, H-Py).

UV c.f (Table 1, fig. 1) λ max (272 and 567 nm)

The spectrometric fragmentation of compounds IVa, V, and (VIa – b) (scheme 5, 6, 7 and 8)

2.3. Antimicrobial activity

The standardized disc–agar diffusion method (Bauer – Kirby 1966 & CLSI 2006) [19] was followed to determine the activity of the synthesized compounds against the tested micro organ- isms.

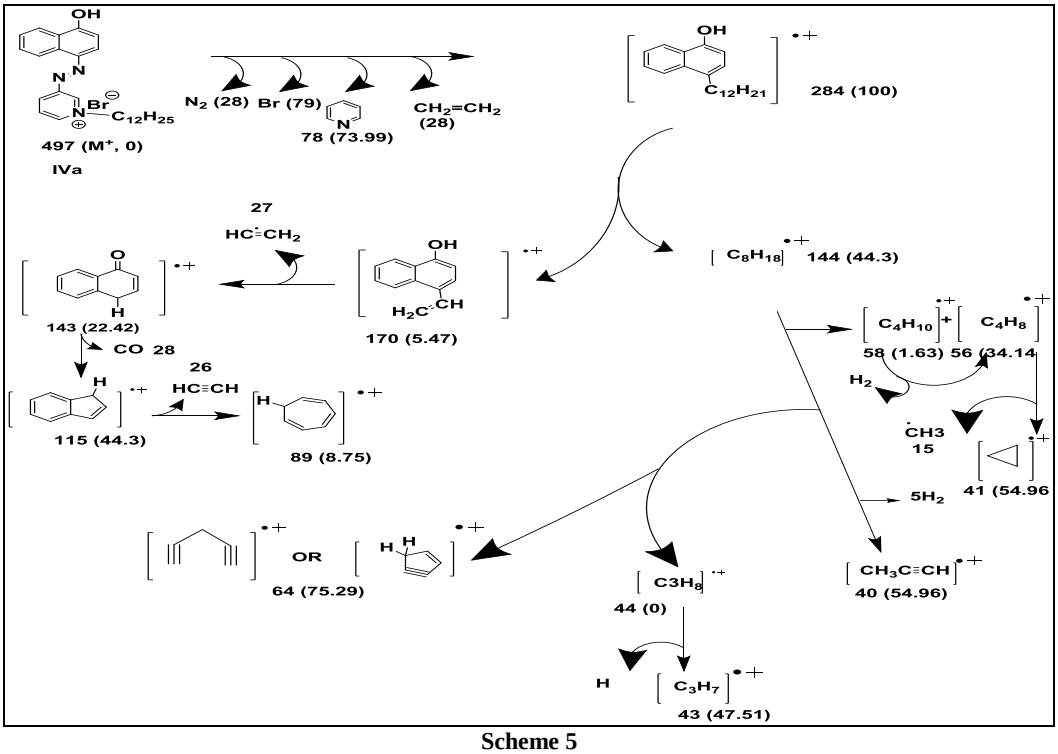
2.3.1. Test Organisms

Cultures of the following microorganism were used in the test: Gram- positive bacteria: *Staphylococcus aureus* (ATCC 25923) and *Bacillus subtilis* (ATCC 6635), Gram – negative bacteria: *Escherichia coli* (ATCC 25922) and *Salmonella typhimurium* (ATCC 14028), Yeast: *Candida albicans* (ATCC 10231) and Fungus: *Aspergillus fumigatus.*

2.3.2. Detecting the possibility of antimicrobial potential:

2.3.2.1. Preparation of tested compound

The tested compounds were dissolved in dimethyl formamide (DMF) solvent and prepared in concentration of 100 mg/ml and then 10 µl of each preparation was dropped on disk of 6 mm in diameter. The concentration



Scheme 5

became 1mg/disk. In the case of insoluble compounds, the compounds were suspended in DMF and subsequently treated.

2.3.2.2. Testing for anti-bacterial and yeasts activity:

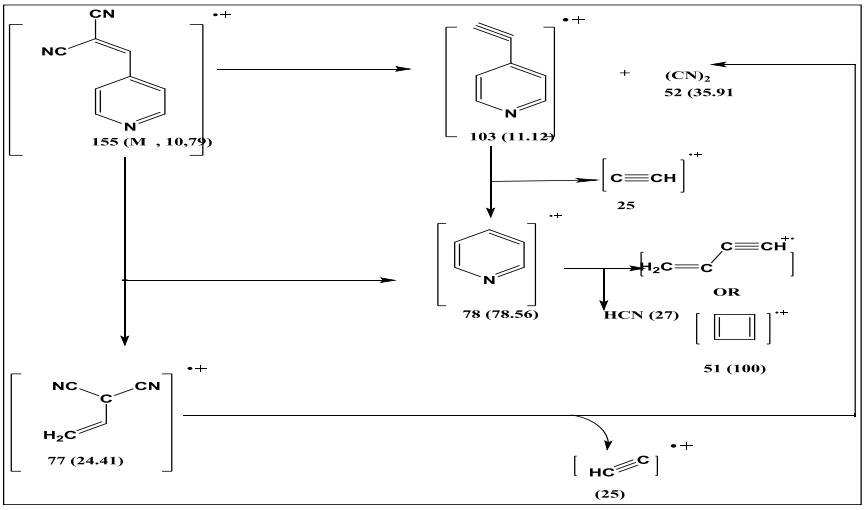
Bacterial cultures were grown in nutrient broth medium at 30 °C. After 16 h of growth, each microorganism, at a concentration of 10^8cells/ml, was inoculated on the surface of Mueller-Hinton agar plates using sterile cotton swab. Next, uniform size paper discs (6 mm diameter) were impregnated with an equal volume (10 µl) of the specified concentration of the dissolved compounds and carefully placed on the surface of each pollination plate. The plates were incubated in the upright position at 36ºC for 24 hours. Three replicates were carried out for each extract against each tested organism. Simultaneously, addition of the respective solvent instead the dissolved compound was surfed as negative controls. After incubation, the diameters of the growth inhibition zones formed around the disc were measured in millimeter with transparent ruler, averaged and the mean values were tabulated.

2.3.2.3. Testing for anti-fungal activity:

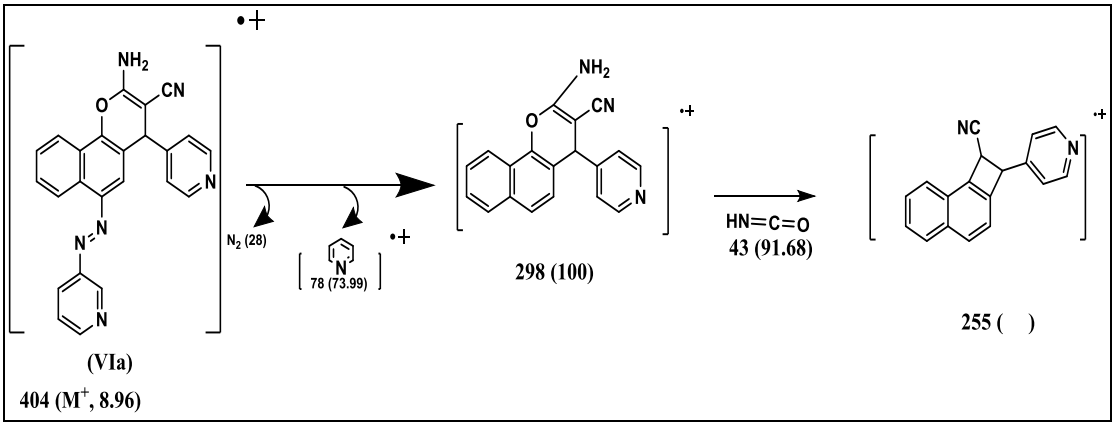
The active vaccine was prepared for experiments by transferring several bacterial rings from cultures farms to the sterilized distilled water (SDW) tubes test that were stirred and diluted with sterile distilled water to achieve a corresponding visual density of 2.0 x10^5 spore/ml. inoculum of 0.1 % suspension was swabbed uniformly and the inoculum was allowed to dry for 5 minutes then the same procedure was followed as described above.

2.3.2.4. Standard references:

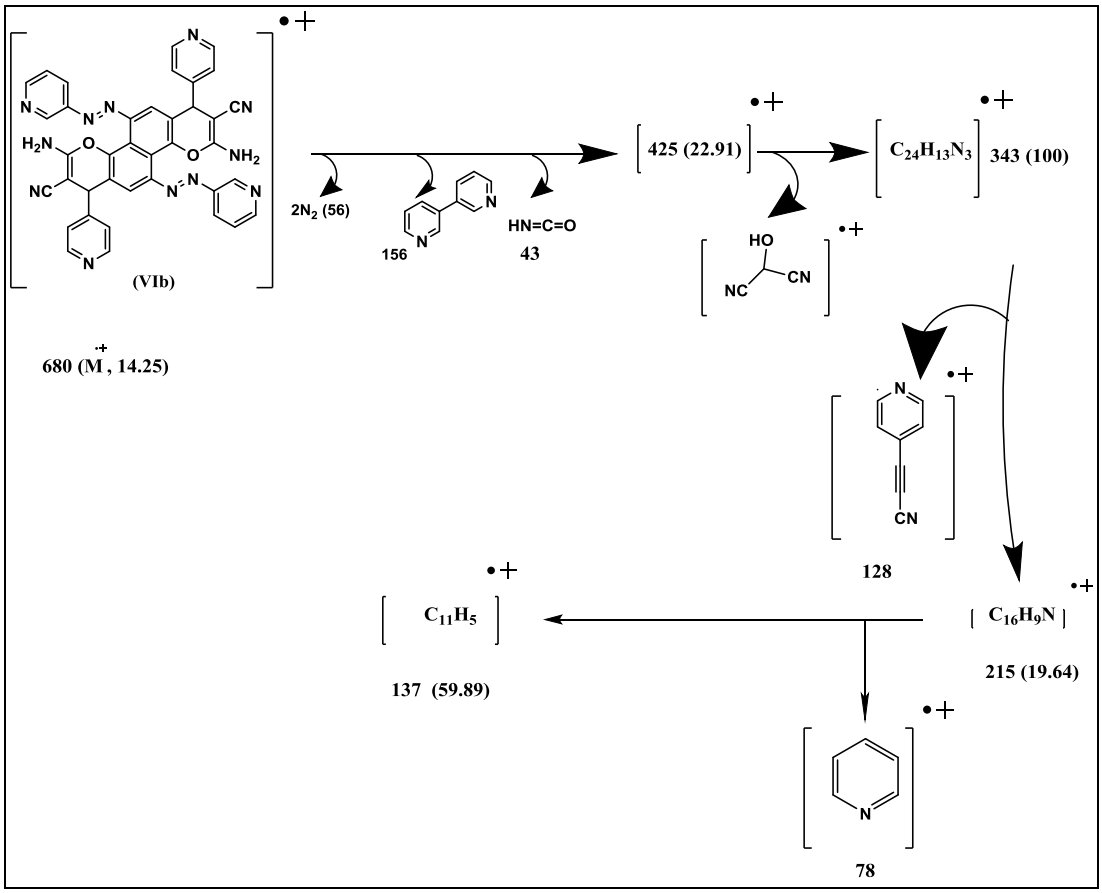
The antibiotic, chloramphenicol was used as standard reference in the case of Gram – negative bacteria, Cephalothin was used as standard reference in the case of Gram – positive bacteria and cycloheximide was used as standard reference in the case of yeasts and fungi.



Scheme 6



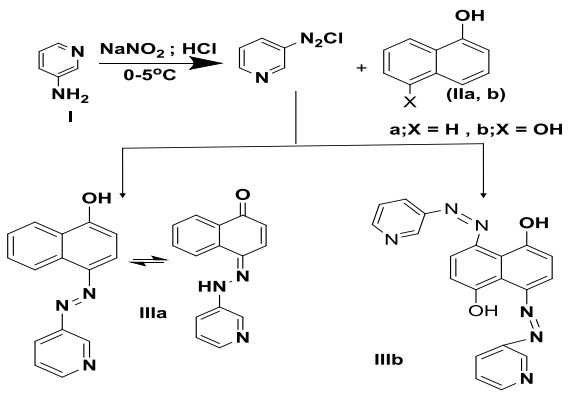
Scheme 7



Scheme 8

3. RESULT AND DISCUSSION

Diazotization of 3-amino pyridine (**I**) and coupling with 1-naphthol and/or 1,5-dihydroxy naphthalene(**IIa, b**) gave the corresponding azo compounds in the form of ((*E*)-4-(pyridin-3-yldiazenyl)naphthalen-1-ol) [15-17] and (4-(*E*)–pyridin–3-yldiazenyl) –8-((*Z*)-pyridin-3-yldiazenyl)naphthalen-1,5-diol) (**IIIa, b**) respectively (scheme 1)



Scheme 1

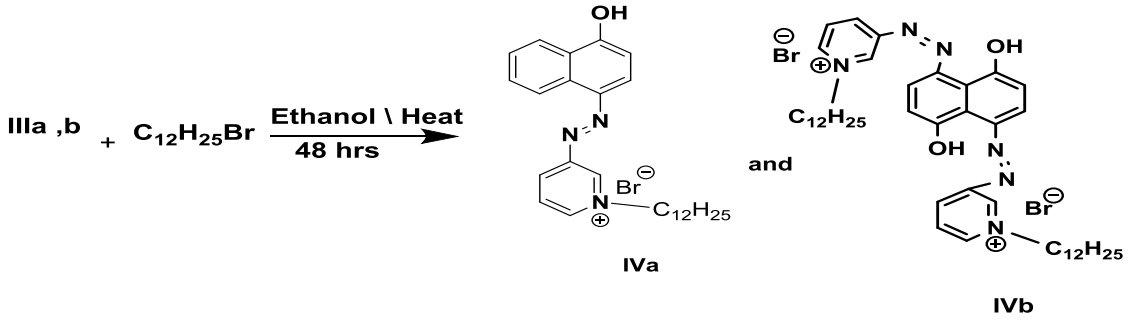
Alkylation of **(IIIa, b)** with dodecyl bromide in boiling ethanol afforded the corresponding mono and di cationic surfactants (**Va, b**) respectively (scheme 2)

Condensation of **((***E***)**–4-(pyridin-3-yldiazenyl) naphthalen-1-ol) and (4-((*E*)–pyridin–3-yldiazenyl)–8-((*Z*)–pyridin–3-yldiazenyl)naphthalene-1,5-diol) (**IIIa, b**) with 4–pyridinylmethylenemalononitrile [18] in ethanol/piperidine afforded the corresponding ((*E*)-2–amino–6-(pyridin–3-yldiazenyl)-4-(pyridin-4-yl)-4H-benzo[h]chromene-3-carbonitrile and 3,9–diamino-5-((*E*)-pyridin-3-yldiazenyl)–11-((*Z*)-pyridin-3-yldiazenyl)-1,7-di(pyridin-4-yl)-1,7–dihydrochromeno[8,7-h]chromene-2,8-dicarbonitrile(**VIa,b**) respectively (scheme 3).

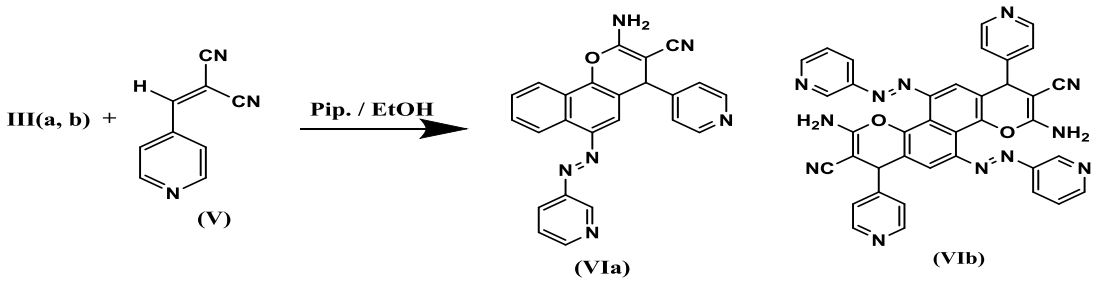
The structures of **VIa, b** has been assigned as reaction product on the basis of spectral data. These data were in assignment with obtained structures. The IR (ν_{max}, cm^{-1}) spectrum of **VI**a displayed absorption at 3380.3 (br) and 2193.5 corresponding to NH_2 and CN groups. Its ^{1}HNMR spectrum exhibited C-H signal at 6.998, NH_2 at 7.074 – 7.125 and complex pattern at **δ** 7.253 – 9.179 ppm region owing to aromatic of pyridine protons. Its mass spectra

showed molecular ion peak at m/z= 404(M^+, 8.96%) together with base peak at m/z= 298 (scheme 7). The IR spectrum (νmax, cm^{-1}) of **VIb** showed absorption NH_2 at 3430.1 (br) and CN at 2192.2 cm^{-1}. Its ^{1}HNMR (**δ** ppm): 6.4 (S, 2H), 6.925(br, $2NH_2$), two doublet at 6.972, 6.99, 7.011 (J_1= 8.8 H_z, J_2= 7.2 H_z) 7.182, 7.272, 7.272 (br) and set of multiplets at 7.378 – 8.80 for pyridine protons as two singlet signals at 9.06, 9.12 for naphthalene protons. Its mass showed (m/z, %) at 680 (14.25) (M^+, $M^{+1)}$ together base peak at 343 (scheme 8)

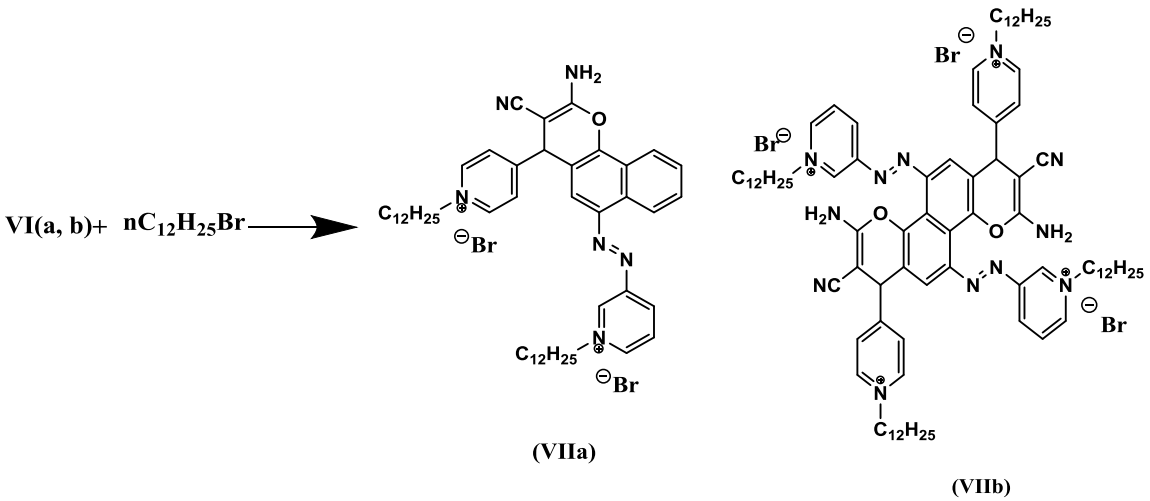
Quaternization of benzo[h] chromene derivatives (**VIa, b**) with dodecyl bromide was successful and corresponding 4,6-di(1-dodecylpyridinium)-4H-benzo[h]chromene and 1,5,7,11-tetra(1-dodecylpyridinium)-1,7-dihydrochromeno[8,7-h]chromine derivatives **VIIa, b** was obtained respectively (Scheme 4). The structures of dicationic and tetracationic pyridine compound **VIIa, b** was supported by by IR (ν_{max}, cm^{-1}) for **VIIa** 3415.79 (NH_2), 2195.78 (CN) and for **VIIb** 3385.03 (NH_2), 2194.4 (CN) and ^{1}HNMR (**δ** ppm): for **VIIa**, displayed the presence of singlet signal at



Scheme 2



(Scheme 3)



Scheme 4

4.7106 ppm attributed to H- 4 protons and broad signal at 6.6449 – 6.6607 ppm for the amino protons. Also,[1]HNMR for **VIIb** showed the appearance of two signalet signals at **δ** 4.4103 and 4.6304 ppm due to 2C-H at position 1,7 and broad signal at 6.8761 ppm due to amino protons in addition to singlet signals at 7.066–7.1945 attributable to aromatic protons at positions besides aliphatic and pyridinium protons

UV-Visible (Table 1; fig. 1)

The absorption maxima (λmax) of the dyes show one of them in the UV range due to (π–π*) transition of C=C in the aromatic moiety and another absorption maxima, lies in the visible region due to (π–π*) of azo linkage N=N of dyes. There is bathochromic shift in case of **IIIa**, **IIIb**, and **VIa** to **VIb** the presence of two hydroxyl groups in dis azo dye. It was found that highest bathochromic shift is shown in case of **IVa** to **IVb** and in case of **VIIa** to **VIIb** which may be attributed to the electron releasing capacity of diol and from monocationic to dicationic and from dicationic to tetracationic dyes.

Biological activity (table 2)

The results obtained indicated that compound **IVa** showed maximum activity (mean zone diameter mm) 43 toward *Candida albicans* (ATCC 10231), while compound **IVb** shows mean zone diameter 40 mm and for derivative **VIIb**, 36 while compound **VIIa** has the same value of control (cyclohexamide). The tested compounds show lower the effect than the control for Gram-positive, Gram-negative bacteria and the compound **VIb** showed no effect. Thus, it is obvious that the monocationic dye **IVa** exhibit higher effect than dicationic dye **IVb** and tetracationic dye contains fused dihydrochromene[8, 7-h]chromene **VIa, VIIb** than dicationic dye containing benzo[h]chromene, **VIIa** nucleus against *Candida albicans* (ATCC 10231).

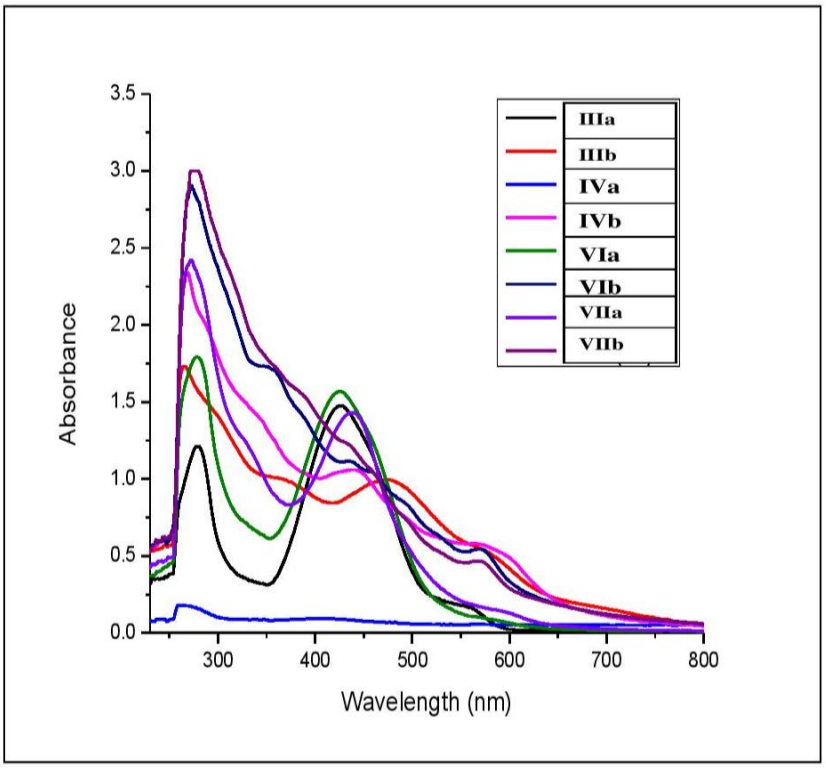
The promising results indicate that hydrophilic balance of the cationic surfactant (**IVa, b** and **VIIb**) has a key role in biological efficiency against *Candida albicans*. Since the azo and carbonyl group which has electron withdrawing effect to positive nitrogen in pyridinium, lead to a more positive quaternary nitrogen atom , which increases the affinity to *Candida albicans* c.f. Table 2.

4. CONCLUSION

Anew naphthol azo dyes (**IIIa, b**) were synthesized and underwent cyclic condensation with 2-(Pyridin-4-ylmethylene)malononitrile (**V**) to give the corresponding benzo[h]chromene and dihydrochromene[8,7-h]chromene derivatives (**VIa, b**). The macromolecule surfactants (**IVa, b**) and (**VIIa, b**) were prepared. The antimicrobial activities were also studied. The cationic dyes (**IVa, b**) and tetracationic dye (**VIIa**) gave promising results against *Cadida albicans*.

compounds	λ nm	ε $M^{-1}cm^{-1}$	compounds	λ nm	ε $M^{-1}cm^{-1}$
IIIa	279	12110	**VIa**	278	17920
	427	14740		426	15670
	565	1490			
IIIb	266	17290	**VIb**	273	29050
	367	9490		347	17330
	476	9430		434	11140
	584	4980		570	
IVa	260	1810	**VIIa**	272	24220
	412	920		437	14300
Ivb	268	23390	**VIIb**	272	30000
	440	10590		567	4670
	563	5820			

UV-Vis spectra of compounds (Table 1)



UV-Vis spectra of compounds **(fig. 1)**

Mean* of zone diameter , nearest whole mm.						
Sample	Gram - positive bacteria		Gram - negative bacteria		Yeasts and Fungi**	
	Staphylococcus aureus (ATCC 25923)	*Bacillus subtilis* (ATCC 6635)	*Salmonella typhimurium* (ATCC 14028)	*Escherichia coli* (ATCC 25922)	*Candida albicans* (ATCC 10231)	*Aspergillus fumigatus*
IIIa	-	-	-	12	8	-
IIIb	-	-	9	14	-	-
VIa	14	16	9	16	18	-
VIb	-	-	-	-	17	-
IVa	23	23	12	24	43	12
IVb	27	24	11	26	40	-
VIIa	18	20	11	23	35	-
VIIb	29	27	22	21	36	-
Control #	35	35	36	38	35	37

Antimicrobial activity of prepared compound (Table 2)

* = Calculate from 3 values. ** = identified on the basis of routine cultural, morphological and microscopical characteristics.

– = No effect. #: Chloramphencol in the case of Gram-positive bacteria, Cephalothin in the case of Gram-negative bacteria and cycloheximide in the case of fungi.

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الملخص العربى

استخدام تكاثف مايكل لتشييد جزيئات كبيرة ذات نشاط سطحى من الآزونافثول والمتوقع لها نشاط ضد الميكروبات

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تم تشييد مشتقات ٤-(بيريدين-٣-يل ديازنيل) نافثالين -١-ول وكذلك ٤,٨- ثنائى -(بيريدين-٣-يل ديازنيل) نافثالين- ١,٥- دايول (**IIIa, b**) . تم تكاثف مركبات (**IIIa, b**) مع مشتق ٢-(بيريدين-٤- يل مثيلين) مالونو نيتريل (**V**) تحت ظروف مايكل حيث اعطت مشتقات بنزو [h] كرومين ، ثنائى هيدرو كرومين [8,7-h] كرومين(**VIa, b**). تم تشييد مشتقات كاتيونية ذات نشاط سطحى وذلك بتفاعل (**IIIa, b**) و(**VIa, b**) مع مشتق دوديسيل بروميد حيث تكونت الكاتيونات المقابلة **IVa,IVb,VIIa,VIIb** على التوالى و لقد تم إثبات التراكيب الكيميائية للمركبات المحضرة بإستخدام الطرق الطيفية المختلفة مثل طيف الأشعة تحت الحمراء و الرنين النووى المغناطيسى لذرة الهيدروجين و طيف الكتلة و طيف الأشعة الفوق بنفسجية ثم دراسة تأثيرها البيولوجى كمضادات للكائنات الدقيقة حيث اتضح ان الكاتيونات (مركبات **IVa,IVb, VIIb**) نتائج ممتازة كمضاد لفطر الكانديدا البيكانز