Synthesis, Identification and Surface Active Properties of Some Nonionic Surfactants Containing Quinazolinone Ring.

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Abstract: This research includes synthesis of new heterocyclic derivatives of quinazolinone and studying the possibility for their application as surfactants. The preparation process started by the reaction of pentadecanoyl chloride with anthranilic acid gave 2-pentadecyl-4H-benzo[3,1]oxazin-4-one [1] which was used as starting material to synthesis some heterocyclic compounds by a reaction with nitrogen nucleophiles. Compound [1] as starting material reacted by three ways. The first way react Compound [1] with semicarbazide, thiosemicarbazide and phenylsemicarbazide in pyridine as solvent to obtained [1-(4-oxo-2-pentadecylquinazolin-3(4H)-yl) urea [2], thiourea [3], phenylthiourea [4] respectively]. The second way include the reaction of Compound [1] with 99% hydrazine hydrate to produce 3-amino-2-pentadecylquinazolin-4(3H)-one [5], then converted to amino derivatives [6-8] by the reaction of Compound [5] with different halogenated compounds such as (benzoyl chloride, acetyl chloride and chloro acetyl chloride ) in DMF and pyridine as catalyst. The third way include the reaction of compound [1] with different substituted amine and amide compounds (thiourea, hydroxylamine hydrochloride, glycine, ammonium acetate and phenyl hydrazine) respectively to obtain derivatives of quinazoline [9-14]. The produced compounds [2,4,5,7 and 12] react with propylene oxide in different moles (n=3, 5 and7) to yield novel groups of nonionic compounds having a function as surface active agents. The surface active properties like surface tension and interfacial tension, wetting time, cloud point, emulsion stability and CMC of these compounds were measured and showed a pronounced surface activity, good emulsifying properties and highly foaming in some of these compounds. Newly synthesized compounds were identified via spectral methods; their [FTIR and some of them by $^1$HNMR, $^{13}$C-NMR] and measurements of some of its physical properties.

Keywords: Quinazolinone derivatives, surface active agent, nonionic surfactant,
ether. The product was heated for 4 hrs under reflux in acetic anhydride then concentrated under vacuum. Physical properties of compound [1] are listed in Table (1).

2.1.2 Synthesis of 1-(4-oxo-2-pentadecylquinazolin-3(4H)-yl) urea [2], thiourea [3], phenyl thiourea [4]:
To a solution of compound [1] (3.57gm, 0.01mole) in 30ml pyridine, (semi carbazide, thiosemicarbazide and phenylsemicarbazide) respectively (0.01 mole) were added and the reaction mixture was heated under reflux for (6-8hrs), and poured into cold diluted HCl. the crude solid product that separated was filtered off, washed with water, dried and recrystallized from ethanol to give crystals. Physical properties of compounds [2-4] are listed in Table (1).

2.1.3 Synthesis of 3-amino-2-pentadecylquinazolin-4(3H)-one [5]:
Compound [1] (3.57gm, 0.01mole) in (10 ml) dimethylformamide (DMF) as solvent; excess of 99% hydrazine hydrate in ethanol (30ml) was added to the reaction mixture and reflexed for (6 hrs.). Finally, the reaction mixture cooled to room temperature, poured on ice-cold water, stirred and filtered. The precipitate was recrystallized from ethanol to give off white crystals. Physical properties of compound [5] are listed in Table (1).

2.1.4 Synthesis of N-(4-oxo-2-pentadecylquinazolin-3(4H)-yl) benzamide [6].
A solution of compound [5] (3.68 gm, 0.01mole) in dry acetone (40ml) containing a catalytic amount of pyridine (3drops), (1.2ml, 0.01mole) benzoyl chloride was added in drop wise maintaining the temperature near 8° C for (1 hrs.). The reaction mixture was refluxed for another (3hrs.), and then cooled at room temperature. The separated solid product was filtered off and recrystallized from ethanol. Physical properties of compound [6] are listed in Table (2).

2.1.5 Synthesis of N-(4-oxo-2-pentadecylquinazolin-3(4H)-yl) aceticamide [7].
A solution of compound [5] (3.68 gm, 0.01mole) in dry acetone (40ml) and acetyl chloride (0.8ml, 0.01mole) in pyridine (20 ml) was refluxed for (5 hrs.). The cold mixture was poured into ice/water. The separated solid was filtered off, dried and recrystallized from benzene-hexane. Physical properties of compound [7] are listed in Table (2).

2.1.6 Synthesis of N-(4-oxo-2-pentadecylquinazolin-3(4H)-yl)-2-chloro aceticamide [8].
A mixture of compound [5] (3.68 gm, 0.01mole) in dry acetone and chloroacetyl chloride (0.8ml, 0.01 mole) was refluxed for 6 hrs. The mixture was then poured into cold water (30 ml) and the precipitated solid was filtered off, dried and recrystallized from benzene. Physical properties of compound [8] are listed in Table (2).

2.1.7 Synthesis of N-(4-oxo-2-pentadecylquinazoline-3(4H)-yl) carbethioamide [9], carboxamide [10].
Compound [1] (3.57gm, 0.01mole) in (15 ml) dimethylformamide (DMF) as solvent; was refluxed with (0.8gm, 0.01 mole) (thiourea and urea) respectively in (40 ml) dry acetone containing a catalytic amount of pyridine (3drops), for (10hrs.). The reaction mixture cooled to room temperature, poured on ice-cooled water, the formed precipitate was filtered and recrystallized from ethanol. Physical properties of compounds [9] and [10] are listed in Table (3).

A solution of compound [1] (3.57gm, 0.01mole) in in (20 ml) dimethylformamide (DMF) and hydroxylamine hydrochloride (0.7gm, 0.01mole) in pyridine (25ml) was refluxed for (16hrs.). The reaction mixture was cooled and poured into a crushed ice water. The solid that separated was filtered off, washed with water, dried and then recrystallized from dioxane to give the required products. Physical properties of compound [11] are listed in Table (3).

2.1.9 Synthesis of 2-(4-oxo-2-pentadecylquinazolin-3(4H)-yl)acetic acid [12].
To a solution of compound [1] (3.57gm, 0.01mole) in (25ml) dimethylformamide (DMF), (0.75gm, 0.01mole) glycine in dry pyridine (20ml) was added and the heated under reflux for (4hrs.) then left to cool at room temperature. The reaction mixture was poured into ice/HCl to reveal the solid product, which was filtered off, washed with water, dried and recrystallized from ethanol. Physical properties of compound [12] are listed in Table (3).
2.1.10 Synthesis of 2-pentadecylquinazolin-4(3H)one\textsuperscript{(10)[13].}

Compound [1] (3.57gm, 0.01mole) was fused with ammonium acetate (3gm, 0.04mole) heated in an oil bath in temperature (160-170°C) for (2hrs.), then cooled, water is added, the solid product obtained after filtration and recrystallized from methanol. Physical properties of compound [13] are listed in Table (3).

2.1.11 Synthesis of 2-pentadecyl-3-(phenylamino)quinazolin-4(3H)-one\textsuperscript{(10)[14].}

Compound [1] (3.57gm, 0.01mole) and phenyl hydrazine (1.08gm, 0.01mole) were dissolved in absolute ethanol (50ml). This solution was refluxed for (12hrs.). Concentrated, cooled and poured into crushed ice and filtered. The solid thus obtained was purified by recrystallization from ethanol. Physical properties of compound [14] are listed in Table (3).

2.2 Conversion of the prepared compounds to nonionic surfactants\textsuperscript{(20)}:

They are prepared by the addition of (n) moles of propylene oxide (n = 3, 5, 7) to one mole of synthesized compounds (2, 4, 5, 7 and 12) by mixed with KOH (0.1 wt %) The mixture was heated up to 130°C and a rapid stream of N\textsubscript{2} gas was passed continuously for about 20 min to exclude the oxygen and water vapors. And the product was characterized by FT-IR spectrophotometer. The addition of propylene oxide gave a mixture of propenoxylated products whose structures were shown through IR spectra to be two broad bands at 1100 and 950 cm\textsuperscript{-1} and by \textsuperscript{1}HNMR spectra showed δ=(3.2 – 3.7) ppm.

2.3 Determination of the performance properties

1. Surface and interfacial tensions:

Surface and interfacial tensions were measured with a Du-Nouy tensiometer (Kruss, Type 8451) using an aqueous solution of surfactants (0.1 wt %) at room temperature (25°C) \textsuperscript{(21)}.

2. Cloud point:

Cloud point was determined by gradually heating a surfactant solution (1.0 wt %) in a temperature controlled bath, and recording the temperature at which the clear, or nearly clear solutions become definitely turbid. The reproducibility of this temperature was checked by cooling the solutions until they became clear again \textsuperscript{(21)}.

3. Wetting time:

Wetting time was determined by immersing a sample of cotton fabric in a (1.0 wt %) aqueous solution of surfactants \textsuperscript{(21)}.

4. Foaming properties:

Foaming properties were measured according to El-Sukkary et al (1987). In this procedure a 25 ml solution (1.0 wt %) was shaken vigorously for 10 seconds in a 100 ml graduated cylinder with glass stopper at 25°C. The solution was allowed to stand for 30 seconds, and then, the foam height was measured \textsuperscript{(22)}.

5. Emulsification stability:

Emulsification stability was prepared from 10 ml of a 20 mmol aqueous solution of surfactant and 5 ml of toluene at 40°C. Emulsion stability was determined as the time it took 9 ml of an aqueous layer to separate from the emulsion once shaking had stopped \textsuperscript{(23)}.

6. Determination of CMC of Surfactant by Surface Tension Method:

Surface tension measurements were done by applying du Nouy ring method using Du-Nouy (Kruss, Type 8451) tensiometer and platinum ring at room temperature (25°C). Stock solution of 5% (v/v) of synthesized nonionic surfactant in aquea was prepared in 1 L volumetric flask. First of all, the surface tension of pure water in a glass vessel was noted. The surface tensions were measured by a dilution method in which a 5% (v/v) of synthesized nonionic surfactant stock solution was gradually diluted by deionized water. After each dilution the solution was stirred for 30 s, and then left for 2 min before reading the surface tension value. All surface tension measurements were done at least three times or up to obtaining repeated value. The CMC values were determined by plotting surface tension versus concentrations of surfactant \textsuperscript{(23)}.

Table (1) : Physical properties and FT-IR spectral data cm\textsuperscript{-1} of the synthesized compounds (1-5).

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DOI: 10.9790/5736-1005013746 www.iosrjournals.org 39 |Page
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<th>No.</th>
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<th>v(\text{C-H}) \text{aliph.}</th>
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<th>v(\text{C=C}) \text{aromatic}</th>
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Table (2) : Physical properties and FT-IR spectral data cm\(^{-1}\) of the synthesized compounds (6-8).

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<th>Color</th>
<th>v(\text{C-H}) \text{arom.}</th>
<th>v(\text{C-H}) \text{aliph.}</th>
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Table (3) : Physical properties and FT-IR spectral data cm\(^{-1}\) of the synthesized compounds (9-14).

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<th>Color</th>
<th>v(\text{C-H}) \text{arom.}</th>
<th>v(\text{C-H}) \text{aliph.}</th>
<th>v(\text{C=O})</th>
<th>v(\text{C=C}) \text{aromatic}</th>
<th>Others</th>
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III. Results And Discussion

The synthetic sequences for preparation of series new 2-pentadecyl quinazolinone compounds by reaction of pentadecanoyl chloride with anthranilic acid gave 2-pentadecyl-4H-benzo[3,1]oxazin-4-one [1] which was used as starting material to synthesis some quinazolinone compounds by a reaction with nitrogen nucleophiles (e.g., semicarbazide, thiosemicrabazide, phenylsemicarbazide and hydrazine hydrate) are show in scheme(1).

![Scheme (1): Synthesis of new derivatives of quinazolinone (1-5)](image)

Physical properties of compounds [2, 3, 4 and 5] are listed in Table (1). FTIR spectrum of prepared compounds [2, 3, 4 and 5] showed appearance of absorptions at (3425-3396) cm\(^{-1}\) and at (3286-3226) cm\(^{-1}\) of vNH\(_2\) asym. and sym. respectively. (3358, 3298) cm\(^{-1}\) of vNH group, Also it showed shift in the vC=O band from (1764 cm\(^{-1}\)) of cyclic ester to (1690- 1645 cm\(^{-1}\)) of amide. FTIR spectral data are listed in Table (1). \(^1\)H-NMR spectrum of compound [3] showed triplet signal at \(\delta=\) (0.85) ppm due to (-CH\(_3\)) protons, multiplet signal at \(\delta=\) (12 - 2.66) ppm due to (C-H) protons of long chain 14CH\(_2\), signals at \(\delta=\) (7.11 -7.60) ppm due to aromatic rings protons, singlet signal at \(\delta=\) (8.09- 8.51) ppm due to (-NH\(_2\)) protons, and singlet signal at \(\delta=\) (11.1) ppm due to (N-H) proton as shown in Table (4). \(^1\)C-NMR spectral data of compound [3] showed signals at \(\delta=\) (22-27) ppm, \(\delta=\) (122-133) ppm, \(\delta=\) (147) ppm, \(\delta=\) (162.29) ppm and \(\delta=\) (174.5) ppm belong to long chain (C\(_1\),H\(_2\)), (C-aromatic), (C=N) imine, (C=O) ester and (C=S) respectively. \(^1\)CNMR spectral data of compound [3] is listed in Table (5).

![Table (4) \(^1\)H-NMR spectral data (ppm) for selected compounds.](image)
9

\[ \begin{align*}
\text{C-NMR spectral data (ppm) for selected compounds.} \\
\text{Com. No} & \quad \text{structure} & \quad \text{13C-NMR Spectral data (ppm)} \\
1 & \quad \text{\includegraphics[width=0.2\textwidth]{structure1.png}} & \quad 22-27 (\text{Long chain } C_2); 122(C_1); 127(C_2)\text{134}(C_3); 147(C_4); 168(C_5); 162.4(C_6). \\
3 & \quad \text{\includegraphics[width=0.2\textwidth]{structure2.png}} & \quad 22-27 (\text{Long chain } C_2); 123(C_1); 128(C_2); 133(C_3)\text{147}(C_4); 162.92(C_5); 174.5(C_6). \\
6 & \quad \text{\includegraphics[width=0.2\textwidth]{structure3.png}} & \quad 22-27 (\text{Long chain } C_2); 122(C_1); 126(C_2); 132(C_3); 145 ( C_5 \text{ and } C_6 ); 146(C_4); 162 ( C_3 ); 168 ( C_4 ). \\
7 & \quad \text{\includegraphics[width=0.2\textwidth]{structure4.png}} & \quad 22-27 (\text{Long chain } C_2); 58 (C_4); 121(C_1); 128(C_2); 133.4(C_3); 145(C_4); 154(C_5); 161 ( C_3 ); 169 ( C_4 ). \\
9 & \quad \text{\includegraphics[width=0.2\textwidth]{structure5.png}} & \quad 17-27 (\text{Long chain } C_2); 121(C_1); 125(C_2); 134(C_3); 148(C_4); 164 ( C_5 ); 182 ( C_6 ). \\
\end{align*} \]

Compound [5] allowed to react with halogenated compounds such as benzoyl chloride, acetyl chloride and chloro acetyl chloride by nucleophilic substitution reaction to synthesize newly derivatives of quinazolinone compounds [6], [7] and [8]. This reaction carried out in presence of catalytic amount of pyridine and DMF. The synthetic sequences for preparation of new N(4-oxo-2-pentadecylquinazolin-3(4H)-yl) benzamide [6], acetamide [7] and chloro acetamide [8] was performed as outlined in scheme (2).

Scheme (2)

Physical properties of compounds [6], [7] and [8] listed in Table (2). FTIR spectrum of compound [6], [7] and [8] showed disappearance of ν (NH₂) absorption band at 3496 and 3245 cm⁻¹ and appearance of characteristic absorption bands at ν cm⁻¹ 3329 for ν (N-H), 3030 for C-H aromatic; 2910 and 2850 for C-H aliph
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1689 for C=O (amide); 1604 for C=O (amide) of compound[6]; 1697 for C=O (amide) of compound[7]; and 1685 for C=O (amide) of compound[8]. νC=O (1604 - 1635) cm⁻¹. ¹H-NMR spectrum data of compound [6] showed triplet signal at δ= (0.84) ppm due to (-CH₃) protons, multiplet signal at δ= (1.22 – 2.50) ppm due to (C-H) protons of long chain 14CH₂, signals at δ= (6.51 -7.84) ppm due to aromatic rings protons, singlet signal at δ= (9.10) ppm due to (N-H) proton. ¹H-NMR Spectral data of compounds [6] are listed in Table (4). ¹³C-NMR spectrum of compound [6] showed signals at δ= (22-27) ppm, δ= (121 -134) ppm, δ= (148) ppm, δ= (164.07) ppm and δ= (168) ppm belong to long chain (C₁₄H₂₉), (C-aromatic), (C=N) imine and (C=O) ester respectively. ¹³C-NMR spectral data of compound [6] are listed in Table (5). While ¹H-NMR spectrum data of compound [7] showed triplet signal at δ= (0.83) ppm due to (-CH₃) protons, multiplet signal at δ= (1.27 – 2.4) ppm due to (C-H) protons of long chain 14CH₂, singlet signal at δ= (3.47) ppm due to (O=C-CH₃) proton, signals at δ= (6.51 – 7.84) ppm due to aromatic rings protons. ¹H-NMR Spectral data of compounds [7] are listed in Table (4). ¹³C-NMR spectrum of compound [7] showed signals at δ= (22-27) ppm, δ= (58) ppm, δ= (128-134) ppm, δ= (145) ppm, δ= (154) ppm, δ= (161) ppm and δ= (169) ppm belong to long chain (C₁₄H₂₉), (O=C-CH₃), (C-aromatic), (C=N) imine, (C=O) ester (C=O-CH₃) respectively. ¹³C-NMR spectral data of compound [7] are listed in Table (5). The syntheses of different new quinazolinone compounds by reaction of compound [1] with different substituted amine compounds. These different synthesized compounds that are presented in Scheme (3).

Scheme (3)

Reaction of compound [1] with thiourea and urea in presence catalytic amount of pyridine afforded the product N-(4-oxo-2-pentadecylquinazoline-3(4H)-yl) carbothioamide [9], carboxamide [10] respectively. Physical properties of compounds [9] and [10] are listed in Table (3). FTIR spectrum of prepared compounds [9-10] showed appearance of absorptions at (3440-3320) cm⁻¹, (3040) cm⁻¹, (2960, 2860) cm⁻¹, (1699 and 1677) cm⁻¹ due to ν N=O, ν C=O for amide, ν C=O for amide, ν C=O for amide, ν C=O for amide, ν C=O for amide, ν C=O for amide, ν C=O for amide, ν C=O for amide, ν C=O for amide, ν C=O for amide, ν C=O for amide, ν C=S of compound [9]. In the other hand¹H-NMR spectra data of compound (9) δ ppm in DMSO-d₆, solvent showed singlet signal at δ= (0.85) ppm due to (-CH₃) protons, multiplet signals at δ= (1.18-2.38) due to long chain (14CH₂) protons, signals at δ= (6.51-7.11) ppm due to aromatic ring protons and δ= (8.5-9.14) ppm due to (-NH₂) protons. As listed in table (4). ¹³C-NMR spectrum data of compound [9] showed signals at δ= (17-27) ppm, δ= (121-134) ppm, δ= (148) ppm, δ= (164.07) ppm and δ= (182.3) ppm belong to long chain (C₁₄H₂₉), (C-aromatic), (C=N), (C=O) amide and (C=S) respectively. ¹³C-NMR spectral data of compound [9] is listed in Table (5). the synthesized quinazolinone derivatives bearing an active hydrogen atom such as (-NH, -OH, -COOH and - NH₂) and the structure of a surface active agent requires a hydrophilic component. This is accomplished through the condensation of propylene oxide with different moles, (3, 5 and 7) moles in the presence of KOH as catalyst at any active hydrogen atom of synthesized compounds [2, 4, 5, 7 and 12] which contain one or more active hydrogen atoms to yield novel groups of nonionic surfactant (2(a-c), 4(a-c), 5(a-c), 7(a-c) and 12(a-c)) respectively that showed in scheme (4).
The study of the surface active properties of the polypropenoxy compounds has been done in an aqueous solution (1 wt%, pH = 7) at 25°C. The surface activity and related properties of the synthesized compounds including surface tension and interfacial tension, wetting time, cloud point, foaming height, emulsification properties and CMC are given in Table (6).

The surface and interfacial tension of the synthesized compounds are shown in Table (6). It can be observed that the nonionic surfactants have pronounced surface activity. The surface and interfacial tension increase with an increase in the number of propylene oxide units added to the molecule.14

A very important factor in making the most efficient use of nonionic surfactants in an aqueous system is an understanding of the property called cloud point. All synthesized compounds showed high cloud points which gave performance in hot water and it was increased by increasing the number of the propoxy group.

All the synthesized compounds showed a decrease in wetting time with an increase in the number of propylene oxide units in the molecule. Moreover, the presence of propylene oxide in different moles caused a reduction in wetting time, i.e. improving their wetting properties which make widely applicable in the textile industry.15

Nonionic surfactants containing an aromatic ring such showed poor foaming properties. The foam height of the prepared surfactants increases with an increase in the number of propylene oxide units per molecule of surfactant. The low foaming power could have an application in the dyeing auxiliary industry.

Emulsification is one of the most important Properties of surfactants. In many textile processes such as scouring and dyeing, it is necessary to introduce surfactants into the bath to remove oily impurities from the fibers. On the other hand, nonionic surfactants with good emulsion stability have been used in such fields as, shampoos, cosmetics, emulsion paints and the textile industry. The results in Table (6) showed that the emulsion stability increases by decreasing the number of propylene oxide units.
Table (6) surface properties of synthesized compounds (2(a-c), 4(a-c), 5(a-c), 7(a-c) and 12(a-c))

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<th>Interfacial tension (dyne/cm) 0.1wt%</th>
<th>Cloud point C 0.1wt%</th>
<th>Wetting time (Sec) 0.1wt%</th>
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<td>93</td>
<td>120</td>
</tr>
<tr>
<td></td>
<td>7</td>
<td>35</td>
<td>14</td>
<td>14</td>
<td>81</td>
<td>21</td>
<td>87</td>
<td>135</td>
</tr>
</tbody>
</table>

The reaction condition of propenoxilated compounds are illustrated in table (7).

Table (7) reaction condition of propenoxilated compounds

<table>
<thead>
<tr>
<th>compd</th>
<th>Catalyst, wt%</th>
<th>Temp C</th>
<th>Propenoxylated compounds</th>
<th>Yield%</th>
<th>Degree of propenoxylation</th>
<th>color</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>KOH, 0.01wt%</td>
<td>130</td>
<td>2(a-c)</td>
<td>55-60</td>
<td>3, 5 and 7</td>
<td>brown cream</td>
</tr>
<tr>
<td>4</td>
<td></td>
<td></td>
<td>4(a-c)</td>
<td>60-65</td>
<td>Yellow White</td>
<td>Pale brown cream</td>
</tr>
<tr>
<td>5</td>
<td></td>
<td></td>
<td>5(a-c)</td>
<td>70-74</td>
<td>Yellow White</td>
<td>Cream</td>
</tr>
<tr>
<td>7</td>
<td></td>
<td></td>
<td>7(a-c)</td>
<td>63-68</td>
<td>Yellow White</td>
<td>Pale brown cream</td>
</tr>
<tr>
<td>12</td>
<td></td>
<td></td>
<td>12(a-c)</td>
<td>72-75</td>
<td>Yellow White</td>
<td>White</td>
</tr>
</tbody>
</table>

1H-NMR spectra data of compound [4(a-c) and 5(a-c)] showed disappearance peaks –NH of compound [4] and –NH₂ of compound [5]. And appearance multiplate signal at δ= (3.2 – 3.7) ppm due to the protons of propenoxy groups (-CH₂-CH-(CH₃)-O)- beside other characteristic bands as listed in table (8) and shown in Figure (1 and 2).

Table (8): ¹H-NMR spectral data δ ppm for compound [4(a-c) and 5(a-c)]

<table>
<thead>
<tr>
<th>Comp. No.</th>
<th>Structures</th>
<th>¹H-NMR Spectral data(δ ppm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>4(a-c)</td>
<td><img src="image" alt="4(a-c) Structure" /></td>
<td>δ 0.83 (1H, CH₃), δ 1.8 – 2.38 (m, 28H, 14CH₂), δ 3.2-3.7 (m, (-CH₂-CH(CH₃)-O)-) δ 7.11 -7.9(m, 9H, ArH)</td>
</tr>
<tr>
<td>5(a-c)</td>
<td><img src="image" alt="5(a-c) Structure" /></td>
<td>δ 0.85 (1H, CH₃), δ 1.8 – 2.38 (m, 28H, 14CH₂), δ 3.2-3.7 (m, (-CH₂-CH(CH₃)-O)-) δ 7.11 -8.3(m, 4H, ArH)</td>
</tr>
</tbody>
</table>

Figure (1) ¹H-NMR spectrum of compound [5(a-c)]
Synthesis, Identification And Surface Active Properties Of Some Nonionic Surfactants Containing

Figure (2) $^1$H-NMR spectrum of compound [4(a-c)]

References


