Mesomorphic properties of liquid crystalline compounds with chalconyl central linkage in two phenyl rings

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ABSTRACT

In order to investigate the influence of the central linking group and the effect of flexibility on mesomorphism, we have synthesised a newly homologous series 3-(3-butoxyphenyl)-1-(4-n-alkoxy phenyl) prop-2-en-1-one (series-I) consisting of 13 homologues C$_7$–C$_{18}$. In the present series, mesophase commences from the C$_8$ homologue. C$_1$–C$_5$ homologues did not exhibit liquid crystalline (LC) property, while C$_6$–C$_{12}$ homologues exhibited an enantiotropic nematic phase and the rest of the homologues C$_{14}$–C$_{18}$ displayed monotropic SmC and nematic mesophase. The transition temperatures of the synthesised compounds were determined by an optical polarising microscopy equipped with a heating stage. All newly synthesised compounds were confirmed by $^1$H-NMR, $^{13}$C-NMR, IR and elemental analysis.

1. Introduction

Liquid crystalline (LC) [1] property of a substance is a unique property, which flows on the surface like a liquid and possesses optical properties like crystals. Therefore, such substances of thermotropic or lyotropic varieties are neither fully crystalline nor fully liquid. The chalconyl derivatives, due to their geometrical shapes, may exhibit LC properties with lower thermometric transitions and bioactivity. The aims and objectives of this article are to study the effect of the central linking group and the flexibility on the LC properties and behaviours [2–6] as a result of molecular flexibility, keeping the molecular rigidity unaltered throughout a series and changing their flexibility from series to series for the same homologue at constant rigidity. LC substances have proven their ability for LC devices to be operated at room temperature [7–12]. The present investigation will include synthesis and characterisation by analytical, thermal and spectral data. Thermometric data will be derived using an optical polarising microscope (POM) equipped with a heating stage and this will be discussed and interpreted in terms of molecular rigidity and flexibility in relation [8,13–15] to molecular structure geometry, size, polarity, polarisability, etc. The LC properties of the present novel series will be compared with the structurally similar analogous series.

A wide range of chalcone derivatives has been reported to exhibit a broad spectrum of antibacterial, anti-fungal, anti-ulcer, anti-malarial, anti-tumour, anti-cancer, anti-inflammatory and anti-tubercular behaviour. The presence of the α, β-unsaturated functional group in chalcone (–CH = CH-CO-) is responsible for the antimicrobial activity, which can be altered depending on the type of substituents present on the aromatic rings [16–19]. Chalcone (Ar–CH = CH-CO–Ar)-based compounds are important intermediates in the synthesis of many pharmaceuticals. Some of the chalcone derivatives play a vital role in numerous fields such as crystallography [20], LC polymers, dye industries and solar cells [21–23]. They are also utilised in material fields such as nonlinear optics, optical limiting, electrochemical sensing and Langmuir films. π-bond conjugation with chalcones (α, β-unsaturated ketone) leads to a good charge transfer axis, and the aromatic rings act as a tool for a donor and an acceptor [24]. The effect of donor–acceptor strength on the electronic properties of conjugated molecules is a major topic in the molecular design of nonlinear optical materials.

Thus, the objective of this work is to synthesise and study the effect of chalconyl-ester linkage group and geometrical shape on the mesomorphic properties of liquid crystals. Doshi et al. reported chalconyl-ester linking group-based homologues series [25–31]. Previously, our research group also reported homologues series based on chalconyl-ester and chalconyl-vinyl ester central group with reference to two or three phenyl rings, respectively [32–45].
2. Experimental

2.1. Reagents and techniques

For the synthesis of compounds of the homologous series, the following materials were used: 4-hydroxy benzaldehyde (SRL, Mumbai), alkyl bromides (SRL, Mumbai) and 3-hydroxy acetoephoneone (Sigma-Aldrich), which were used without purification. All the solvents were dried and distilled prior to use. Representative homologues of a series were characterised by elemental analysis, FT-IR (cm⁻¹, KBr), ¹H and ¹³C NMR spectra (300 MHz, CDCl₃) using tetramethylsilane as an internal standard. IR spectra were recorded on Perkin-Elmer spectrum GX, and ¹H NMR spectra were recorded on Bruker using CDCl₃ as a solvent. Microanalysis was performed on Perkin-Elmer PE 2400 CHN analyser. Texture images of the nematic phase were determined by the miscibility method (Table 1). Transition temperature (Table 2) and LC properties (textures) were determined using a POM equipped with the heating stage. The compound is sandwiched between a glass slide and a cover slip, and the heating and cooling rate is 2°C.

2.2. Synthesis and method

Alkylation of 4-hydroxy benzaldehyde to give 4-n-alkoxy benzaldehyde was carried out by the reported method [46,47]. 3-n-butoxy acetoephoneone was obtained by the alkylation of 3-hydroxy acetoephoneone by the reported method [46,47]. Thus, the chalconyl homologue derivatives (C) were usually prepared by the established method [48]. The final products were collected and filtered, washed with ethanol solution, dried and purified until constant transition temperatures were obtained using a POM. The synthetic route to the series is mentioned below as Scheme 1. The ¹H and ¹³C NMR spectra of comp.C₁₀ is shown in Figures 1 and 2.

2.3. Reaction scheme

2.4. Analytical data

C₆ (Hexyloxy): IR (KBr): νmax/cm⁻¹ 2914 (C-H str. of alkane), 2842 (C-H str. of -(CH₂)ₙ group of -OC₆H₁₃ alkyl chain, 1640 (C = O str. of carbonyl carbon of chalconyl group), 1604 (C = C str. of alkene in chalcone), 1510, 1543 (C = C str. of aromatic ring), 999 (C-H bending of alkene), 1178 (C-O str. of ether linkage), 1178, 1246 (C-O str. of carbonyl (>CO) group, 972 (trans, -CH = CH-) group, 770 polymethylene (-CH₂)ₙ of -OC₆H₁₃, 675 polymethylene (-CH₂)ₙ of -OC₆H₁₃, IR data confirms the molecular structure of comp.C₆, ¹H NMR: 0.89–0.90 (t, J = 8.0 Hz, 6H, -CH₃ of polymethylene -C₆H₁₃ and -C₆H₉), 1.76 (m, J = 7.1 Hz, 4H, -OC₆H₁₃ and -OC₆H₉), 1.31 (m, J = 7.1 Hz, 4H, -CH₂-CH₂-CH₂-CH₂- of -OC₆H₁₃), 1.31 (q, J = 7.4, 8H, -CH₂-CH₂-), 4.06 (t, J = 7.0 Hz, 4H, -OCH₂-CH₂-), 7.59–8.06 (d, J = 15.1 Hz, 2H, -CH = CH-), 7.43, 7.45, 7.82 and 7.24 (4H, J = 8.1 Hz, second –meta-substituted phenyl ring), 6.94, 7.56 & 7.97 (4H, J = 8.0 Hz, first phenyl ring with alkyl chain). ¹³C NMR (CDCl₃): 161.3, 130.2, 129.3, 120.7, 114.9, 114.1, (Ar-C), 14.1 (-CH₃), 15.25, 31.9, 68.2, 29.6, 25.9, 29.6, 29.3, 22.7 (-CH₂), 145.1, 121.3 (-CH of olefin). elemental analysis: calculated for C₃₂H₃₂O₅: C, 78.94; H, 8.42; O, 12.63%; found: C, 78.88; H, 8.38; O, 12.57%.

C₈ (Octyloxy): IR (KBr): νmax/cm⁻¹ 2914 (C-H str. of alkane), 2842 (C-H str. of -(CH₂)ₙ group of -OC₈H₁₇ alkyl chain, 1660 (C = O str. of carbonyl carbon of chalconyl group), 1604 (C = C str. of alkene in chalcone), 1510, 1543 (C = C str. of aromatic ring), 996 (C-H bending of alkene), 1178 (C-O str. of ether linkage), 1286, 1240 (C-O str. of carbonyl (>CO) group, 972 (trans, -CH = CH-) group, 771 polymethylene (-CH₂)ₙ of -OC₈H₁₇, 782 polymethylene (-CH₂)ₙ of -OC₈H₁₇, IR data confirms the molecular structure of comp.C₈, ¹H NMR: 0.80–0.90 (t, J = 8.0 Hz, 6H, -CH₃ of polymethylene -C₈H₁₇ and -C₈H₉), 1.76 (m, 4H, J = 7.1 Hz, CH₃-CH₂-CH₂-CH₂-CH₂-CH₂- of -OC₈H₁₇, 1.28 (m, J = 7.1 Hz, 8H -CH₂-CH₂-CH₂- of -OC₈H₁₇), 1.31 (q, J = 7.1 Hz, 8H, -CH₂-CH₃ of -OC₈H₁₇), 4.06 (t, J = 7.1 Hz, 4H, -OCH₂-CH₂- of -OC₈H₁₇, -OC₈H₉), 7.59–8.06 (d, d = 15.1 Hz, 2H, -CH = CH-), 7.43, 7.28 & 7.83 (4H, J = 8.0 Hz, -meta- substituted phenyl ring), 6.94 and
Scheme 1. Synthetic route to the series.

Figure 1. $^1$H NMR spectra of the C$^{10}$ homologue.

Figure 2. $^{13}$C NMR spectra of the C$^{10}$ homologue.
7.62 (4H, J = 7.5 Hz, phenyl ring with alkoxy chain), $^{13}$C NMR (CDCl$_3$): 161.3, 130.2, 129.3, 120.7, 114.9, 114.1, (Ar-C), 14.1 (-CH$_3$), 15.25, 31.9, 68.7 (-CH$_2$- bridge), 29.6, 25.9, 29.6, 29.3, 22.7 (-CH$_2$), 145.1, 121.3 (-CH of olefin) elemental analysis: calculated for C$_{27}$H$_{36}$O$_3$: C, 79.41; H, 8.82; O, 11.76%; found: C, 79.36; H, 8.78; O, 11.74%.

C$_{10}$ (Decyloxy): IR (KBr): $\nu_{\text{max}}$/cm$^{-1}$ 2914 (C-H str. of alkane), 2842 (C-H str. of -(CH$_2$)$_n$ group of -OC$_{10}$H$_{21}$ alkyl chain, 1640 (C = O str. of carbonyl carbon of chalconyl group), 1604 (C = C str. of alkenyl in chalcone), 1510, 1543 (C = C str. of aromatic ring), 999 (C-H bending of alkenyl), 1178 (C-O str. of ether linkage), 1288, 1246 (C-O str. of carbonyl (>CO) group), 964 (trans, -CH = CH-) group, 771 polymethylene (-CH$_2$-) of -OC$_6$H$_9$, 792 polymethylene (-CH$_2$-) of -OC$_{10}$H$_{21}$, IR data confirms the molecular structure of comp. C$_{10}$, $^1$HNMR (CDCl$_3$): 0.89 to 0.90 (t, J = 8.0 Hz, 6H, -CH$_3$ of polymethylene -C$_{10}$H$_{21}$ and -C$_6$H$_9$), 1.80 (m, J = 7.1Hz, 4H, CH$_3$-CH$_2$-CH$_2$-CH$_2$-CH$_2$- of -OC$_{10}$H$_{21}$), 1.28 (m, 6H, -CH$_2$-CH$_2$-CH$_2$- of -OC$_{10}$H$_{21}$), 1.31 (q, 4H, -CH$_2$-CH$_3$ of -OC$_{10}$H$_{21}$), 4.06 (t, J = 7.1Hz, 4H, -O-CH$_2$-CH$_2$- of -OC$_{10}$H$_{21}$, and -OC$_6$H$_9$), 8.06 (d, J = 15.1 Hz, 2H, -CH = CH), 7.43, 7.28 and 7.79 (4H, J = 8.1 Hz, -meta-substituted second phenyl ring), 7.62 and 7.83 (4H, J = 8.0 Hz, first phenyl ring with alkoxy chain), $^{13}$C NMR (CDCl$_3$): 161.3, 158.6, 130.2, 129.3, 120.7, 114.9, 114.1, (Ar-C), 14.1 (-CH$_3$), 15.25, 31.9, 68.7 (-CH$_2$- bridge), 68.4 (29.6, 25.9, 29.6, 29.3, 22.7 (-CH$_2$), 145.1, 121.3 (-CH of olefin) elemental analysis: calculated for C$_{29}$H$_{40}$O$_3$: C, 79.81; H, 9.17; O, 11.00%; found: C, 79.76; H, 9.11; O, 10.62%.

C$_{12}$ (Dodecyloxy): IR (KBr): $\nu_{\text{max}}$/cm$^{-1}$ 2992 (C-H str. of alkane), 2880 (C-H str. of -(CH$_2$)$_n$ group of -OC$_{12}$H$_{25}$ alkyl chain, 1660 (C = O str. of carbonyl carbon of chalconyl group), 1604 (C = C str. of alkenyl in chalcone), 1510, 1543 (C = C str. of aromatic ring), 999 (C-H bending of alkenyl), 1178 (C-O str. of ether linkage), 1288, 1242 (C-O str. of carbonyl (>CO) group), 972 (trans, -CH = CH-) group, 771 polymethylene (-CH$_2$-) of -OC$_6$H$_9$, 804 polymethylene (-CH$_2$-) of -OC$_{12}$H$_{25}$, IR data confirms the molecular structure of comp. C$_{12}$, $^1$HNMR: 0.88 (t, 6H, -CH$_3$ of polymethylene -C$_{12}$H$_{25}$ and -C$_6$H$_9$), 1.79 (p, 10H, CH$_3$-CH$_2$-CH$_2$-CH$_2$-CH$_2$- of -OC$_{12}$H$_{25}$ and -OC$_6$H$_9$), 1.28 (m, 8H, -CH$_2$-CH$_2$-CH$_2$- of -OC$_{12}$H$_{25}$), 1.29-1.31 (q, 8H, -CH$_2$-CH$_3$ of -OC$_{12}$H$_{25}$ and -OC$_6$H$_9$), 4.06 (t, 4H, -OC$_2$H$_7$-CH$_2$-), 7.59 (d, J = 15.2 Hz, 2H, -CH = CH), 7.43, 7.28 and 7.83 (4H, J = 8.0 Hz, -meta-substituted second phenyl ring), 7.62 and 6.94, 6.45 (m, 4H, J = 8.1Hz, first phenyl ring with alkoxy chain), $^{13}$C NMR (CDCl$_3$): 164.6, 158.6, 130.2, 129.3, 126.8, 120.2, 114.6, 114.3, (Ar-C), 14.1 (-CH$_3$), 15.25, 31.9, 68.2, 29.6, 25.9, 29.6, 29.3, 22.7 (-CH$_2$), 145.1, 121.3 (-CH of olefin) elemental analysis: calculated for C$_{31}$H$_{44}$O$_3$: C, 80.17; H, 9.48; O, 10.34%; found: C, 79.11; H, 9.43; O, 10.28%.

### 3. Result and discussion

#### 3.1. POM investigation

The target chalconyl base compounds and their intermediates were synthesised as outlined in Scheme 1. 4-n-alkoxy benzaldehydes condensation with 3-butoxy acetophenone yielded 13 chalconyl derivatives. The common structural features of the compounds are that they consist of the same linkage group and the left n-alkoxy terminal side chain at one end. Compounds C$_6$-C$_{18}$ show LC property in an enantiotropical manner, whereas compounds C$_{14}$-C$_{18}$ exhibit monotropically nematogenic and smectogenic phases. C$_1$-C$_5$ homologues are non-mesogenic in nature due to the presence of short alky1 spacer in the -meta group. The phase diagram of the present series is shown in Figure 3.

The transition temperatures (Table 2) of the present newly homologous series-1 are determined by POM, and the phase diagram is plotted against the transition temperature versus the number of carbon atoms present in the n-alkyl chain ‘R’ of the-OR terminal group and subsequently on linking like or related points, the transition curves Cr-I/N, I-N or N-Sm are obtained. The Cr-I/N transition curve falling up to the C$_6$ homologue increases at the C$_7$ homologue because of the odd—even effect and then continues to descend up to the last C$_{18}$ homologue. The N-I or I-N transition curve falls with descending tendency up to

![Figure 3. Phase behaviour of the present series-1.](image-url)
the last homologue of the present series. An odd–even effect is absent in the N–I or I–N transition curve. Thus, it behaved in a normal manner neglecting minor deviating effect from the C₈ homologue beyond merging of the N–I/I–N curves for the higher homologue of longer n-alkyl chain ‘R’ of the -OR group. The monotropic N–Sm transition curve starts descending with increasing right-meta-substituted alkyl spacer from the C₁₄ to C₁₈ homologue to induce a smectic mesophase. The mesophase length for N–Sm transition is very short of the fraction for 4–5°C. The textures of the nematic phase are threaded or rod type and those of the smectic C phase are needle type as judged directly from the heating top of the POM. Analytical, thermal and spectral data supported the molecular structures of the newly synthesised compounds. Thermal stability of nematic to isotropic phase is 64.3°C. Thus, the temperature ranges of the mesophase are very small or shorter. The LC properties of thermotropic novel LC chalcones from homologue to homologue in the same series undergo variation with changing length of the molecules or permanent dipole moment across the longer molecular axis.

The sequential order of mesophase appearance for monotropy and enantiotropy is relapsed compared with the normal order of phase sequence observed in other homologous series. The variations in the mesogenic behaviours from homologue to homologue in the same series are observed throughout a novel series with increasing number of carbon atoms in the n-alkyl chain ‘R’, keeping the rest of the molecular part unchanged. Exhibition of mesomorphism either in monotropic or in enantiotropic manner by the homologues of the present newly synthesised series, except for five non-mesomorphic compounds, is attributed to the increase in molecular length, molecular polarity and polarisability, molecular rigidity and flexibility, permanent dipole moment across the long molecular axis, suitable magnitudes of dispersion forces and dipole–dipole interactions, which under exposed thermal vibrations lead to facilitating the molecular arrangement required to induce the smectic and/or nematic phase reversibly or irreversibly above or below the isotropic temperature from the C₈ homologue under floating condition. The texture images of compounds C₁₀ and C₁₄ are shown in Figure 4. The nematic texture image of compound C₁₀ is exhibited at 74°C in the heating condition, while the typical texture image of the SmC phase for compound C₁₄ is observed at 58°C on cooled condition.

The phase sequence of compound C₁₆ on the cooling condition is shown in Figure 5. The compound C₁₆ homologue is cooled from its isotropic temperature; the nematic phase is formed at 64°C; on further cooling it is transformed into a needle-type SmC phase at 54°C. Finally, a solid crystal is obtained at lower temperature.

In the present synthesised series, an attempt is made to synthesise LC material based on two phenyl rings and a single chalconyl linking group. We observed that the stability of the mesophase is lower due to one central linkage group and increasing the flexibility by two side chains to induce mesophase at lower temperature. As a result, lowering of the transition temperatures of homologues is attributed to the predominance of intermolecular distances due to widening of the molecule, which causes a reduction in the cohesive forces in competition with the cohesive forces generated by

Figure 4. Textures of compound of series-1 observed between cross-polarisers: (a) nematic texture image of C₁₀ at 74°C; (b) SmC texture image of C₁₄ at 58°C.
polarisability occurring by the laterally \textit{meta}-substituted \( -\text{OC}_4\text{H}_9 \) flexible group and changing of the left side chain from the \( \text{C}_6 \) and \( \text{C}_{18} \) homologues to exhibit nematic and smectic phase, respectively. The odd-even effect observed for the N–I transition curve is due to the sequentially added methylene unit. The non-mesomorphic behaviours of the \( \text{C}_1 \)–\( \text{C}_5 \) homologues are due to the low magnitudes of dispersion forces and the low magnitudes of the dipole–dipole interactions, leading to high crystallising tendency and inducing unsuitable magnitudes of anisotropic forces of end-to-end and lateral attractions. Diminishing of the odd-even effect for higher homologues beyond the \( \text{C}_7 \) homologue of longer \( n \)-alkyl chain \( '\text{R}' \) of \( -\text{OR} \) and \( -\text{OC}_4\text{H}_9 \) (n) lateral flexible groups is attributed to coupling with the major axes of the core structure of a molecule. Therefore, the reversal of monotropy and enantiotropy in the present novel series may be due to the unpredictable nature and uncertainty arising from the unpredictable status of the \( n \)-alkyl chain \( 'R' \) of \( -\text{OR} \) and \( -\text{C}_4\text{H}_9 \) (n) of the \textit{meta}-substituted lateral group.

\section*{3.2. Comparative parameter}

The variations in the LC property and the degree of mesomorphism from homologue to homologue in the same series or from series to series for the same homologue are attributed to the changing magnitudes of molecular rigidity and flexibility due to changing molecular polarity and polarisability and other related parameters concerning the suitable magnitudes of intermolecular cohesions and closeness. The mesogenic properties of the presently investigated homologous series-1 are compared with structurally similar series-X \cite{43} and -Y \cite{49}, as shown in Figure 6.

Homologous series-1, -X and -Y under a comparative study consisted of two phenyl rings and one central chalcone bridge (\( -\text{CH} = \text{CH-CO}- \)) in the present series-1 and also series-X and -Y. The left terminal alkoxy group (\( -\text{OR} \)), in which the \( n \)-alkyl chain \( 'R' \) varies with the number of methylene units from homologue to homologue in the same series but the number of methylene units of \( 'R' \) on the left remains unaltered for the same homologue from series-1 to series-Y, contributes partly towards the sharing of the total molecular flexibility. For the laterally substituted tail groups \( -\text{OC}_4\text{H}_9 \) (n), \( -\text{OC}_{14}\text{H}_{29} \) (n) and \( -\text{OC}_{16}\text{H}_{33} \) (n), the molecular flexibility, group polarities and polarisability vary from series to series with the broadening of the alkyl spacer but remain unaltered from homologue to homologue in the same series, respectively, due to their respective lateral groups being linked to the \textit{meta} position of the second phenyl ring but vary with changing \( 'R' \) of the alkoxy terminal group. Thus, variations in the LC

egin{figure}[h]
\centering
\includegraphics[width=\textwidth]{phase_sequence}
\caption{Phase sequence of the \( \text{C}_{16} \) homologue on cooling condition by POM: (a) isotropic at 69°C; (b) nematic texture image appeared at 64°C; (c) needle-type SmC texture image observed at 54°C; (d) solid crystal is formed below 54°C.}
\end{figure}
properties among the series-1, -X and -Y can be attributed to the varying features related to mesomorphism because of even a minute changing feature or the total changing flexibility of the terminal and/or lateral groups for the same homologue from series to series.

3.3. Thermal stability and temperature range of the mesophase

Table 3 represents some thermometric data evaluated from the present investigation of series-1 compared with series-X and -Y.

The homologous series-1, -X and -Y are identical with respect to the exhibition of smectogenic and nematogenic properties. Exhibition of the smectogenic mesophase commences from $C_{14}$ (series-1), $C_6$ (series-X) and $C_7$ (series-Y). The nematic mesomorphism commences from $C_6$ (series-X) and $C_2$ (series-X, -Y). Thermal stability for the nematic phase increases from series-X to -1 to -Y, respectively. However, the stabilisation of the smectogenic character is very poor in series-1 compared with series-2 and -3.

The geometrical shapes of the presently synthesised series and other comparative series are shown in Figure 6. Structurally similar analogous series.

Table 3. Thermal stability in °C.

| Series   | Series-1 | Series-X | Series-Y |
|----------|----------|----------|----------|
| Sm-I or Sm-N or N-Sm Commencement of smectic phase | $1-2.0^\circ\text{C}$ | $1-2.0^\circ\text{C}$ | $1-2.0^\circ\text{C}$ |
|          | ($C_{14}$-$C_{18}$) | ($C_6$-$C_{18}$) | ($C_7$-$C_{18}$) |
| N-I or I-N Commencement of nematic phase | $79.12^\circ\text{C}$ | $67.5^\circ\text{C}$ | $72.6^\circ\text{C}$ |
|          | ($C_6$-$C_{18}$) | ($C_2$-$C_{18}$) | ($C_2$-$C_{18}$) |
| Temperature range of mesophase (total) | $06.0-15.0^\circ\text{C}$ | $05.0-12.0^\circ\text{C}$ | $05.0-21.0^\circ\text{C}$ |
|          | $C_6$-$C_{16}$ | $C_8$-$C_7$ | $C_6$-$C_{18}$ |

Figure 7. The aromaticity, permanent dipole moment and molecular rigidity of lower member ($C_1$) to higher member ($C_{18}$) became unaltered at right terminal side with differs in right side substituted tail ended group under comparative study. The length of the laterally -meta-substituted groups increases from series-1, -X and -Y in order of $-\text{OC}_4\text{H}_9(n)$ < $-\text{OC}_{14}\text{H}_{29}(n)$ < $-\text{OC}_{16}\text{H}_{33}(n)$, which differs by increasing the $-\text{CH}_2-$ unit from series-1 to series-X to series-Y. However, the longer $n$-alkyl -meta-substituted chain bonded through the oxygen atom of the lateral group also may cause the difference in polarity and polarisability due to the gradually added $-\text{CH}_2\text{-CH}_2-$ unit and the same longer $n$-alkyl chains may couple with the major axis of the core structure of the molecule, which may modify the magnitudes of flexibility and the magnitudes of intermolecular cohesions and closeness for the same homologue from series to series under the influence of the exposed thermal vibrations when floated on the surface. However, the experimentally evaluated thermometric data suggest that there is very little difference in the thermal stabilities, commencements of nematic phase, degrees of mesomorphism or facilitations of the upper and lower total temperature range of the mesophase as well as the types of mesophases for the same homologue from series to series.

4. Conclusions

In this article, we have described the synthesis and thermotropic properties of liquid crystal based on the chalcone linkage group. A novel chalconyl homologous series is predominantly nematogenic and partly smectogenic with lower transition temperatures. $C_1$–$C_5$ display non-LC property whereas $C_6$–$C_{18}$ show an enantiotropic nematic phase. Compounds $C_{14}$, $C_{16}$ and
C$_{18}$ show a smectic mesophase on cooling. The thermal stability of the nematic phase in series-1 is higher than that of series-X and -Y due to the short alkyl chain substituted at the second phenyl ring while in series-X tetradecyloxy and in series-Y hexadecyloxy alkyl chain is present, which increases the flexibility of the molecule and decreases its thermal stability. The group efficiency order is derived on the basis of thermal stabilities, commencement of the mesophase and the upper and lower temperature ranges for the smectic and nematic mesophases.

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**Disclosure statement**

No potential conflict of interest was reported by the authors.

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