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2-Aminobenzothiazole Containing Invented Azomethine Esters Withstate of Matter Derivatives: Studying for New Antibacterial agents

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ABSTRACT

The 2-amino benzothiazole and invented azomethine esters contain a wide spectrum of biological activities, medicinal characteristics, and state of matter behavior, making them essential functionalities. In light of the significance of these organic heterocyclic derivatives, a new series of 2-Aminobenzothiazole derivatives comprising unique azomethine esters were created through organic reactions. Combining elemental analysis with conventional spectroscopic techniques allowed for the characterization of the produced substances. Then, using a polarized. Gram progressive and Gram harmful bacteria were verified for them *in vitro* uncontaminatedaction using the produced organic heterocyclic derivatives. Correlated with the favored heterocyclic structural derivatives, synthesized organic heterocyclic derivatives shown notable antimicrobial activity. While the homologues of the higher members displayed smectic C and nematic mesophase, the lower and middle members had enantiotropic nematic mesophase. To assess how central linkage and different lateral substituents.

Keywords: 2-Aminobenzothiazole, Liquid crystalline, Novel Schiff base esters, Antibacterial activity, DSC.

INTRODUCTION

The molecular architecture of a calamitic organic compound largely determines its liquid-crystalline behavior; even little modifications to the molecular geometry can result in significant changes to the substance's mesomorphic characteristics. Heterocyclic elements like sulfur[S], oxygen[O], in additionnitrogen[N]be able to significantly alter the more polar, polarizability, and infrequently the molecule's differentform, which can affect the mesophase type, phase conversion temperatures, dielectric, and other mesogen characteristics[1]. The use of 2-aminobenzothiazole as a moiety in state of matter compounds, however, is only partially documented[2–9].

Nevertheless, there is very raredata on the use of 2-amino benzothiazole as a moiety in state of matter combinations[10–17]. As photoconductive materials, benzothiazole derivatives have been investigated[18–20]. The fast hole transport capability of 2-(4-heptyloxyphenyl)-6-dodecylthiobenzothiazole, a photoconductive calamatic liquid crystal, has been described by Funahashi and Hanna[21]. Both a low ionization potential and the induction of a smectic phase can be attributed to a 2-aminobenzothiazole core that contains having many electrons in sulfur atom. An effective hopping mechanism of charge transfer may also be made possible by a more degree of interaction molecular wave function in fused heterocyclic rings due to their flat molecular form and minimal inter-annular twisting[15]. Additionally, luminous compounds were found to include a benzothiazole core, which is advantageous in applications due to the more fluorescence quantum product in the presence of the stiff moiety.[22] Derivatives of benzothiazoles have recently been the subject of ongoing research for use in organic matter, thin-film related-effect transistors concept[23]. A sequence of 6-methoxy benzothiazole-based state of matter have been synthesized in response to the increasing concept in the production of heterocyclic atoms -based state of matter by scientists. In addition to expanding the mesophase range[24], the less polar methoxy fatal functionalset can aid in the creation of the nematic meso-phase[12].

The main goal of this study was to create a Schiff base of phenyl vanillin based on benzothiazole heterocyclic. Alkoxy chains of varying sizes (carbon numbers = 1–4, 6, 8, 10, 12, 14, and 16) are incorporated into ester moieties. Utilizing thermal analysis and computational computation (density functional theory, or DFT), the mesomorphic character and optical properties were examined.[25]

The current study's goal is to scheme and create resorcinolarenas activated benzothiazole-moiety supramolecular derivatives (BTMR1-BTMR4) by incorporating fluorescent active benzothiazole units on the four sides of the resorcin[26] arene moiety with varied alkyl supports of the molecule. Each of the four synthetic substances exhibits liquid crystalline characteristics of the nematic kind. We also investigated how alkyl chains.

In the present our research effort, we explain theproduction and different phase criteria of a same twelve members of azomethine esters, [2-(4-alkanoyloxybenzylidenamino) benzothiazoles], where alkoxy chain of the mesogenic functional sets varied (n=1–8, 10, 12, 14, 16, 18) as shown in System 1.

EXPERIMENTAL

Synthesis

For present synthesized homologous sequence required materials: para-Hydroxy benzaldehyde, 2-aminobenzothaizole, the suitable n-alkyl halides(R-Br), (KOH) potassiumhydroxide, methanol (CH_3OH), glacial acetic acid (CH_3COOH), dry ethanol, (DCC)-N, N′-Dicyclohexylcarbodiimide, (DMAP)-4-Dimethylaminopyridine and dry tetrahydrofuran (Dry THF) were used in present work. The proper solvent was distilled over and dried before use. Fourier transform infrared were collected on shimadzu IR408 spectrometer using KBr pellets. ^{1}H Nuclear Magnetic Resonance spectral data were carried out by the using of Bruker advanced Neospectrometer (400MHz) with the help of tetramethyl silane (TMS) and Deuterated chloroform ($CDCl_3$) solvent. Phase transition shown by polarizing optical microscopy[POM] along heating stage. Shimadzu DSC-60 (Differential Scanning Calorimeter) through measured enthalpies phase transitions atchilling and reheating rates 10°C minute^{-1}.

Synthesis of benzothiazole [A]

In a 60 mL solution of dry ethanol (C_2H_5OH), 2-aminobenzothiazole (0.10mole) and 4-hydroxybenzaldehyde (0.10mole) were refluxed for three hours after, droplets of glacial acetic acid(CH_3COOH) were mixed. The filtrate was then allowable to evaporate in the fume hood at ambient temperature after the reaction mixture had been filtered. Before being employed in a subsequent procedure, the yellow crystalline solid that was produced (2-amino benzothiazole[A] was recrystallized by dry ethyl alcohol[27].

4-n-Alkoxybenzoic acids [B]

Para-anisic acid, B. D. H., or para-methoxybenzoic acid, was employed. There are several recognized techniques for alkylating para-hydroxybenzoic acid[28,29].

Nonetheless, Dave and Vora's[30] Methodology was used in this investigation. After dissolving 0.1 moles of para-hydroxybenzoic acid, 0.120 moles of suitable n-alkyl bromide, and 0.25 moles of potassium hydroxide (KOH) in 100 milliliters of ethyl alcohol, the combination was refluxed for six to eight hours. After adding 25 milliliters of a 10% aqueous potassium hydroxide (aq. KOH) solution, heated was maintained for two to three hours in order to hydrolyze any ester that might have developed. After being dissolved in 100 milliliters of ethanol, 0.1 moles of para-hydroxybenzoic acid, 0.12 moles of suitable n-alkyl bromide, and 0.25 moles of potassium hydroxide solution (KOH) were heated for six to eight hours. For two to three hours, reflux was maintained while 25 milliliters of a 10% aqueous potassium hydroxide (aq. KOH) resolution was additional in order to hydrolyze any ester that might have developed. 50%icy aqueous hydrochloric acid (HCl) was mixed to the solution after it had cooled, resulting in a white precipitate. A constant transition temperature was achieved by crystallizing the alkoxy[RO-] acids from methanol or acetic acid one or two times, depending on the higher member. There is a good agreement between the transition temps and the literature review[29].

Synthesis of [2-(4-alkanoyloxybenzylidenamino) benzothiazoles

The process for creating [2-(4-alkanoyloxy-benzylidenamino) benzothiazoles involves dissolving 0.1 mole of benzothiazole [A] in 50 milliliters of dry tetrahydrofuran (THF), adding the required Para-n-Alkoxybenzoic acids (0.10mole) and DMAP (0.10mole), and stirring at room temperature. Dropwise additions of DCC (31) (0.1 mole) mixed in 10 mL of dry tetrahydrofuran (THF) were made to the mixture, which was then continuallywhirled for 12 times at room temperature. Ultimately, the mixture was detached, and slow evaporation was used to extract the solvent.The subsequent yellow solid was recrystallized twice using ethanol, yielding the pure chemical. All of the compounds' purity was examined using TLC[thin-layer chromatography] (Merck 60 F254) and seen under small-wave Ultra Violetsunlit. Infra-red, Nuclear Magnetic Resonance (1H and elemental analysis), and DSC were used to analyze a few typical compounds of [2-(4-alkanoyloxybenzylidenamino) benzothiazoles.

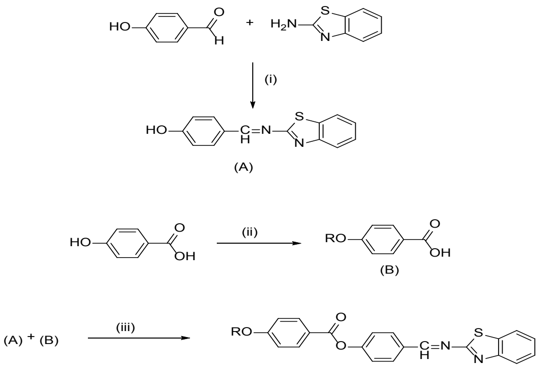
Calorimetric studies

Research using calorimetry is useful for identifying phase transitions. We can draw inferences about the characteristics of the many phases that take place during phase transitions since it produces quantitative results. The enthalpies of derivative of series I (n = 4, 6, and 7) were determined in the current investigation using differential scanning calorimetry. Table 3 contains the recorded readings. In Fig. 2(a), 2(b), and 2(c), thermograms (graphs) are displayed.

Optical Polarizing microscopy textures studies

According to the polarizing optical microscopic analysis, the phase transition displayed by series I derivatives was determined to be consistent with the earlier findings. texture of the focus conic texture in a microphotograph Sm A cooling mesophase exhibited (Series first; n = butoxy) at 264°C (Fig. 3) Shileren nematic phase (Series first; n = 6) upon cooling at 246°C (Fig. 4). Shilerennematic mesophase.

Synthetic route



Where, R= $-CnH_2n^{+1}$ n=1 to 8,10,12,14,16

(i) Dry Ethanol, Glacial acetic acid (ii) R-Br, KOH, MeOH.
(iii) DCC, DMAP, Dry THF

Scheme. 1

Table 1: Phase behavior readings (°C) of the sequencefirst derivatives

Derivative No	R = $-C_nH_{2n+1}$ n =	Crystal		SmC		N		I
1	1	•	-	•	131	•	226	•
2	2	•	-	•	123	•	221	•
3	3	•	-	•	117	•	215	•
4	4	•	-	•	116	•	264	•
5	5	•	-	•	106	•	205	•
6	6	•	-	•	126	•	247	•
7	7	•	-	•	106	•	203	•
8	8	•	-	•	109	•	199	•
9	10	•	-	•	112	•	196	•
10	12	•	112	•	165	•	194	•
11	14	•	109	•	161	•	189	•
12	16	•	104	•	153	•	181	•

Cry = crystal-likedense; Sm A = smectic A mesophase; N = nematic mesophase; I = isotropic liquid mesophase; • = phase occurs

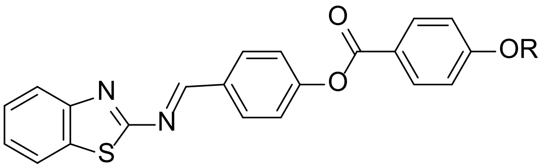


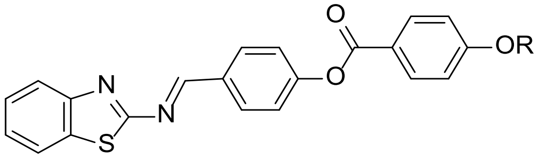
Table 2: Fundamentalexamination of the series-1

Derivative	R=C_nH_{2n+1} n =	Formula No	%Required (%Found) C	H	N
1	2	$C_{22}H_{16}N_2O_3S$	68.04(68.00)	4.12(4.00)	3.60(3.50)
2	3	$C_{23}H_{18}N_2O_3S$	68.65(68.50)	4.47(4.35)	3.48(3.40)
3	4	$C_{24}H_{20}N_2O_3S$	69.23(69.00)	4.80(4.50)	3.36(3.30)
4	5	$C_{25}H_{22}N_2O_3S$	69.76(69.50)	5.11(5.00)	3.25(3.00)
5	6	$C_{26}H_{24}N_2O_3S$	70.27(70.10)	5.44(5.39)	3.15(3.10)
6	7	$C_{27}H_{26}N_2O_3S$	70.74(70.50)	5.67(5.55)	3.05(3.00)
7	8	$C_{28}H_{28}N_2O_3S$	71.18(71.00)	5.93(5.87)	2.96(2.80)
8	9	$C_{29}H_{30}N_2O_3S$	71.60(71.40)	6.17(6.00)	2.88(2.70)
9	10	$C_{30}H_{32}N_2O_3S$	72.00(71.80)	6.40(6.30)	2.80(2.70)
10	11	$C_{31}H_{34}N_2O_3S$	72.37(72.20)	6.61(6.50)	2.72(2.65)
11	13	$C_{33}H_{36}N_2O_3S$	73.33(73.00)	6.66(6.60)	2.59(2.50)
12	15	$C_{35}H_{38}N_2O_3S$	74.20(74.00)	6.71(6.66)	2.47(2.40)
13	17	$C_{37}H_{40}N_2O_3S$	75.00(74.90)	6.75(6.70)	2.36(2.30)

Spectral data

IR for 2-(4-Butyloxybenzylidenamino)-benzothiazole: [n = 4]

IR(KBr) νmax cm^{-1}: 3099 (Carbon-Hydrogen aromatic nature), 2951, 2870(Carbon-Hydrogen aromatic nature), 1734 (-COO ester), 1618 (-HC=N, azomethine thiazole), 1060 (Benzothiazole), 645 (C-S-C).



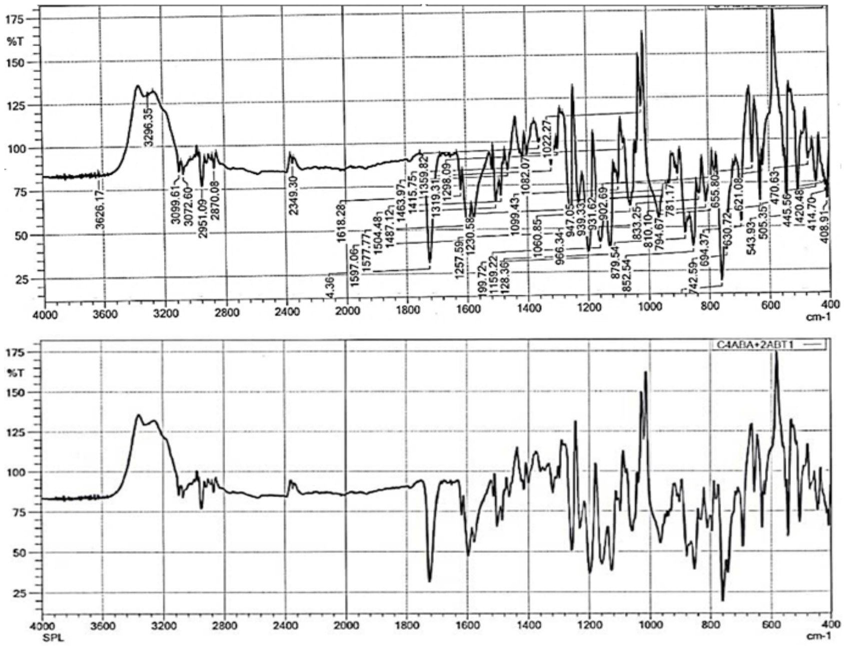


Fig. 1. IR dataofseries I (n=4)

2-(4-heptyloxybenzylidenamino)-benzothiazole: [n=Hexyloxy derivative]

IR(KBr) νmax cm^{-1}: 3099 (Carbon-Hydrogen aromatic nature), 2951, 2870(Carbon-Hydrogen aromatic nature), 1734 (-COO ester), 1618 (-HC=N, azomethine thiazole) 1060(Benzothiazole), 645(C-S-C).

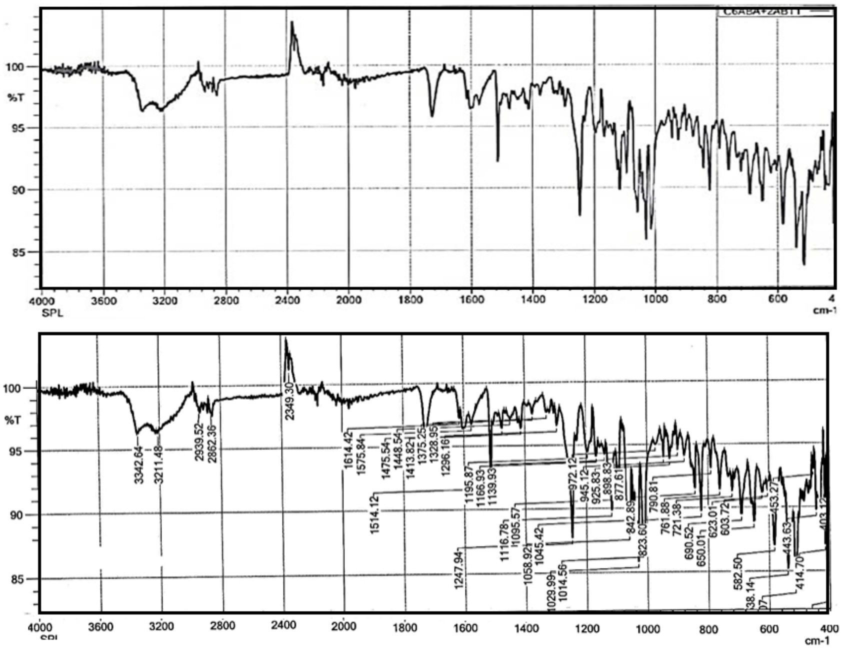


Fig. 2. IR dataofseries I (n=6)

2-(4-heptyloxybenzylidenamino)- benzothiazole: [n=Heptyloxy derivative]

IR (KBr) νmax cm^{-1} 3063 (Carbon-Hydrogen aromatic nature), 2959, 2847 (Carbon-Hydrogen aromatic nature), 1717 (-COO ester), 1614 (-HC=N, azomethine thiazole), 1060 (Benzothiazole), 655 (C-S-C).

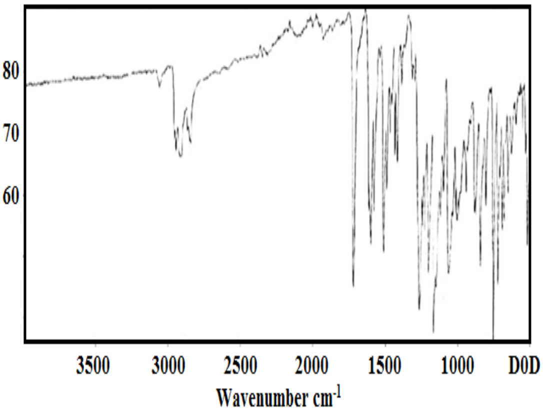


Fig. 3. IR dataofseries I (n=7)

2-(4-dodecyloxybenzylidenamino)- benzothiazol: [n=12]

IR (KBr) νmax cm^{-1}: 3061 (Carbon-Hydrogen aromatic nature), 2956, 2845 (Carbon-Hydrogennaturealiphatic), 1714 (-COO ester), 1610 (-HC=N, azomethinethiazole), 1060(Benzothiazole), 655(C-S-C)

^{1}H Nuclear Magnetic Resonance (400 MHz, $CDCl_3$):

2-(4-Butyloxybenzylidenamino)-benzothiazole: [n=4]

^{1}H Nuclear Magnetic Resonance: (400 Mega Hz, $CDCl_3$, δ parts pm): 0.95 (t, 3H, CH_3-methyl), 1.43-1.76 (quint 4H, 2H, $–CH_2CH_2O–$), 4.08 (t, 2H, $CH_2O–Ar–$), 7.11 (doublet, 2H, Aromatic–H), 7.46 (doublet, 2H, Aromatic-H), 7.48 (t, 1H, Aromatic–H), 7.76 (doublet, 2H, Aromatic–H), 8.08 (doublet, 2H, Aromatic–H), 8.14 (doublet, 2H, Aromatic–H), 9.13 (s, 1H, –N=CH–).

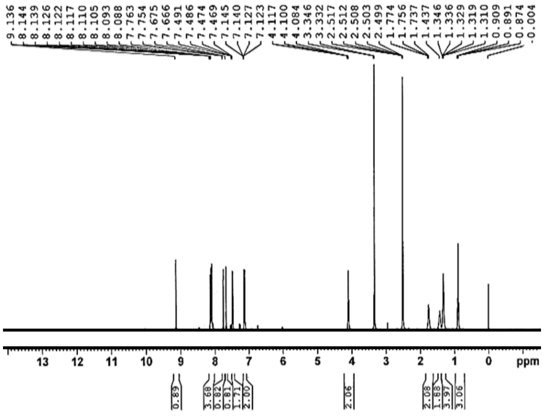


Fig. 4. NMR dataofseries I (*n*=4)

2-(4-Hexyloxybenzylidenamino)- benzothiazole: [*n*=6]

^{1}H Nuclear Magnetic Resonance (400 Mega Hz, $CDCl_3$, δ parts pm): 0.95 (triplet, 3H, CH_3-methyl), 1.437-1.76 (quint 6H, 2H, $–CH_2CH_2O$-), 4.08 (t, 2H, CH_2O–Ar–), 7.123 (doublet, 2H, Aromatic–H), 7.47 (d, 2H, Ar-H), 7.48 (t, 1H, Aromatic–H), 7.76 (doublet, 2H, Aromatic–H), 8.08 (doublet, 2H, Aromatic–H), 8.14 (doublet, 2H, Aromatic–H), 9.13 (s, 1H, –N=CH–).

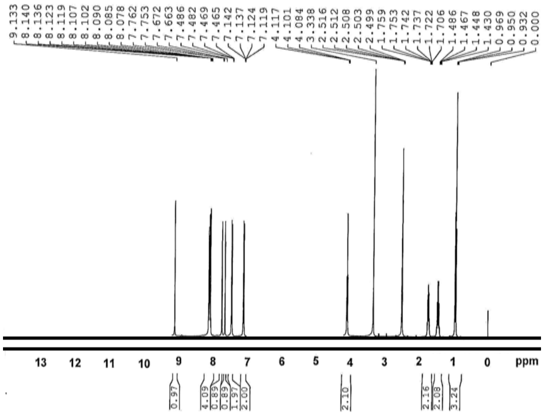


Fig. 5. NMR dataofseries I (*n*=6)

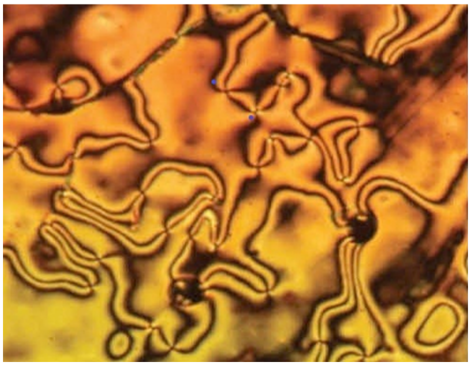


Fig. 6. POMtexture of ShilerenNematic phase [Sequence-1, *n* = 4]

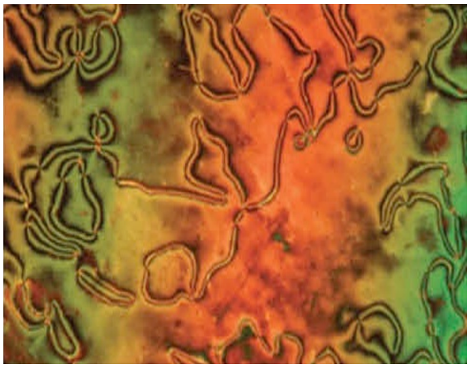


Fig. 7. POM texture of Shileren Nematic phase [Sequence-1, *n* = 6]

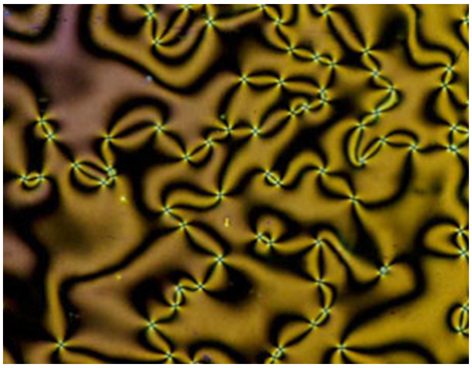


Fig. 8. POMof schlieren texture of SmC phase (Sequencel; n = 12) on 125°C

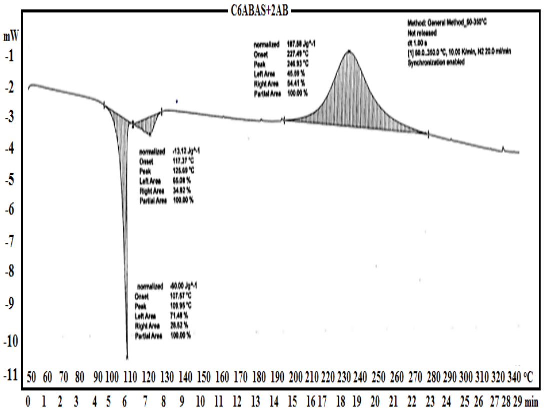


Fig. 9. DSC plots of derivative4

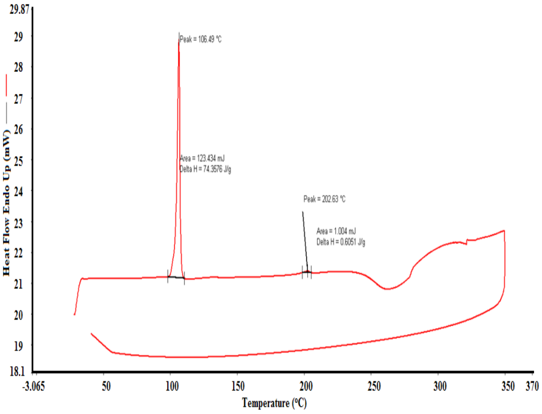


Fig. 10. DSC plots of derivative6

RESULT AND DISCUSSION

Structure Related Discussion

Comparing the soap like phase variety, evolution temperature, and molecular construction of demonstrativecomposite ten (*n* = twelve) of the current sequence [first]I with architecturally comparable other series A[32], B[33], C[34], and D[35] is summarized in this Table 4.

Table 4: Comparison of the phase behaviour, Smectic A phase range and comparative molecular moiety's of sequences [first] I,A,B,C and D

Derivative No	Phase length Sm	Phase length N	Thermal stability Sm	Thermal stability N	Coming of smectic A phase
I	86	29	165	194	C_{12}
A	8	-	90	-	C_8
B	126	-	277	-	C_1
C	153	04	264	268	C_1
D	123	-	254	-	C_1

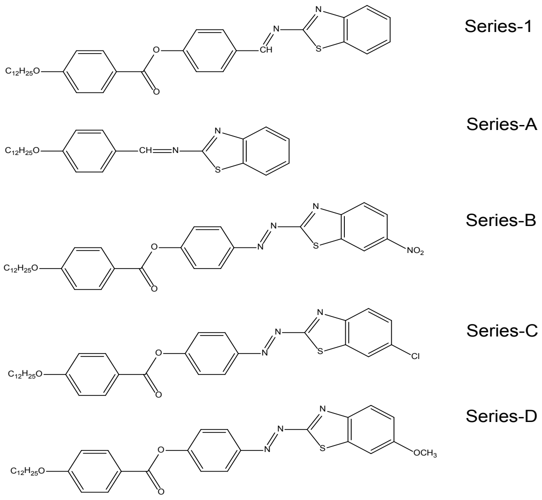


Fig. 11. DSC plots of derivative 7

Demonstrates the presence of the smectic[soaplike] A phase in both Sequence I and A. SeriesI exhibits a smectic phase length and smectic thermal steadiness that are 78°C and 75°C longer, correspondingly, then seriesA. This is because the increased aromatic ring and central ester (-COO-) connection provide Series Ihave a longer length. Because of its improved polarizability anisotropy and increased intermolecular cohesive forces, the smectic mesophase has a longer duration and greater thermal stability.

There are differences in the numeral of phenyl rings and chief linkages between molecules in series I and A. Series I has a longer phase distance and upperwarm airsteadiness because of the added phenyl ring and dominant bond, which makes the fragmentlengthier and more polarizable. As a result, series I also has a greater emetic mesophase length than series A.

Table 4.0 also demonstrates that Series D only displays nematic [thread like] phase; there is no smectic mesophase, which could be due to the weakly dipolar methoxy group [$C-OCH_3$] bond, making Series D less polarizable than Series B and C, which have lateral more polar nitro [$C-NO_2$] and choro [C-Cl] groups, respectively.

The lateral substituent with decreased bipolarity has a significant impact on depressing the smectic mesophase, as explained by Gray[36]. When associating the nematic [thread like] phase extent and thermal stability, Series D is the lone viable option when compared to Series B and C. This could be as the nematic [thread like] phase extent and nematic warm airconstancy are not solely dependent on molecular lesspolarizability; they also depend on the forces that keep the nematic state ordered, which diminish as the long molecular axes get farther apart. For example, the breadth effect is the main factor influencing the nematic mesophase stability, while the dipolar and breadth effects work together to impact the smectic thermal stability[36].

By diagrammatically representing the potential sets in an endwisefilling of the fragment of n-alkyl aryl ethers, for example 4-n-alkoxy [-OR] benzoic acids, Gray[36] has provided an explanation for the fluctuation of N-I changing temperatures. The terminal methyl groups in short alkyl chains present various faces to them other or to additionalcloseclusters in the fragmentsreliant on whether the alkyl chain is even or odd if it extends strictly down its own axis. The many resulting attractive forces would influence the system's energy and explain temperature changes. The stiffer aromatic portions may push the alkyl chain to align with the main axis when it comes to the higher homologues.

As the series is ascended, the petering out of the alternation can be explained by the closecluster'sinteraction gradually being the similar in flora for odd even carbon manacles. The molecular makeup of organic substances and mesomorphism are closely related. Thermal steadiness and mesophase length, which are indicators of mesomorphism, can therefore be linked to the compounds' molecular makeup.

The two compounds' lateral substituents are different. The lateral substituent in Series B is the -NO′ group, while the lateral position in Series C is the -Cl group. Compared to C, the molecule of Series

B exhibits stronger smectic phase thermal stability due to its increased molecular polarizability. Although Series B is completely smectogenic, Series C also exhibits nematic mesophase. This could be because Series B contains bigger substituents (such as -Br, -I, and -NO′) that often exclude nematic mesophase in comparison to the -Cl group[34]. Thattogether the complexes have diverseside substituent. Series B has-NO cluster as the adjacentsubstituent while, Series C has-Cl group at the lateral position. The molecule of Series Bhas superior molecular less polarizability and henceforthadvanced smectic[soap like] phase thermal stability than C. Series C also display nematic mesophase whileSeries Bis virtuouslysmectogenic, this might be due to the occurrence of larger substituent (i e.-Br, -I and -NO) inSeries B, which oftenremove nematic phase as compare to thechloro[-Cl] group[34].

Biological investigation

Antimicrobial assay

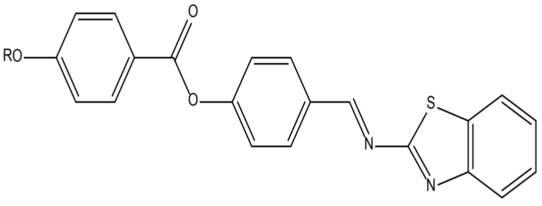
Gentamycin was used as the standard to assess the sterile activity of the newly manufactured derivatives (1–12) using least inhibitory attention (MIC) at a concentration range of 0-100 μg/mL against *Gram-positive* microorganisms (*S. aureus*; MTCC 3160), *Gram-negative* microorganisms (MTCC 4673), and *B. subtilis* (MTCC 9788). From the Institute of Microbial Technology (Chandigarh, India), the necessary bacterial strains were acquired. The protocol was followed in order to perform the serial broth dilution experiment. You may find the whole protocol.[37]

Antifungal assay

Using the serial broth dilution method, the antifungal activity of all compounds (1–12) against *Candida albicans* (MTCC1637) was evaluated. Concentrations ranging from 0 to 100 μg/mL were used in the investigation. As a reference, miconazole was used to compare each compound's activity. From the Institute of Microbial Technology (Chandigarh, India), the necessary bacterial strainingwere acquired. The published protocol was followed in the experimental setup. You may find the complete protocol in the supplemental file.[38,39]

Biological study

Table 5. Antimicrobial and antifungal activities of compounds 1-12.



Where, R=C_nH_{2n+1}, *n*=1 to8, 10,12, 14 &16

Table 5: Antimicrobial and antifungal activities of compounds 1-12.

Compound code	*n*	R	Antibacterial MIC(μg/mL)			Antifungal MIC(μg/mL)
			S. aureus	*Bacilus subtilis*	*P. aeruginosa*	*C. albicans*
1	1	CH_3	1.26±0.02	1.08±0.04	0.98±0.03	1.76±0.02
2	2	C_2H_5	1.78±0.40	1.60±0.05	1.56±0.07	2.30±0.26
3	3	C_3H_7	2.09±0.06	2.34±0.07	3.45±0.34	2.95±0.58
4	4	$CH_3(CH_2)_3$	3.99±0.12	4.33±0.43	5.67±0.57	3.23±0.66
5	5	$CH_3(CH_2)_4$	4.15±0.18	5.29±0.03	6.73±0.62	4.58±1.09
6	6	$CH_3(CH_2)_5$	7.21±0.22	8.46±0.27	9.93±0.38	6.10±0.07
7	7	$CH_3(CH_2)_6$	10.11±0.25	14.51±0.46	16.44±1.02	9.15±1.14
8	8	$CH_3(CH_2)_7$	14.28±0.44	16.71±0.52	18.19±0.08	12.23±0.25
9	10	$CH_3(CH_2)_9$	16.09±0.30	17.37±0.35	19.21±0.09	14.07±0.83
10	12	$CH_3(CH_2)_{11}$	18.11±0.62	19.39±0.17	22.46±0.10	16.37±0.55
11	14	$CH_3(CH_2)_{13}$	21.23±0.47	26.47±0.19	28.49±0.19	24.12±0.67
12	16	$CH_3(CH_2)_{15}$	28.98±0.32	30.02±0.78	32.77±0.36	36.45±1.81
Gentamycin	-	-	2.56±0.62	3.76±0.96	7.51±0.09	-
MIconazole				-		3.12±0.11

MIC* minimum inhibitory concentration represented as mean of three independent replicates with SD

Using gentamycin and miconazole as standards, the synthetic compounds' antibacterial and antifungal properties were evaluated. *Gram-negative (P. aeruginosa)* and *Gram-positive (S. aureus/B. subtilis)* strains stayed examined, along with the compounds' antifungal properties.

Alkoxy was replaced with various carbon chains R (*n* = 1 to 8, 10, 12, 14, and 16) to change the compounds. Compounds 1, 2, and 3 performed better than expected; their MICs ranged from 1.26 to 3.45 µg/mL for all bacterial strains and from 1.76 to 2.95 µg/mL for all fungal strains. However, compounds 4 and 5, which have a carbon chain length of (*n* = 4, 5), showed comparable to the standard in terms of effectiveness against fungi and bacteria. Comparing compounds 6 through 12 (*n* = 6, 7, 8, 10, 12, 14, and 16) to the standard, none of them showed any discernible action. Compounds exhibited increased activity up to a carbon chain length of 1 to 3, while compounds with longer chains (*n* = 4 to 16) showed moderate to decreased activity. The most effective compound in the series was found to be compound 1, which had a MIC of 0.98 µg/mL against the gram-negative bacteria under study. These results imply that additional research should be done on compound 1 in order to create stronger chemicals. The findings are shown in Table 1.

CONCLUSION

The synthesized organic heterocyclic derivatives were assessed for them in vitro sterile activity opposite gram positive and *Gram-negative* bacteria. Produced organic heterocyclic derivatives showed significant activity in contradiction of microorganisms, which can be correlated with the privileged heterocyclic compound derivatives.

The homologues of lower and middle members exhibited enantiotropic nematic mesophase whereas higher members exhibited smectic C and nematic phase transition. The phase transition of the current sequence is associated with furtherarchitecturallyconnectedcomposites to assess the result of chief linkage and lateral exchange on their phase transition 0behavior.

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Conflict of interest

The author declare that we have no conflict of interest.

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