Synthesis and characterization of some new heterocyclic compounds with two Heteroatom's (Nitrogen)in their cyclic
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Abstract

The Pyrimidines derivatives play an essential role in several biological processes and have considerable important compounds for pharmaceutical medicinal and industrial material applications. The work describes the synthesis and characterization of some new pyrimidines derivatives: 2- mercapto 3, 4 di hydro -4-oxo -[6- (4- alkoxy phenyl)- 4H] pyrimidine -5- carbonitriles and 2- mercapto 3,4 di hydro -4-oxo -[6-(4- substituted benzene - 4-H] pyrimidines -5- carbonitriles(3a- d). These Compounds (3a-d) were prepared from the reaction between ethylcyano acetate (0.01mole) and numbers of substituted benzaldehydes compounds (0.01mole) as starting materials. The compounds (4a-d) were obtained from the reaction of (3a-d) with aryl halide or alkyl halide under reflux for 5hrs, while the compounds (5a-d) were formed from the reaction of (4a-d) with phosphorous oxy chloride. The compounds (6a-d) were synthesized from the reaction of (5a-d) with thiourea under reflux for 6hrs and the compounds (8a-d) were obtained from the reaction between (6a-d) with chloro acetic acid (0.01mole) under refluxed for 3hrs. All the synthesized compounds of pyrimidines derivatives were identified by the physical properties by it's melting points and colors, and the yields were characterized by the elemental (CHN)analysis, IR, UV, and visible spectra data.

Key words: Ethyl cyano acetate, substituted benzaldehydes, aryl and alkyl halides, phosphorous oxy chloride, thiourea, chloro acetic acid, sodium ethoxide pyrimidines derivatives, elemental analyzer (CHN), IR, UV spectrum.

Introduction

A heterocyclic compounds are these which possess acyclic structure with two different kinds of atoms in the ring such as Nitrogen, Oxygen and sulfur are the most common heteroatom's. Most of the sugar, vitamins, alkaloids, which are Nitrogenous bases occurring in many antibiotics, including penicillin, are heterocyclic compounds(18). Pyrimidines derivatives have been found to possess interesting antibacterial(1), antipsychotic (22), anticancer (20), anti schizophrenia(5), and antihypertensive(12) activity anti viral(15), anti titumer(2), anti inflammatory (19), anti microbial (6) and anti fungal(11) anti histaminic (21), and analgesic, malaria, Alzheimers disease, Parkinson's disease (3) and anti oxidant properties (14). Pyrimidine nucleus occurs in a wide range of compounds having biological activity(10,7) and therefore, it was decided to synthesis some new pyrimidines derivatives, The pyrimidines ring is fused to various heterocyclic such as: (purine in nucleic acids, pyrrolo pyrimidines, pyrido pyrimidines, pteridines, quinazolines, tri azolo Pyrimidines, pyrazolopyrimidines and furopyrimidines) are agro chemicals, and veterinary products (4,16,17); fused pyrimidine continues to attract considerable attention because of their great practical usefulness primarily, due to very wide spectrum of biological activity(13). Thiophenopyrimidines occupy a special position among these compounds,
Synthesis and characterization of some new Pyrimidines derivatives by using ethyl cyano acetate and substituted Aldehyde as starting materials.

A series of Pyrimidines derivatives were synthesized by reacting ethyl cyano acetate with substituted aldehydes (1a-d) to form (3a-d) derivatives in (scheme -1-). The chemical names of the derivatives benzaaldehydes : a= para- methoxy benzaldehyde , b= para- methyl benzaldehyde c= para- hydroxy benzaldehyde d= para- ethyl benzaldehyde. These Compounds (3a-d) were prepared from the reaction between ethylcyano acetate (0.01mole) and numbers of substituted benzaaldehydes compounds (0.01mole) as starting materials. The compounds (4a-d) were obtained from the reaction of (3a-d) with aryl halide or alkyl halide under reflux for 5hrs ,while the compounds (5a-d) were formed from the reaction of (4a-d) with phosphorous oxy chlorid . The compounds (6a-d) were synthesized from the reaction of (5a-d) with thiourea under reflux for 6hrs and the compounds (8a-d) were obtained from the reaction between (6a-d)with chloro acetic acid (0.01mole) under refluxed for 3hrs. All the synthesized compounds of pyrimidines derivatives were identified by the physical properties by it's melting points and colors and the yields were characterized by the elemental (CHN) analysis, IR, U, and visible spectra data.

Aim of the Study
Synthesis and characterization of some new Pyrimidines derivatives by using ethyl cyano acetate and substituted Aldehyde as starting materials.

Materials and Methods
All melting points were recorded using electro thermal 9100 melting point apparatus and fourier transform infrared spectra were recorded using the KBr disc technique on A JASCO 440 FTIR spectra photo meter. The elementals (CHN) analysis were performed using an Exeter CE -440 Elemental Analyzer, and the UV spectrum was recorded on ashimadzu mini -1240 spectrophotometer.

The general procedures for preparation:
Method A: Preparation of Compounds (3a-d)
A mixture of substituted aldehydes (0.01mole) ethyl cyano acetate (0.01mole) Thiourea (0.01mole) and potassium carbonate (0.01mole)in ethanol was heated under reflux for 6hrs .The solid precipitated during the reaction was collected by stirred water and acidified with acetic acid .The deposited precipitate was collected, washed with water and crystallized from the proper solvent to give the products.

Method B: Preparation of Compounds (4a-d).
A mixture of (3a-d) (0.01mole) alkyl halide or aryl halide and potassium carbonate 0.01mole) in ethanol 40ml was heated under reflux for 5hrs ,allowed to cool and diluted with water. The solid product was filtered off and recrystallized form proper solvent .

Method C: Preparation of Compounds (5a-d)
A solution of (4a-d) 0.01mole in dioxane 40ml was heated with phosphorous oxy chloride 20ml and heated under reflux for 4hrs .The reaction mixture was cooled and poured into ice water. The solid form was collected, dried and recrystallized from the proper solvent.
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**Method D:** Preparation of Compounds (6a-d)
A mixture of (5a-d) 0.01mole and thiourea 0.01mole in ethanol was heated under reflux for 6hrs. The reaction mixture was left to cool, then the solid form was filtered and recrystallized from the proper solvent.

**Method E:** Preparation of Compounds (8a-d)
A mixture of compounds (6a-d) 0.01mole, chloro acetic acid 0.01mole and sodium ethoxide (0.012mole) in ethanol 30ml was refluxed for 3hrs. The reaction mixture allowed to cool, then filtered off and recrystallized from ethanol or chloroform.

**Results and Discussions**
The pyrimidines derivatives were synthesized by the reaction between substituted benzaldehydes(1a-d)with ethyl cyano acetate and potassium carbonate in the present of ethanol as a solvent to give the intermediate compounds (2a-d) and the cyclo condensation of compounds (2a-d) with thiourea in ethanol yield of the products compounds (3a-d). The pyrimidines derivatives (3a-d) were identified by its melting points(234-235°C), (242-243°C),168.2°C,304 decompose corresponding, while the yields of these compounds are :73%, 65.7%, 56.5%, 61.68%.

**Table (1):** The physical properties for the synthesized compounds (3a-d)

| Compounds NO | Aryl | M. Formula | M. weight g/mole | Yield % | M.P Cº | C/F |
|--------------|------|------------|------------------|---------|--------|-----|
| C12H9N3SO2  |       |             |                  |         |        |     |
| 3a           |      | C6H5-P-CH3 | 254              | 73      | 234-235| 55.59 C% 3.47 H% 16.21 N% 12.15 O% 12.35 S% |
| 3b           |      | C6H5N3SO   | 243              | 65.7    | 242-243| 59.25 C% 3.70 H% 17.28 N% 6.58 O% 13.16 S% |
| 3c           |      | C6H5-P-OH  | 245              | 56 white| 168.2 | 53.87 C% 2.85 H% 17.10 N% 13.06 O% 13.06 S% |
| 3d           |      | C6H5N3SO   | 257              | 61.86   | 304 Decompose | 60.70 C% 4.28 H% 16.34 N% 6.22 O% 12.45 S% |

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Synthesis and characterization of some new compounds (4a, 4b, 5a, 6a, 8a) were identified by melting points 4a= (156-157 °C) 4b= (281-282 °C) 5a=(180-181 °C), 6a= 245 °C, 8a= 304 decompose corresponding, while the yields of these compounds are: 70.83% 52.66% 80%, 60%, 61.86. The synthetic pathway of the compounds (4a, 4b) were shown in Scheme (2) and (5a) in Scheme (3) and the compound (6a) in Scheme (4), while the synthetic of compound (8a) is shown in Scheme (5).

**Table (2):** The physical properties for the synthesized compounds 4a, 4b, 5a, 6a, 8a

| Compounds NO | Aryl | M. Formula | M. weigh g/mole | % yield color | MP °C | C% | H% | N% | O% | S% | CL% |
|--------------|------|------------|-----------------|---------------|-------|----|----|----|----|----|-----|
| 4a           | C₂H₅OCH₃ | C₁₀H₁₂N₃O₃Cl₃ 363 | 70.83 white | 156-157 | 62.80 | 3.58 | 11.57 | 13.22 | 8.81 | 12.25 | - |
| 4b           | C₂H₅CH₃ | C₁₀H₁₂N₃SO | 52.66 white | 281-282 | 61.99 | 4.79 | 15.49 | 5.90 | 11.80 | - |
| 5a           | C₂H₅OCH₃ | C₁₀H₁₃N₃SOCl Cl₃ 381.5 | 80 white | 180-181 | 59.76 | 3.14 | 11.00 | 8.38 | 8.38 | 9.30 | 9.25 |
| 6a           | C₂H₅OCH₃ | C₁₀H₁₃N₃SO₂ Cl₃ 379 | 60 yellow | 245 | 60.15 | 3.43 | 3.69 | 3.60 | 6.22 | 16.09 | - |
| 8a           | C₂H₅CH₂ CH₃ | C₁₀H₁₃N₃SO | 61.86 white | 304 decompose | 60.70 | 4.28 | 16.34 | 6.22 | 12.45 | - |

Where 2a and 3a Ar = P-OCH₃-C₆H₅
2b and 3b Ar = P-CH₃-C₆H₅
2C and 3C Ar = P-OH-C₆H₅
2d and 3d Ar = P-CH₃-CH₂-C₆H₅

The pyrimidines derivatives 4a, 4b, 5a, 6a, 8a were identified by melting points 4a= (156-157 °C) 4b= (281-282 °C) 5a=(180-181 °C), 6a= 245 °C, 8a= 304 decompose corresponding, while the yields of these compounds are: 70.83% 52.66% 80%, 60%, 61.86. The synthetic pathway of the compounds (4a, 4b) were shown in Scheme (2) and (5a) in Scheme (3) and the compound (6a) in Scheme (4), while the synthetic of compound (8a) is shown in Scheme (5).
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Scheme (3)

\[
\begin{align*}
\text{(4a)} & \quad \text{Where } 4a \text{ Ar} = \text{P- OCH}_3 - \text{C}_6\text{H}_5 \\
\text{(5a)} & \quad \text{Where } 5a \text{ Ar} = \text{P- OCH}_3 - \text{C}_6\text{H}_5 \\
\end{align*}
\]

\[
\begin{align*}
\text{(4b)} & \quad \text{Where } 4b \text{ Ar} = \text{p- CH}_3 - \text{C}_6\text{H}_5 \\
\text{R} & = \text{CH}_2 - \text{CH}_3 \\
\text{4C and } 5C & \quad \text{Ar} = \text{P- OH - C}_6\text{H}_5 \\
\text{R} & = \text{CH}_2 - \text{CH}_3 \\
\text{4d and } 5d & \quad \text{Ar} = \text{P- CH}_3 - \text{CH}_2 - \text{C}_6\text{H}_5 \\
\text{R} & = \text{CH}_3 \\
\end{align*}
\]
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Scheme (4)

\[
\begin{align*}
\text{CL} & \quad \text{S} \\
\text{NC} & \quad \text{NC} \\
\text{Ar} & \quad \text{SAr} \\
\xrightarrow{\text{H}_2\text{N-C-NH}_2} \quad \text{EtOH} \Delta \\
\text{SH} & \quad \text{NC} \\
\text{Ar} & \quad \text{SAr}
\end{align*}
\]

(5a) Where 5a Ar = P-OCH$_3$-C$_6$H$_5$

(6a) Where 6a Ar = P-OCH$_3$-C$_6$H$_5$

\[
\begin{align*}
\text{O} & \quad \text{O} \\
\text{Ar} & \quad \text{Ar} \\
\xrightarrow{\text{H}_2\text{N-C-NH}_2} \quad \text{EtOH} \Delta \\
\text{SH} & \quad \text{NC} \\
\text{Ar} & \quad \text{SAr}
\end{align*}
\]

(5b-d)

where 4b and 5b Ar = p-CH$_3$-C$_6$H$_5$
R = -CH$_2$-CH$_3$
4C and 5C Ar = P-OH - C$_6$H$_5$
R = -CH$_2$-CH$_3$
4d and 5d Ar = P-CH$_3$-CH$_2$-C$_6$H$_5$
R = -CH$_3$
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Scheme (5)

\[
\text{Scheme (5)}
\]

(6a)

Where \(6a\) \(Ar = P\cdot OCH_3\cdot C_6H_5\)

\(Ar = C_6H_5\cdot C\cdot O\)

(7a)

Where \(6a\) \(Ar = P\cdot OCH_3\cdot C_6H_5\)

\(Ar = C_6H_5\cdot C\cdot O\)
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Where 7b and 8b Ar = p - CH3 - C6H5

R = - CH2 - CH3

7c and 8c Ar = P- OH - C6H5

R = - CH2 - CH3

7d and 8d Ar = P- CH3- CH2 - C6H5

R= - CH3

FT Infra Red Analysis of Compounds (3a - d):

The selected FTIR data are listed in Table (3) and the spectra of 3a, 3b, 3c, 3d are shown in Figures (1 - 4). The IR spectrum of compounds (3a, 3b, 3c, 3d) showed characteristic absorption bands at (3446 - 3177) cm⁻¹ for (\(\text{C} = \text{N}\)) stretching bands and the appearance of broad band of (3c) compound at (3545 - 3445) cm⁻¹ was assigned to the stretching of \(\nu - \text{OH}\) band. The main absorptions bands are observed at (1620- 1519) cm⁻¹ for (\(\text{C} = \text{C}\)), but it showed that (\(\text{C} = \text{N}\)) stretching vibration bands are (1666- 1588) cm⁻¹ and the appearance a strong bands at (1705- 1660) cm⁻¹ for (\(\text{C} = \text{O}\)) pyrimidinon; the bands with medium intensity observed (\(\text{C} \equiv \text{N}\)) at (2236-2229) cm⁻¹ the appearance band observed the substituted benzen ring at (3063- 3023) cm⁻¹ scribed to the stretching of aromatic (\(\text{C}_\text{Ar} \equiv \text{C} \equiv \text{H}\)) and the bands observed at (2987- 2818) cm⁻¹ for the (\(\text{C} \equiv \text{H}\)) and strong band for (\(\text{C} = \text{S}\)) at (1272 - 1228) cm⁻¹, while in compounds (3a, 3c) the stretching bands for (\(\text{C} = \text{O}\)) were at (1146- 1100) cm⁻¹ for methoxy and hydroxy groups respectively.
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Table (3): The FTIR absorptions of the prepared compounds (3a-d)

| Compounds No | - NH - OH | C_Aryl - H | C_Ali - H | C = C | C = N | C = C = N | C = O | C- O | C = S |
|--------------|-----------|------------|-----------|------|-------|----------|------|------|-------|
| 3a           | 3440      | 3063       | 2840      | 1573 | 1666  | 2236     | 1705 | 1146 | 1272  |
| 3b           | 3446      | 3059       | 2949-2818 | 1620 | 1640  | 2233     | 1680 | -    | 1228  |
| 3c           | 3420-3290 | 3023       | 2987-2903 | 1519 | 1588  | 2234     | 1660 | 1100 | 1230  |
| 3d           | 3446-3177 | 3049       | 2968-2873 | 1567 | 1607  | 2229     | 1679 | -    | 1240  |

Fig (1): IR spectrum of compound (3a)

Fig (2): IR spectrum of compound (3b)
Fig (3): IR spectrum of compound (3C)

Fig (4): IR spectrum of compound (3d)
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The Ultra Violet Spectrums of compounds (3a-d):

The selected UV data are listed in Table (4) and the spectra of 3a, 3b, 3c, 3d are shown in Figures (5 - 8). The appearance of three big bands in the compounds (3a, 3d) and absorptions of these compounds at (331-222) nm indicated the presence of achromophoric group in (C = S) or (C = C) or (C= N) from (Л → Л*) and (n → Л*) and the last band in the visible absorption. While in the compounds (3b, 3c) appearance absorption was two big bands at (340-203) nm.

Table (4): The UV absorptions of the prepared compounds (3a-d)

| Compounds No | λ nm | ε  | A  |
|--------------|------|----|----|
| 3a           | 222  | 73970 | 0.7397 |
|              | 286  | 19300 | 0.1930 |
|              | 330  | 11030 | 0.1103 |
| 3b           | 203  | 70470 | 0.7047 |
|              | 340  | 29940 | 0.2094 |
| 3c           | 221  | 56330 | 0.5633 |
|              | 338  | 15900 | 0.1590 |
| 3d           | 222  | 73580 | 0.7358 |
|              | 268  | 19570 | 0.1967 |
|              | 331  | 12210 | 0.1221 |

A = ε . C . L
A = absorbance
ε= Molarity absorbance
C = the concentrate Molarities
L = length of cell

Fig (5): UV Spectrum of compound (3a)
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Fig (6): UV Spectrum of compound (3b)

Fig (7): UV Spectrum of compound (3c)
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**Fig (8):** UV Spectrum of compound (3d)

**The FT Infra Red Analysis of compounds (4a , 5a, 8a):**

The selected FTIR data of compounds 4a, 5a, 8a are listed in Table (5) and the spectra compound (4a) is shown in Figure (9). The IR spectrum of compound (4a) showed a characteristic absorption band at 3422cm$^{-1}$ for (-NH) and 1613cm$^{-1}$ for (C=N) 1676 cm$^{-1}$ for (C = O ) , 2218 cm$^{-1}$ for (C ≡ N) and 1518cm$^{-1}$ for (C= C),1260 cm$^{-1}$ for (C − O) and651cm$^{-1}$ or(C − S). The IR spectrum of compound (5a) showed characteristic absorption band at 1607cm$^{-1}$for (C= N) , and 1532cm$^{-1}$ for (C= C) , 2224 cm$^{-1}$ for (C≡ N) , and 1276 cm$^{-1}$ for ( C − O) , and 840 cm$^{-1}$for ( C − S), while 1148cm$^{-1}$for (C$_{Aryl}$− cl). The spectra compound (5a) is shown in figure(10). The IR spectrum of compound (8a) showed a characteristic absorption band at 1646 cm$^{-1}$ for (C = N) and 1577 cm$^{-1}$for (C = C), while the appearance of the observed big wide band for (−COOH) at 3423cm$^{-1}$, and 1160cm$^{-1}$for (C− O) , and 890 cm$^{-1}$ for (C− S) the spectra compound of (8a) is shown in Figure( 11).

**Table (5) : The FTIR absorptions of the prepare compounds 4a , 5a , 8a .**

| Compounds NO | -NH -OH -COOH | C$_{Aryl}$-H | C-H | C =C | C = N | C = O | C − O | C − S | C$_{Aryl}-$ cl |
|--------------|----------------|--------------|-----|------|-------|------|-------|-------|----------------|
| 4a           | 3422           | 3015         | 2930- 2819 | 1518 | 1613  | 2218 | 1676  | 1260  | 661            |
| 5a           |                |              | 3071- 3006 | 2979-2843 | 1532| 1607 | 2224 | -1276 | 840 | 1148     |
| 8a           | -3423          | -            | 2902 | 1577 | 1646  | -    | -1160 | 890   | -              |

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Fig (9): IR Spectrum of compound (4a)

Fig (10): IR Spectrum of compound (5a)
The Ultra Violet spectrums of compounds (4a, 5a, 8a)

The selected UV data are listed in Table (6) and the spectra of compound (4a) is shown in Figure (12). The appearance observed only one big band absorption at 202 nm to indicate the presence of achromophoric group of double bonds in (C = C) or (C = N). The band absorption indicated the transfer from (π → π*), while the UV absorption of compound (5a) showed two bands absorption at 202 nm and 215 nm. The spectra of this compound is shown in Figure (13). The UV absorption of compound (8a) showed only one absorption band at 202 nm and indicated the presence of achromophoric group for (─ COOH). The spectra of compound (8a) is shown in Figure (14).

Tabel (6): UV absorptions of the prepare compounds 4a, 5a, 8a

| Compounds No | λ nm | 3   | A    |
|--------------|------|-----|------|
| 4a           | 202  | 20270 | 0.2027 |
| 5a           | 202  | 19660 | 0.1966 |
|              | 215  | 10860 | 0.1086 |
| 8a           | 202  | 24980 | 0.2498 |

Fig (11): IR Spectrum of compound (8a)
Fig (12): UV Spectrum of compound (4a)

Fig (13): UV Spectrum of compound (5a)
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**Conclusion**

1- A heterocyclic compounds are those which possess acyclic structure with two different kinds of atoms in the ring such as: Nitrogen, Oxygen and sulfur which are the most common heteroatom's. Most of the sugar, vitamins, alkaloids, which are Nitrogenous bases occurring in many antibiotics, including penicillin, are heterocyclic compounds. Pyrimidines derivatives have found to possess interesting antibacterial, antipsychotic, antiscizophrenia and antihypertensive activity anti viral, anti titermer anti inflammatory,anti microbial and anti fungal, anti histaminic, and analgesic, malaria, Alzheimers disease, Parkinson's disease and anti oxidant properties.

2-All the synthesized compounds of pyrimidines derivatives were identified by the physical properties by it's melting points and colors and the yield were characterized by the elemental (CHN) analysis, IR, UV and visible spectra data.

3- The IR spectrum of the prepared compounds were characterized by higher intensities.

4- The absorption bands show higher frequencies for the prepared compounds, while in compound (8a) the appearance of a broad band was assigned to the stretching of ν - COOH band, and especially. The ν -(C= C) , ν(C≡ N ) band; this fact together with the achromophoric shift in (C≡ S) or (C = C) or (C≡ N) from (J → J*) and (n → J*) the UV Spectra.

5- Entrance of substituent's into the prepared compound (8a) leads to decreased intensity was suggested due to intermolecular hydrogen bonding, with disappearance of (C ≡ N) stretching which present in the parent compound.

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Fig (14): UV Spectrum of compound (8a)
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تخليق وتشخيص بعض المركبات الحلقية الجديدة غيرالمتجانسة المحتوية على درتي
نتروجين في تركيبها الحلقي

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الملخص
تقوم مشتقات البيريميدين بوظيفة أساسية و مهمة في مختلف العمليات البيولوجية كما أن لها حضور في تركيب العديد من الأدوية والمستحضرات الطبية إذ أنها تستخدم صناعياً في إنتاج العديد من العقاقير الطبية كمضادات الحيوية ومسكن الألم ومضادات البكتيريا ومضادات الالتهابات ومضادات الأكسدة والفطريات. وفي هذا العمل تم تخليق وتشخيص بعض المشتقات الجديدة للبيريميدين وهي:

- 2-مركبتو 3,4-ثنائي الهيدرو-4-أوكسو [H4]بيريميدين - 5 - كاربونيتريل
- وكذلك 2-مركبتو 3,4-ثنائي الهيدرو-4-أوكسو [H4]بيريميدين - 4 [مستبدلات] البنزين - 4 [بيريميدين - 5 - كاربونيتريل (d) ].
- أما المشتقات الأخرى (3a-d) التي استخدمتها كمواد أولية مع أريل أو الكل هاليد وذلك بتسخينها باستخدام المكثف العاكس لمدة 5 ساعات تم الحصول على المركبات (5a-d) من تفاعل الفوسفواوكسيا كلورايد مع مشتقات البيريميدين (4a-d) وذلك بتسخينها باستخدام المكثف العاكس لمدة 4 ساعات. كذلك تم تحضير المركبات (5a-d) من تفاعل الثيوريا مع مشتقات البيريميدين كمواد أولية (6a-d) في وجود الأيثانول و وذلك بتسخينها باستخدام المكثف العاكس لمدة 6 ساعات. ناتج التفاعل من الخطوة السابقة (7a-d) تم معاملته مع كلوريد حمض الخليك وأثوكسي الصوديوم ويوجد الأيثانول كذيب وباستخدام المكثف العاكس لمدة 3 ساعات تم الحصول على المركبات الحلقيه لمشتقات البيريميدين (8a-d).

وقد خضعت المركبات التي تم تخليقها لدراسة خواصها الفيزيائية مثل تعيين درجات انصهار وتحديد درجات انصهار وتحديد ألوانها وكذلك المردود المنوي (الحصيلة) كما تم تشخيصها من خلال تحليل عناصر ودراسة طياف الأشعة فوق البنفسجية والأشعة تحت الحمراء.

الكلمات المفتاحية: أريل سانتون أسئت, مشتقات (مستبدلات) البنزالدهيد, أريل والكل هاليد, الفوسفواوكسيا كلورايد, الثيوريا, كلوريد حمض الخليك, أثوكسي الصوديوم, مشتقات البيريميدين, أطيف IR, الأشعة فوق البنفسجية, UV, الأشعة فوق الحمراء.