SYNTHESIS OF META-ALTERED ARYLMALEINAMIDE AND PREPARATION OF ESTERS IN THEIR PRESENCE

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СИНТЕЗ МЕТА-ИЗМЕНЕННОГО АРИЛМАЛЕИНАМИДА И ПОЛУЧЕНИЕ СЛОЖНЫХ ЭФИРОВ В ИХ ПРЕСУСТВИИ

Хуршида ТУРАЕВА (torayevah@mail.ru), Мухаббат ЮЛДАШЕВА (ymuxabbat@bk.ru), Садокат ХАЙДАРОВА (haydarova.sadoqat@mail.ru)
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Po-прежнему актуальным остается разработка новых методов синтеза, используя более дешевые реагенты при получении производных малеиновой кислоты, изучение химических свойств и определение новых направлений практического применения производных малеиновой кислоты. Поэтому результаты этой работы являются актуальной задачей. Целью данного исследования было получение синтеза мономалеинамида в различных условиях для получения арилмалеинамидных производных малеиновой кислоты и их перенос в частные состояния для дальнейших реакций. В данном исследовании была проведена научная исследовательская поисково-уточняющая работа. Методом получение мономалеинамида из малеиновой кислоты на основе молекулярных реакций ароматических соединений с функциональными группами: –ОН, -СООН, -СО2Н с малеиновым ангидридом и малеиновой кислотой в метанол и гликоле при пропагионировании на уровни реакции. Относительная активность аминов в реакциях поликонденсации изменяется в зависимости от концентрации условий. Исходя из этой последовательности м-нитроанилин оказался более активным. Предложены методами изучено влияние растворителей (диметилформамид, диметилформамид) на реакцию монархамидов с малеиновым ангидридом, а также на реакции с малеиновой кислотой (ацилло, лейдияуская кислота) и влияние различных температур на выход реакции. Апротон показал высокие выходы в реакции, ацетон оказался более активным. В результате реакции этирификации арилмалеинамида и метилового эфира были проведены синтез соответствующих сложных эфиров. Строение полученных соединений подтверждено методами ЯМР, GC-MS и другими методами. Изучен уровень активности N-(3-гидроксифенил)малеинамида в отношении некоторых микроорганизмов.

Ключевые слова: маленновый ангирид (МА), маленовая кислота (МК), м-аминофенол, м-аминофенокси, м-нитроанилин, ацетон, маленовая кислота, тонкослойная хроматография (TLC), ЯМР-спектроскопия, ИК-спектроскопия.

META ALMASHINGAN ARILMALEINAMIDLAR SINTEZI VA ULAR ISHTIROKIDAGI MURAKKAB EFIR O LISH REAKSIYASI

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Маленковый ангирид (МА), маленовая кислота (МК), м-аминофенол, м-аминофенокси, м-нитроанилин, ацетон, маленовая кислота, тонкослойная хроматография (TСХ), ЯМР-спектроскопия, ИК-спектроскопия.

Introduction

According to the literature, compounds containing amide or imide group have been identified as various biologically active substances. Therefore, this type of pharmacological synthesis has aroused our interest. The obtained compounds are expected to be used in the polymer industry, perfume industry, along with the fact that they may have biological activity.

Products based on maleic acid derivatives are used in the field of electronics [1], aviation technology [2], medicine [3, 4], as an isolating agent in machinery, as well as in the production of adhesives, paints and copolymers [5-7]. These types of compounds have been recommended in medicine as pharmaceuticals with high efficacy for the treatment of a number of diseases, including cancer, HIV, diabetes, Alzheimer’s [8], Leishmaniasis, and others [9-11]. Maleic acid derivatives show high fungicidal and bactericidal activity [12, 13]. Maleic acid and its
derivatives are reagents of particular importance in the field of organic synthesis with their high reactivity. As a result of the action of the double carbonyl group in maleic acid derivatives, it has the property of easily initiating coupling reactions [14]. In this study, we conducted research on finding convenient ways to obtain amide derivatives of maleic anhydride with some monoamines. The structure of the obtained monoamide derivatives was defined using analytical techniques.

In general, the direction of the reaction for the synthesis of maleinamides depends on the validity and structure of the initial monoamide, the solvent and the temperature.

Material and methods
The reactions were performed in different solvents. In the equimolar reaction of meta exchanged aromatic amine derivatives (-OH, -COOH, -NO2) - with maleic anhydride was carried out in acetone and a monoamide of the corresponding maleic acid was synthesized. The good solubility of the starting materials in acetone and the poor solubility of the mono-exchange product obtained in the reaction lead to the reaction product being obtained purely and with high yields. Since the nucleophilic binding of maleic anhydride to amines is exothermic, the reactions take place at 25°C and even below. The resulting substance was filtered under the vacuum.

Equation of reaction of maleic anhydride with corresponding amines:

\[
\text{R}^+\text{N}^- + \text{MA}^- \rightarrow \text{RN}^-\text{MA}^+
\]

The course of the reaction can be explained using the following mechanism scheme. The reaction starts with an attack of an amino group with high meta arylmonoamines (m-ArA) nucleophilicity on a strongly polar MAh and the corresponding arylmonomaleinamide is formed. The mechanism of reaction of maleic anhydride with the corresponding amines:

The products were obtained with high yields, as shown in Table 1 below.

In general, the reaction between arylamine derivatives and maleic anhydride gave increased yield for acceptor substituents than donor substituents [15].

Based on the results of the experiment, it can be stated that as the temperature decreases, the side reactions decrease and the chances of obtaining monomaleinamide with high yield increase. As the reaction time increases, the yield of the product also increases consistently. Addition, the nature of the solvents affects the yield of the product and the course of the reaction.

The known polarity values of the solvents used in the reactions (\(E_l\) 30), \(kcal/mol\)) were dioxane-0.164, acetone-0.355, DMFA-0.404, ethanol -0.654 [16].

The reason for choosing acetone as a solvent in the reaction is that the starting materials dissolve well in this solvent at room temperature, while the solubility of resulting product is poor in this solvent. Moreover, ethanol, DMFA, and similar polar solvents might undergo a chemical interaction with carbonic acids. In addition, as the solubility of the synthesized products in these solvents is good, it would be difficult to precipitate them and the losses increases. In the dioxane, however, the low solubility of the starting materials in this solvent does not correspond to the optimal reaction conditions. Hence, when maleinamide synthesis is carried out in acetone, the reaction proceeds readily with high yield at room temperature (Figure 1).

Based on the results of the experiment, in the acetone solvent, with increasing reaction time at room temperature, side reactions were reduced, which allowed to obtain monomaleinamides with

<table>
<thead>
<tr>
<th>№</th>
<th>Names of amines</th>
<th>Temperature, °C</th>
<th>Solvent</th>
<th>Reaction duration (hours)</th>
<th>Product yield, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>m-aminophenol</td>
<td>20-25</td>
<td>Acetone</td>
<td>24</td>
<td>60</td>
</tr>
<tr>
<td>2</td>
<td>m-aminobenzoic acid</td>
<td>20-25</td>
<td>Acetone</td>
<td>24</td>
<td>91</td>
</tr>
<tr>
<td>3</td>
<td>m-nitroanilin</td>
<td>20-25</td>
<td>Acetone</td>
<td>1</td>
<td>95</td>
</tr>
</tbody>
</table>
high yields.

Reactions were also performed with maleic acid. Reactions of amines with maleic acid require higher temperatures and longer time than those of maleic anhydride. Reactions with maleic acid are given in Table 2 below.

Mechanism of reaction of maleic acid with appropriate amines:

\[
\begin{align*}
\text{O} & \quad \text{C} \quad \text{O} \\
\text{O} & \quad \text{C} \quad \text{NH}_2 \\
\text{H}_2 & \quad \text{N} \\
\end{align*}
\]

Figure 1. Effect of solvent on the reaction yield of maleic anhydride in reactions with m-exchange arylamines.

**Table 2**

<table>
<thead>
<tr>
<th>№</th>
<th>Name of amines</th>
<th>Temperature, ºC</th>
<th>Solvent</th>
<th>Reaction duration (hours)</th>
<th>Product yield, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>m-aminophenol</td>
<td>55-60 / 90-100</td>
<td>Acetone</td>
<td>6 / 4</td>
<td>38</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Ice acetic acid</td>
<td></td>
<td>50</td>
</tr>
<tr>
<td>2</td>
<td>m-aminobenzoic acid</td>
<td>55-60 / 90-100</td>
<td>Acetone</td>
<td>5 / 4</td>
<td>48</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>Ice acetic acid</td>
<td></td>
<td>63</td>
</tr>
<tr>
<td>3</td>
<td>m-nitroanilin</td>
<td>55-60 / 90-100</td>
<td>Acetone</td>
<td>4 / 3</td>
<td>68</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Ice acetic acid kislota</td>
<td></td>
<td>72</td>
</tr>
</tbody>
</table>

**Table 3**

**Characterization of synthesized monomaleinamides**

<table>
<thead>
<tr>
<th>№</th>
<th>Name of amines</th>
<th>Mol. mass</th>
<th><strong>Rf</strong></th>
<th>Brutto formula</th>
<th><strong>T</strong>$_{\text{lique}}$, ºC</th>
<th>Solubility (s-soluble; d-difficult to dissolve; * -soluble (25 ºC))</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>N-(3-Hydroxyphenyl) maleinamide</td>
<td>207</td>
<td>0.24</td>
<td>C$<em>{10}$H$</em>{9}$NO$_{4}$</td>
<td>168-169 Light green</td>
<td>Aseton d Methanol, ethanol s Hexane, benzene, water *</td>
</tr>
<tr>
<td>2</td>
<td>N-(3-Carboxyphenyl) maleinamide</td>
<td>235</td>
<td>0.49</td>
<td>C$<em>{11}$H$</em>{9}$NO$_{5}$</td>
<td>209-210 White yellow</td>
<td>Ethanol d Methanol s Benzene, hexane, toluene, water *</td>
</tr>
<tr>
<td>3</td>
<td>N-(3-Nitrophenyl) maleinamide</td>
<td>236</td>
<td>0.19</td>
<td>C$<em>{11}$H$</em>{9}$N$<em>{2}$O$</em>{5}$</td>
<td>192-193 Light yellow</td>
<td>Ethanol d Methanol S Benzene, toluene, water *</td>
</tr>
</tbody>
</table>

**Thin layer chromatography (Pre-coated TLC sheets ALUGAM® Xtra SIL G / UV$_{254}$), (silufol, system benzene:methanol 3:1), opener-UV lamp (camera).**
Monomaleinamide is obtained by heating monoammonium salts of maleic acid. In an acidic medium.

Some properties of the monomaleinamides synthesized are given in Table 3.

Subsequent reactions were carried out with complex esters by carrying out the reaction in the presence of alcohols. This was done by boiling N-(3-Nitrophenyl)maleinamide in the presence of P2O5 with methanol and ethanol for 3-4 hours. As a result, the corresponding ester was obtained with R: CH3=48% and R: C2H5=61% yields. Methyl ether - yellowish substance, ethyl ether - dark yellow substance.

The reaction of N-(3-Carboxyphenyl) maleinamide with these methods for 3 hours showed that side reaction products were formed. Even the hydrolysis of N-(3-Carboxyphenyl) maleinamide was found to break it down to m-amino benzoic acid. Analysis of the reaction product by thin-layer chromatography revealed that additional substances were formed on the plate. A 1:1 mole ratio of benzene and methanol was used as the solvent for thin-layer chromatography (Figure 2).
This was confirmed by the chromato-mass spectrum (Figure 3).

The results of the analysis of the chromato-
mass spectrum of the substance obtained from the
reaction of N- (3-carboxyphenyl) maleinamide with
ethanol in the device GC-MS are shown in Figure 3.

In conclusion, it was found that increasing
the reaction time resulted in a decrease in ester
yield and even an increase in side reaction products
as a result of decomposition.

Experimental part: Infrared Fourier spec-
trometer "IRTracer-100" (SHIMADZU CORP., Ja-
pan 2017) in complete with the prefix broken total
internal reflection (NIP) MIRacle-10 c prism dia-
mond/ZnSe (spectral range on the scale of wave
numbers 4000÷400 cm⁻¹; resolution - 4 cm⁻¹, sensi-
tivity signal-to-noise ratio 60,000:1; scanning speed
-20 spectra per second); ¹H NMR -spectrometer the
Unity 400plus (Varian) ICPS AS RUz spectrometer
in (CD₃OD). GC-MS: Mass-Hunter/GC-MS/1/600
have been used. The purity of obtained compounds
was determined on thin-layer chromatography
(TLC) with plates (Pre-coated TLC sheets
ALUGAM® Xtra SIL G/UV254), mobile phase-
benzene: methanol 3:1.

Research methods. Method A. N-(3-Hydroxyphenyl) maleinamide synthesis. In a flask equipped with a mechanical stirrer, reverse coolant and dropper funnel, add 2.94 g (0.03 mol) of maleic anhydride dissolved in 15 ml of acetone and 3.69 g (0.03 mol) of meta-aminophenol dissolved in 15 ml of acetone in a drip funnel. The reaction was carried out for half an hour while stirring. The color of reaction mixture changed to orange. Once the reaction was completed, the mixture was kept at room temperature for one day and the precipitated yellow solid state compounds were filtered under vacuum, washed several times in cold acetone, and dried in the open air. 4 g (61%) (ethanol), green crystals, \( \approx 168-169 \degree C \). (silufol, system benzene:methanol 3:1, \( R_f=0.24 \)).

In the 1H NMR spectrum (CD3OD \( \delta \), ppm) the multiplet signals of the four hydrogen protons of the aromatic ring are \( \delta=6.55-7.17 \), \( 6.22-6.51 \) d (2H, \( \text{CH}^{-\text{CH}} \)), 6.55-7.17 m (4H, \( \text{ArH} \)).

\[
\begin{align*}
1 & \text{N-(3-Hydroxyphenyl) maleinamide} & 3.24 \text{ s (H, OH)}, 4.92 \text{ s (H, NHCO)}, 6.22-6.51 \text{ d (2H, CH}^{-\text{CH}} \text{), } 6.55-7.17 \text{ m (4H, ArH)}. & \text{m/z 207, 128, 112, 100, 84, 69, 58, 41, 29.} & 3211(\text{nOH}), 1471, 1377(\text{dOH}), 1456, 1413(\nu=\text{C=C, ArH}), 2970(=\text{C-H, ArH}), 775, 725(\text{d=\text{C-H, ArH}}, 3305, 1575(\nu=\text{N-CO-}), 1631(\nu=\text{C=C}). \]
\end{align*}
\]

In the IR spectrum, it was shown that the valence absorption frequencies of the \( \text{cis-} \) carbon-carbon \( \text{C=C} \) double bond in the maleic acid residue gave a weak intensive absorption frequency at 1631 cm\(^{-1}\). The deformation vibration frequency of the \( =\text{C-H} \) group was observed in the 839 cm\(^{-1}\) domains, the mean weak valence and deformation vibrations of the \( \text{C=C} \) bond in the aromatic ring were observed in the 2970 cm\(^{-1}\), 775, 725 cm\(^{-1}\) domains. Valence oscillations of C=C group in the aromatic ring was observed in the region of 1456-1413 cm\(^{-1}\); the \( \text{C=O} \) valence oscillations of the nitrogen-bonded carbonyl group were observed in the 1699 cm\(^{-1}\) domain, while the valence and deformation oscillations for the bonded OH in the carboxyl group were observed in the 3211.48 cm\(^{-1}\), 1377 cm\(^{-1}\) domains. The valence and deformation oscillations associated with \( =\text{C-} \) characteristic of acid amides were shown in the 3055.99 cm\(^{-1}\), 1575 cm\(^{-1}\) region. The deformation vibration of the \( \text{OH} \) group in the benzene ring was observed in the intensive 1471 cm\(^{-1}\) region. The obtained spectral results clearly confirm the presence in the molecule of the synthesized substance \( =\text{HC}^{-\text{CH}}, \text{aromatic ring and its hydroxyl group, carbonyl, amide groups (Figure 5)}. \)

\[
\begin{align*}
\text{N-(3-Carboxyphenyl) maleinamide} & 3.24 \text{ s (H, COOH)}, 4.82 \text{ s (H, NHCO)}, 6.25-6.52 \text{ d (2H, CH}^{-\text{CH}} \text{), 7.39-8.21 m (4H, ArH)}. & \text{m/z 207, 128, 112, 100, 84, 69, 58, 41, 29 (Figure 6).} & 3097(\text{v=\text{C-H, ArH}}, 1540, 1440(\nu=\text{C=C, ArH}), 802, 734(=\text{C=H, ArH}), 3284(\text{nOH}), 1290(\text{dOH}), 1492, 1406(\nu=\text{C=C, ArH}), 3097, 1556(\nu=\text{N-CO-}), 1633(\nu=\text{C=C}). \]
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\[
\begin{align*}
\text{N-(3-Nitrophenyl) maleinamide} & 3.24 \text{ s (H, COOH)}, 4.84 \text{ s (H, NHCO)}, 6.25-6.52 \text{ d (2H, CH}^{-\text{CH}} \text{), 7.51-8.58 m (4H, ArH)}. & \text{m/z 207, 128, 112, 100, 84, 69, 58, 41, 29 (Figure 6).} & 3097(\text{v=\text{C-H, ArH}}, 1540, 1440(\nu=\text{C=C, ArH}), 802, 734(=\text{C=H, ArH}), 3284(\text{nOH}), 1290(\text{dOH}), 1492, 1406(\nu=\text{C=C, ArH}), 3097, 1556(\nu=\text{N-CO-}), 1633(\nu=\text{C=C}). \]
\end{align*}
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In the IR spectrum, it was shown that the valence absorption frequencies of the \( \text{cis-} \) carbon-carbon \( \text{C=C} \) double bond in the maleic acid residue gave a weak intensive absorption frequency at 1631 cm\(^{-1}\). The deformation vibration frequency of the \( =\text{C-H} \) group was observed in the 839 cm\(^{-1}\) domains, the mean weak valence and deformation vibrations of the \( =\text{C-H} \) bond in the aromatic ring were observed in the 2970 cm\(^{-1}\), 775, 725 cm\(^{-1}\) domains. Valence oscillations of C=C group in the aromatic ring was observed in the region of 1456-1413 cm\(^{-1}\); the \( \text{C=O} \) valence oscillations of the nitrogen-bonded carbonyl group were observed in the 1699 cm\(^{-1}\) domain, while the valence and deformation oscillations for the bonded OH in the carboxyl group were observed in the 3211.48 cm\(^{-1}\), 1377 cm\(^{-1}\) domains. The valence and deformation oscillations associated with \( =\text{C-} \) characteristic of acid amides were shown in the 3055.99 cm\(^{-1}\), 1575 cm\(^{-1}\) region. The deformation vibration of the \( \text{OH} \) group in the benzene ring was observed in the intensive 1471 cm\(^{-1}\) region. The obtained spectral results clearly confirm the presence in the molecule of the synthesized substance \( =\text{HC}^{-\text{CH}}, \text{aromatic ring and its hydroxyl group, carbonyl, amide groups (Figure 5)}. \)
Rf=0.49). In the $^1$H NMR spectrum (CD$_3$OD NMR δ, ppm) 3.24 s (H, COOH), 4.82 s (H, NHCO), 6.25 -6.52 d (2H, CH=CH), 7.39-8.21 m (4H, ArН). IR spectrum ν, sm$^{-1}$ 3284 (νOH), 1492, 1290 (δOH), 1492, 1406 (νC=С, ArH), 3030 (ν=C-H, ArH), 752 (δ=C-H, ArH), 3097, 1556 (ν -N-CО-), 1633 (νС=С).

**N-(3-Nitrofenil) maleinamide synthesis.**

13.8 g (0.1 mol) of m-nitroaniline dissolved in 25 ml of acetone solvent was added dropwise to 9.8 g (0.1 mol) of maleic anhydride dissolved in 25 ml of acetone and the reaction mixture was stirred. The reaction mixture begins to heat up so it is carried out chilled. The reaction mixture was kept for 1 hours. The precipitated white-yellow crystalline substance was filtered under vacuum and washed several times in acetone and dried in the open air. Yield 22.5 g (95%), white-yellow crystals, $T_{liqui}$=192-194 °C. (silulfol, benzene system:methanol 3:1, Rf=0.19). In the $^1$H NMR spectrum (CD$_3$OD NMR δ, ppm) 2.4 s (H, COOH), 4.84 s (H, NHCO), 6.25-6.52 d (2H, CH=CH), 7.51 -8.58 m (4H, ArН). IR spectrum ν, sm$^{-1}$ 3097 (νC=С), 1587 (νasNO$_2$), 1525 (ν -N-CО-), 1620 (νС=С), 1712 (νC=O), 1269 (νsNO$_2$).

IR spectrum. In the **cis** case, it was observed that the valence absorption frequencies of the carbon-carbon bond (C=C) in the maleic acid residue gave a weak absorption frequency at 1620.21 cm$^{-1}$. (=C-H) group oscillations were observed in the 852 cm$^{-1}$ regions of the deformation vibration frequency, the average weak valence (=C-H) in the aromatic ring in the 3097.68 cm$^{-1}$ and the

<table>
<thead>
<tr>
<th>Concentration of the compound (mg / ml)</th>
<th>Death zone of microorganisms (mm)</th>
<th>N-(3-Hydroxyphenyl) maleinamide</th>
<th>Nystatin (control)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Bacillus subtilis</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>7.0</td>
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<td><strong>Escherichia coli</strong></td>
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<td><strong>Fusarium oxysporum</strong></td>
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deformation 734, 802 cm\(^{-1}\) regions. Valence oscillations were observed in the average weak region of 1548–1440 cm\(^{-1}\) in the aromatic ring (C=C). The value of the carbonyl group (C=O) in the strong vibration field was 1712.79 cm\(^{-1}\), for the acid (OH) group 3265.49 cm\(^{-1}\), the absorption frequency in the weak k field and the deformation vibration frequency in the 1354.03 cm\(^{-1}\) field. Acid amides (O=C-NH) were observed to have a specific valence 3194.12 cm\(^{-1}\) absorption frequency and deformation oscillations 1525.69 cm\(^{-1}\) associated with cis. One of the frequencies with an intense appearance was the oscillation of nitro compounds (NO\(_2\)) in this aromatic ring in the valence symmetric domains 1269 cm\(^{-1}\) and the asymmetric frequencies 1587 cm\(^{-1}\). The obtained spectral results clearly confirm the presence in the molecule of the synthesized substance -HC=CH-, aromatic ring and its nitro group, carbonyl, amide groups.

**Method B.** Maleic acid and monoarylamine compounds (3.69 g (0.03 mol) metamaminophenol, 1.2 g (0.0087 mol) metamino-benzoic acid, 13.8 g (0.1 mol) m-nitroanilin) in a mixture of acetic acid 90-100°C, the reaction was carried out for 4 h. The mixture was then cooled to room temperature, the precipitate was filtered and separated from the solution (by water pump) and the residue was washed several times with cold water and dried in the open air for 12 h and recrystallized in ethanol.

**Synthesis of esters.** Place 30 ml (ethanol, methanol) on top of N-(3-nitrophenyl) maleinamide (2.36 g, 0.01 mol) in a round-bottomed round flask equipped with a reverse coolant, then add P2O5 (5 g) and cons.H2SO4 (1 ml) was added and mixed. The reaction was heated for 3–4 h. When the reaction was complete, the excess alcohol (ethanol, methanol) was removed. The reaction mixture was cooled to room temperature and then placed in a flask filled with ice water. The fallen oily liquid was separated in a separating funnel. washed several times with cold water. As a result, the corresponding ester was obtained with R: CH\(_3\)=48% and R: C\(_2\)H\(_5\)=61% yields. Methyl ether - yellowish substance, ethyl ether - dark yellow substance.

To summarize the spectral analysis, the specific valence oscillation value of the carbonyl group (C=O) in the maleic acid amide in the IR spectra was observed in the 1699-1712 cm\(^{-1}\) regions. Due to the presence of unsaturated carboxylic acid, it is reduced by about 20-30 cm\(^{-1}\). Acid amides (O=C-NH) were observed to have cis-bonded valence 3300–3090 cm\(^{-1}\) specific absorption frequencies and deformation oscillations in the 1570–1525 cm\(^{-1}\) regions. In addition, it was observed that the valence absorption frequencies of the carbon-carbon bond (C=C) in the maleic acid residue in the of the maleic acid product gave a weak absorption frequency in the 1633-1620 cm\(^{-1}\) region. It can be concluded that the obtained spectral results determine the presence in the molecule of the synthesized substances -HC=CH-, aromatic ring and carbonyl, amide groups.

In addition, the 1H NMR spectra of monoamides contain singlet signals of a hydrogen proton in the amide group (O=C-NH) (4.92–4.82) and double signals of a hydrogen proton in a double bonded carbon atom (H, CH=CH) (6.49-6.52) (Table 4).

Studies on the biological activity of synthesized N-(3-hydroxyphenyl) maleinamide have shown antimicrobial effects, including Bacillus subtilus, Escherichia coli, Pseudomonas aeruginosa, Staphylococcus aureus bacterial species, and Candida albicans, Mucor sp., Monilia sp., Fusarium oxysporium, Alternaria alternaria fungal species were used and activity levels were studied (Table 5).

**Conclusion**

Monomaleinamide derivatives of aromatic amines containing an electron-acceptor group (-COOH, -NO\(_2\)) in the meta state were obtained with high yields under mild conditions. In the meta-state, in the reactions of aromatic amines with hydroxyl, that is, the electron-donor group, with maleic anhydride, a monomaleimide derivative with relatively low yields was obtained. It can be concluded that if there are strong directing electron acceptor groups in the meta-state of aromatic ring, the reactivity of the amino groups increases and it is better to conduct the reactions with maleic anhydride in acetone solvent at room temperature. Furthermore, if there is an electron donor (-OH) group in the meta-state of aromatic ring, it takes longer time to increase the reaction yield.

The practical significance of the results of the study is that the biological activity of N-(3-hydroxyphenyl)maleinamide was studied and found to have bacteriolytic and fungicidal properties. The solutions of N-(3-hydroxyphenyl)maleinamide at concentrations of 5, 10 and 15 mg / ml together with Escherichia coli, Bacillus subtilus Pseudomonas aeruginosa Staphylococcus aureus Fusarium oxysporium, Monilia sp and Fusarium oxysporum have been found to have high biological activity in a solution with a concentration of 10 mg / ml in the suppression of pathogenic fungi.

**Acknowledgement**

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REFERENCES


