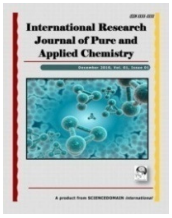

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Synthesis of Nitrogen-Containing Chalcone Via One-Pot Three-Component Reaction: Part IV

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Authors' contributions

This work was carried out in collaboration between all authors. All authors read and approved the final manuscript.

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ABSTRACT

The mannich reaction is one of the most important C-C bond formation methods in organic synthesis. The mannich-reaction is employed in the organic synthesis of natural compounds like for instance peptides-nucleotides-antibiotics and alkaloids. Other application are in agrochemicals such as plant growth regulators, paint and other polymer chemistry, catalysts and cross linking. The mannich reaction is also used in synthesis of medicinal compounds.
The compound 4-Hydroxy-4'-methoxychalcone was prepared by reacting 4-hydroxybenzaldehyde with 4-methoxyacetophenone. The aminomethylation of this chalcone was accomplished by reaction with formaldehyde and suitable amine in acetonitrile to obtain 4-hydroxy-4'-methoxy-3,5-bis-dimethylaminomethylchalcone(2) 4-hydroxy-4'-methoxy-3, 5-bis-pyrrolidinomethylchalcone(3)

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and4-hydroxy-4'-methoxy-3, 5-bis-piperdinomethylchalcone(4). The products were purified by column and thin layer chromatography and were identified along with their intermediates by spectroscopic methods: UV, IR, and NMR and mass spectrometry.

Keywords: Chalcones; mannich bases; aminoalkylation; three components reaction.

1. INTRODUCTION

The aim of this study to increase the bioactivity of the chalcones by introducing alkylamino group. Its increase the lipophilicity and hydrophilicity of chalchones by methylene and teretary amino group respectively.

The Mannich reaction is a three-component single pot reaction in which a secondary amine reacts with an aldehyde and an active hydrogen compound to afforded compounds known as Mannich bases. Sometimes the secondary amine is replaced by a primary amine or ammonia.

Studies on the chemistry of Mannich bases are of interest in various areas of applications. A large number of aminoalkyl derivatives have been synthesized in order to correlate their structure and reactivity with their pharmacological potential. Also Mannich bases represent easily obtainable intermediates for the synthesis of other compounds such as heterocycles, aminoalcohols …*etc.*

Mannich bases are known for their biological potential. Some Mannich bases possess anticonvulsant activity [1,2], others exhibit analgesic potency [3], some Mannich bases were reported [13] as potential chemo preventive agents. Mannich bases with putative cytotoxic activity were reported [4,5,6]. Stephen et al. [7] claimed antimalarial activity for some aminomethylated phenols. Tomas et al. [8] described the antibacterial potential of some fused Mannich ketones. Afaf et al. [9]. Reported some aminomethylated benzimidazoles with potent antimicrobial activity. The anticancer potential of some Mannich bases was outlined [10,11].

Chalcones are valuable intermediates in organic synthesis because of their ability to act as activated unsaturated systems in addition reactions of carbanions. They react with active methylene compounds of some phytochemicals to offered synthetics of pharmacy potential [12,13,14,15].

Chalcones exhibits diverse pharmacological activities, including anti-inflammatory [16], antileshmania [l7], antimitotic [17], antiinvasive [18], antitubercolosis [19], antifungal [20], antimalarial [21], antiplasmodial [21], antitumor [22], antioxidant [23], immunosuppressive [24], and cytotoxic [25] properties.

Bearing such interesting properties of Mannich bases and chalcones in mind it, was decided to join Mannich bases and chalcones in one molecule probably which potential pharmacological activities. The target molecule is approached via effective and facile strategy involving synthesis of chalcones and subsequent aminomethylation.

2. MATERIALS AND METHODS

2.1 Instruments

IR spectroscopy was carried out using spectrum BX instrument model L1050033, uv/visspectroscopy was carried out using beckman coulter instrument model DU 800 spectrophotmeter.

NMR spectroscopy was carried out using procker instrument model avanceII 600 and using procker instrumen avanceII 300 and MS spectroscopy carried out using MDS SCIEX instrument modelAPI 2000 LC/ MS/MS System.

2.2 Synthesis of 4-hydroxy-4'-methoxychalcone (1)

The solution of sodium hydroxide (10 ml of 10%) was added to a solution of the 4-methoxyacetophenone (0.02 mol) and 4-hydrxybenzaldehyde (0.02 mol) in ethanol (6 ml).The mixture was stirred at room temperature for 24 h and pourred into water (100 ml). After neutralization with 10% hydrochloric acid a yellow solid was obtained. m.p 152-154℃ (yield 85%) (Fig. 1).

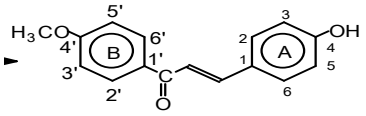


Fig. 1. 4-hydroxy-4'-methoxychalcone (1)

2.3 Synthesis of 4-hydroxy-4'-methoxy-3,5-bis-dimethylaminomethylchalcone(2)

A mixture of 4-hydroxy-4'-methoxychalcone (1) (0.005 mol), formalin (0.01 mol) and dimethylamine (0.01 mol) were reacted in refluxing acetonitrile (50 ml) for 36 h. On cooling the precipitate was formed. This crude product was fractionated on silica gel G using the solvent (hexane/ethylacetate/methanol/isopropylamine 7.5:1:1:0.5), 4-hydroxy-4'-methoxy-3,5-bisdimethyl aminomethylchalcone (2) was obtained as pale yellow crystals, m.p 112-116 ℃ (yield 41%) (Fig 2).

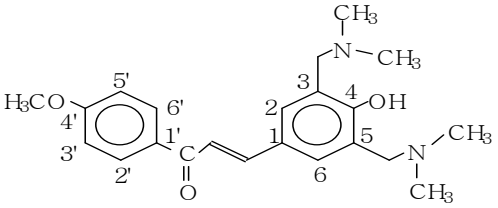


Fig. 2. 4-hydroxy-4'-methoxy-3,5-bis-dimethylaminomethylchalcone(2)

2.4 Synthesis of 4-hydroxy-4'-methoxy-3,5-bis-pyrrolidinomethylchalcone (3)

A mixture of 4-hydroxy-4'-methoxychalcone **(1)** (0.005 mol), formalin (0.01 mol) and pyrrolidine (0.01 mol) were reacted in refluxing acetonitrile (50 ml) for 36 h. On cooling the precipitate was formed. This crude product was fractionated on silica gel G using the solvent (hexane/ethylacetate/methanol/isopropylamine 7.5:1:1:0.5), 4-hydroxy-4'-methoxy-3,5-bis-pyrrilidinomethylchalcone **(3)** was obtained as pale yellow crystals, m.p 124-125℃ (yield 50%) (Fig. 3).

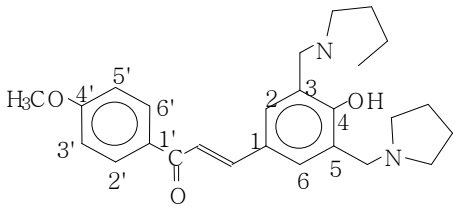


Fig. 3. 4-hydroxy-4'-methoxy-3,5-bis-pyrrolidinomethylchalcone (3)

2.5 Synthesis of 4-hydroxy-4'-methoxy-3,5-bis-piperdinomethylchalcone (4)

A mixture of 4-hydroxy-4'-methoxychalcone (1) (0.005 mol), formalin (0.01 mol) and piperidine (0.01 mol) were reacted in refluxing acetonitrile (50 ml) for 36 h. On cooling the precipitate was formed. This crude product was fractionated on silica gel G using the solvent system: hexane /ethyl acetate/ isopropyl amine (6:3.1) where 3-hydroxy-4'-methoxy-4-piperidinochacone (4) was obtained as pale yellow crystals, m.p 192-193℃ (yield 42%)(Fig. 4).

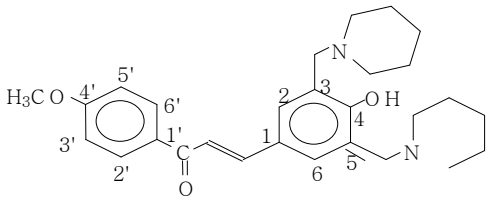
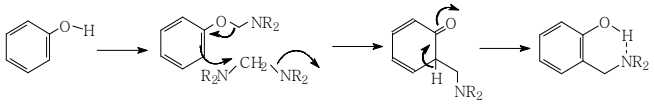


Fig. 4. 4-hydroxy-4'-methoxy-3,5-bis-piperdinomethylchalcone (3)

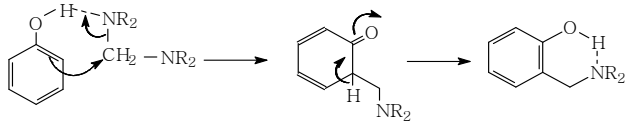
3. RESULTS AND DISCUSSION

The new chalcones with Mannich side chain presented in this work were synthesized by recting the chlcone 4-Hydroxy-4'-methoxychalcone with formaldehyde and suitable amine (dimethylamine, pyrroline and piperdine) in acetonitrile to obtain 4-hydroxy-4'-methoxy-3,5-bis-dialkylaminomethylchalcone.

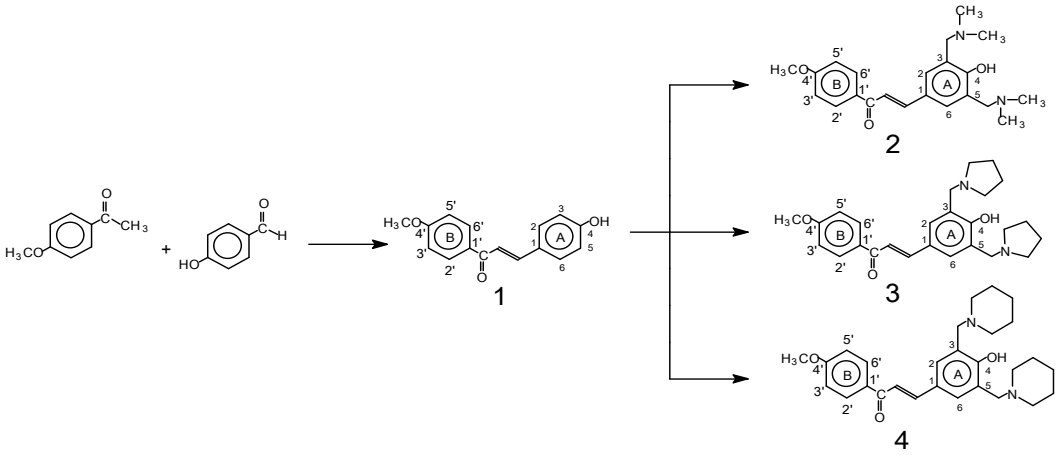
In the reaction mechanism all this groups (R-CH2-OH, R2N-CH2-NR2 and R2N+=CH2 ⇌ R2N=CH2+) were formed during the Mannich reaction, but the bis(dialkylamino)methane (aminal) is eligible to function as intermediate. Its eligibility was established by successful use of bis(dialkylamino)methane in abbreviated Mannich reaction in aqueous media bis(dialkylamino)methane (aminal) and alkoxydialky aminomethane (aminol) should take part in Mannich reactin like claisen rearrangement rather than elctrophelic aromatic substitution because the reaction occur in ortho position of phenolic group, and the intermediate is considered to be in enolic form or in an analogous tautomeric form.



Also the observed preference for attack ortho to hydroxyl group has result suggestion that the mechanism of mannich reaction involves hydrogen bonding of bis (dialkylamino) methane with phenolic group.



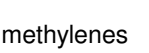
Three chalcones with Mannich side chain **(2)**, **(3)** and **(4)** were prepared together with their intermediate.

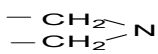
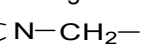


4-Hydroxy-4'-methoxychalcone was obtained by reaction of 4-methoxyacetophenone and 4-hydroxybenzaldehyde in alkaline ethanol solution m.p 152-154 ◌̊C (yield 85%) The **UV$_\lambda$** spectrum **λ_{max}** (ethanol), 250, 316 and 324 and 372 nm due to the benzoyl and cinnamoyl chromophores. The IR spectrum showed **v(KBr)** 829 (C-H, Ar, bending), 1226.6 (C-O), 1554, 1581, 1600 (C=C, Ar, st, vib), 1643 (C=O. st, vib), 3000 and 2800 and 3080 (C-H Ar) and 3182 cm^{-1} (OH). The ^{1}H-NMR spectrum showed signal at δ 3.95 (s, 3H) assigned for methoxyl group. The α and β protons resonate at δ 7.58 (d, J = 15.1 Hz, 1H) and δ 7.7 (d, J = 15.1 Hz, 1H). The signal at 7.71 (d, J = 9.0 Hz, 2H) was assigned for C_3 and C_5-H, while the signal at δ 7.06 (d, J = 9.0 Hz, 2H) is due to $C_{2,}$ and C_6-H of ring B. The doublet at δ 8.33 (J = 8.5 Hz, 2H) was assigned for $C_{3'}$ and $C_{5'}$-H, while the signal at δ 7.70 (d, J = 8.5 Hz, 2H), is characteristic of $C_{2',6'}$-H of ring A. ^{1}H-^{1}H cosy NMR demonstrated a diagonal relationship between α- and β-H of the chalcone moiety. Also coupling between C_3 and C_5-H $C_{2,}$ of ring B and C_6-H of ring A. The ^{13}CNMR spectrum showed a pattern characteristic of a C_{16} system. Apt experiments showed 11 carbons in positive mode (one –OCH_3, one Me, nine =CH-), and five types are in negative mode (quaternary carbons).

When 4-hydroxy-4'-methoxychalcone **(1)** was reacted with dimethylamine and formalin in dry acetonitrile under reflux the 4-hydroxy-4'-methoxy-3,5-bis-dimethylaminomethylchalcone **(2)** was obtained. m.p 112-116 (yield 41%) The ^{1}H-NMR spectrum showed a singlet at δ 2.40 (12H) assigned for four methyl groups. The signal at δ 3.70 (s, 2H), is characteristic of  . The methoxy groups. The resonance at δ 7.73 (d, 1H, J = 15.5) is characteristic of β –H , while the singlet at δ 7.45 (2H) was assigned C_2 and C_6-H. The signal at δ 6.98 (J 8.2 Hz, 2H) was assigned for $C_{3'}$ - and $C_{5'}$-H, while the signal at δ 8.07 (d, J 8.2 Hz, 2H) is characteristic of $C_{2'}$

and $C_{6'}$-H. ^{13}C NMR spectrum showed a pattern characteristic of a C_{22} system. Apt experiments showed 13 carbons in negative mode (one –OCH_3, four Me, eight =CH-), and 9 carbons in positive (two CH_2-, and seven quaternary carbons). The mass spectrum gave m/z 369.2 (42%) for the molecular ion. Other fragment at m/z 324.2 (100%) (base peak) is due to loss of amino group.

When 4-hydroxy-4'-methoxychalcone **(1)** was reacted with pyrrolidine and formalin in dry acetonitrile under reflux the 4-hydroxy-4'-methoxy-3, 5-bis-pyrrolidinomethylchalcone **(2)** was obtained. m.p 122-124, (yield 50%) In the IR showed **v(KBr**) 808 (C-H, Ar, bending), 1022 (C-N), 1163, 1253 (C-O), 1586 (C=C, Ar, st, vib), 1652 (C=O. st, vib), 2830 (C-H, aliphatic) 2930 (C-H and 2962 (OH) cm^{-1}. The ^{1}H-NMR spectrum showed a multiplet at δ 1.82-1.88 (8H) characteristic of the four methylene groups of  moiety. The resonance centered at δ 2.05-3.25 (8H) was assigned for four methylenes of of the pyrrolidine ring. signal at δ 3.98 (s, 4H), is characteristic of two methylenes  in the Mannich side chain. The methoxy groups were observed as a singlet at δ 3.78. The resonance at δ 7.43 (s, 1 H) was assigned for β–H while the signal at δ 7.73 (d, 1H, J = 15.5 Hz) was assigned for α–H The singlet at δ 7.40 (2H) was assigned C_2-H and C_6-H. The signal at δ 6.06 (J 9.0 Hz, 2H) was assigned for $C_{3'}$ – and $C_{5'}$-H, while the signal δ 8.05 (d, J 9.0 Hz, 2H) assigned for $C_{2'}$ – and $C_{6'}$-H. ^{1}H-^{1}H cosy NMR demonstrated a diagonal relationship between 8 protons of  (δ 1.82-1.88) and 8 protons of (δ 2.05-3.25). The ^{13}CNMR spectrum showed a pattern characteristic of a C_{25} system. Apt experiments showed 9 carbons in negative mode (one –OCH_3, eight =CH-), and 17 carbons in positive (ten CH_2-, and seven quaternary carbons). The noesy experiments showed long range coupling between C_2-H and C_6-H. The mass spectrum gave m/z 350 (100%) (base peak) for the molecular ion. Other fragment at m/z 279 (99%) are due to loss of amino group.

When 4-hydroxy-4-methylchalcone was reacted with piperdine and formaldehyde in dry acetonitrile under reflux. The 4-hydroxy-4'-methoxy-3,5-bis-piperlidinomethylchalcone **(4)** was obtained, m.p 124-125℃ (42%). The UV spectrum gave **λmax** (ethanol) 252, and 354 nm due to the benzoyl and cinnamoyl chromophores. The IR showed **v(KBr)** 829 (C-H, Ar, bending), 1149 (C-N), 1255 (C-O), 1471 and 1598 (C=C, Ar, st,vib), 1652 (C=O. st, vib), , 2796 (C-H, aliphatic) 2848 (C-H Ar) and 3933 (OH) cm^{-1} . The ^{1}H-NMR spectrum showed a multiplet at δ 2.40-260 (2H) characteristic of  of the piperidine moiety, while the multiplet at δ 1.70-1.90 (4H) was assigned for the  protons .The resonance at δ 1.53-173 (4H) was assigned for  of the piperdine ring. The methoxyl protons resonate at δ 3.90 (s, 3H). The signal at δ 3.64 (s, 2H), is characteristic of  . The resonance at δ 7.40 (s, 2H) was assigned for β–H and the signal at δ 7.74 (d, 1H, J =15.5 Hz) was assigned for α–H The singlet at δ 7.39 (2H) was assigned C_2- and C_6-H. The signal at δ 6.98 (J 9.0 Hz, 2H) is characteristic of $C_{3'}$- and $C_{,5'}$-H, while the signal δ 8.05 (d, J 9.0 Hz, 2H) was assigned for $C_{2'}$- and $C_{6'}$-H. ^{1}H-^{1}H cosy NMR demonstrated a diagonal relationship between the α and β protons of the chalcone moiety which resonate at δ 7.74 and δ 7.40 respectively, also demonstrated a diagonal relationship between all protons at piperdine moiety. The ^{13}CNMR spectrum showed a pattern characteristic of a C_{28} system. Apt experiments showed 9 carbons in negative mode (one –OCH_3, eight =CH-), and 19 in positive mode (twelve CH_2-, and seven quaternary carbons). The mass spectrum gave m/z 449.5 (3%) for the molecular ion. The most important fragments are at m/z 364.4 (100%) (base peak) due to loss of amino group, and m/z. 279.3 (80%) due to lost of two amino groups.

Two possible routes for target molecules (chalcones with Mannich side chains) are done during this work. The first route the dialkylaminomethyl group was introduced to aldehyde and then the chalcone was prepared (part i and ii). In the second route the chalcone was prepared and then dialkylaminomethyl group was introduced (part iii and iv).

The Mannich bases are important synthetic products used in different fields of applied sciences, and due to this application the present

work was designed to synthesize a number of Mannich bases of chalcones that could further be assessed for their different biological activities.

4. CONCLUSION

The aminomethylation of chalcone by reaction with formaldehyde and suitable amine in acetonitrile was achieved and characterization of the products and their intermediates by spectroscopic methods: UV, IR, and NMR and mass spectrometry was discussed.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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