Fourth International Electronic Conference on Synthetic Organic Chemistry (ECSOC-4), www.mdpi.org/ecsoc-4.htm, September 1-30, 2000

[A0050]

Microwave-mediated Regioselective Synthesis of Novel Pyrimido[1,2-a]pyrimidines under Solvent-free Conditions

Jean Jacques Vanden Eynde*[a], Nancy Hecq[a], Olga Kataeva[b] and C. Oliver Kappe[c]

[a]University of Mons-Hainaut, Organic Chemistry Department, Place du Parc 20, B – 7000 Mons, Belgium

E-mail: jjvde@umh.ac.be

[b]A.E. Arbuzov Institute of Organic and Physical Chemistry, Russian Academy of Sciences, Arbuzov street 8, Kazan 420083, Russia
E-mail: kataeva@kfti.knc.ru

[c]Institute of Chemistry, Karl-Franzens-University Graz, Heinrichstrasse 28, A – 8010 Graz, Austria
E-mail: oliver.kappe@kfunigraz.ac.at

Received: 8 July 2000 / Uploaded: 31 July 2000

Introduction

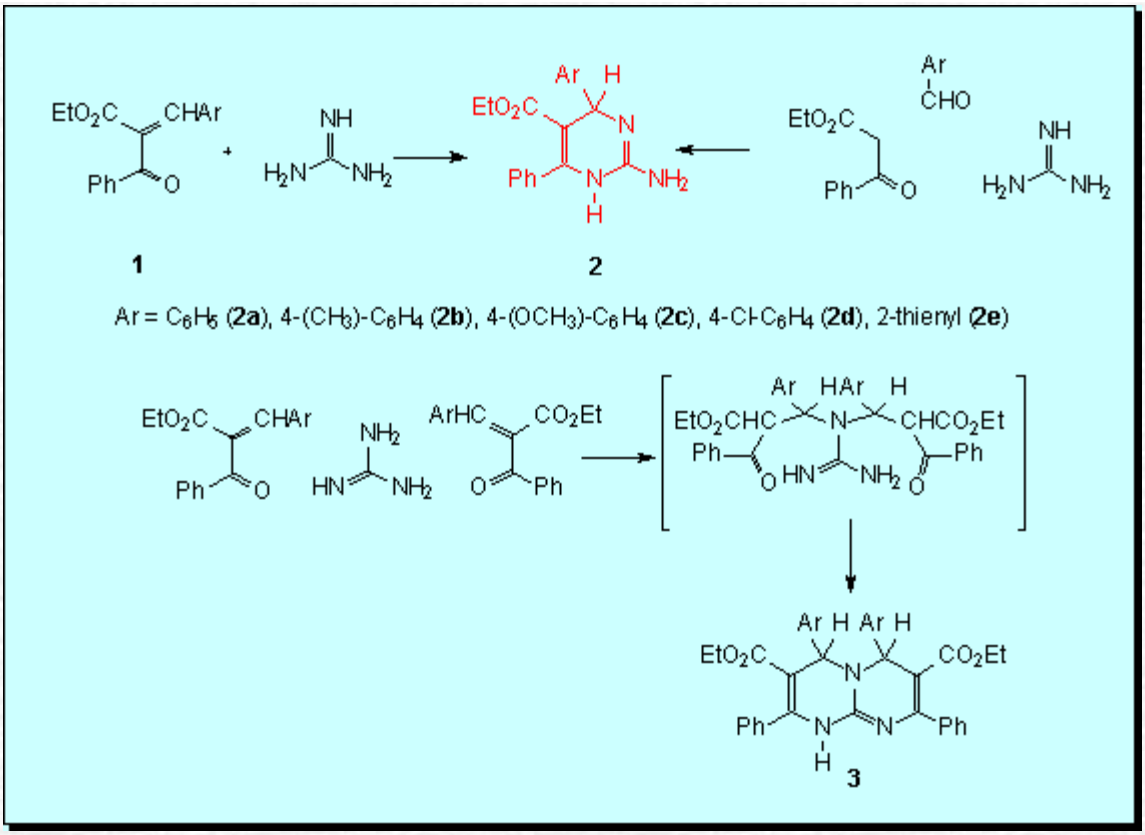
In recent years there has been increasing interest in the design of alkyl 1,4-dihydropyrimidine-5-carboxylates (1,4-DHPMs) and related Biginelli-like compounds [1] which are presented as valuable substitutes [2] for the well known Nifedipine® and other 1,4-dihydropyridine drugs [3] clinically used in the treatment of cardiovascular diseases. That interest is illustrated, *i.a.*, by the disclosure of elegant protocols involving solid phase synthesis approaches [4] as well as solvent-free preparations under microwave irradiation. [5]

The purpose of the present work is to extend the scope of those studies to 2-amino derivatives and especially to the evaluation of their synthetic potential for the construction of novel pyrimido[1,2-a]pyrimidines, a ring system that can be found in marine-derived natural products such as crambescidin [6] and batzelladine [7] alkaloids.

Results and Discussion

Preparation of the starting 2-amino-1,4-DHPMs

A recent paper of Milcent [8] describes the synthesis (Scheme 1) of alkyl 2-amino-4,6-diaryl-1,4-dihydropyrimidine-5-carboxylates (**2**) from alkyl 3-aryl-2-benzoylpropenoates (**1**) and guanidine in DMF and the presence of an inorganic base. That procedure affords the desired heterocycles within reaction times ranging from 8 to 48 hours but reported yields (not optimized) do not exceed 40 % because of a competitive reaction yielding dialkyl 2,4,6,8-tetraryl-4,6-dihydro-*1H*-pyrimido[1,2-a]pyrimidine-3,7-dicarboxylates (**3**). As those bicyclic derivatives arise from Michael type condensations between two molecules of ester (**1**) and guanidine, we reasoned that their formation could perhaps be disfavoured when directly starting from arylaldehydes, ethyl benzoylacetate, and guanidine. That proposal could be verified as the three-component reactions enabled to obtain derivatives 2**a** - **e** within 3 hours in 75 to 90 % yield whereas formation of **3** was not detected.

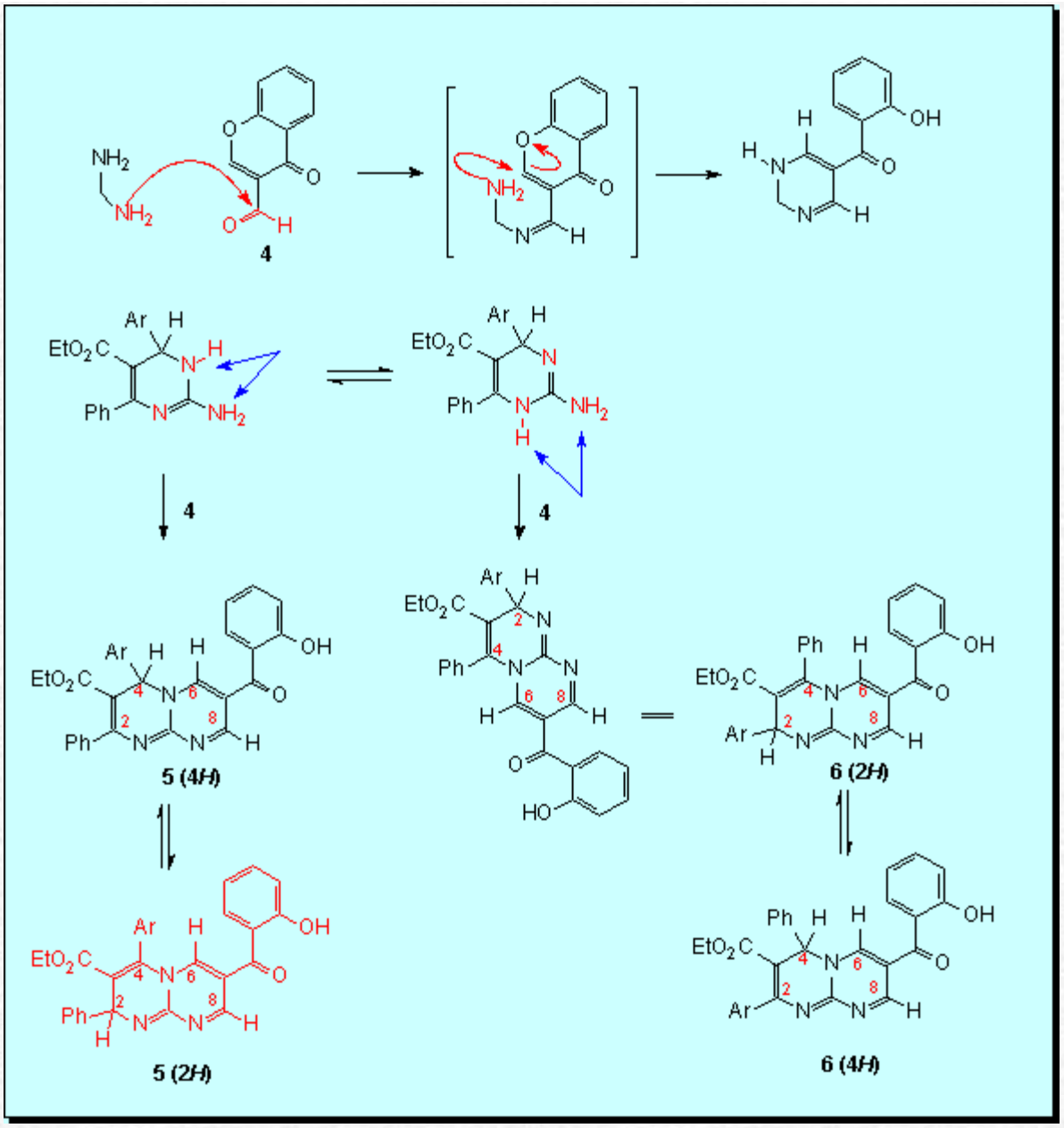


Scheme 1

*Reaction with 3-formylchromone **4***

Diamines are known to react with 3-formylchromone **4** to yield pyrimidines [9]. The reaction initially takes place on the formyl group and is followed by an intramolecular attack of the second amine function on the C-2 atom of the pyrone ring followed by opening of that ring (Scheme 2). In such a sequence, derivatives **2** are excellent candidates for the preparation of bicyclic systems but due to the presence of three nitrogen atoms in **2**, formation of two isomeric substances (2-aryl or 4-aryl derivatives) may be foreseen as illustrated in Scheme 2.

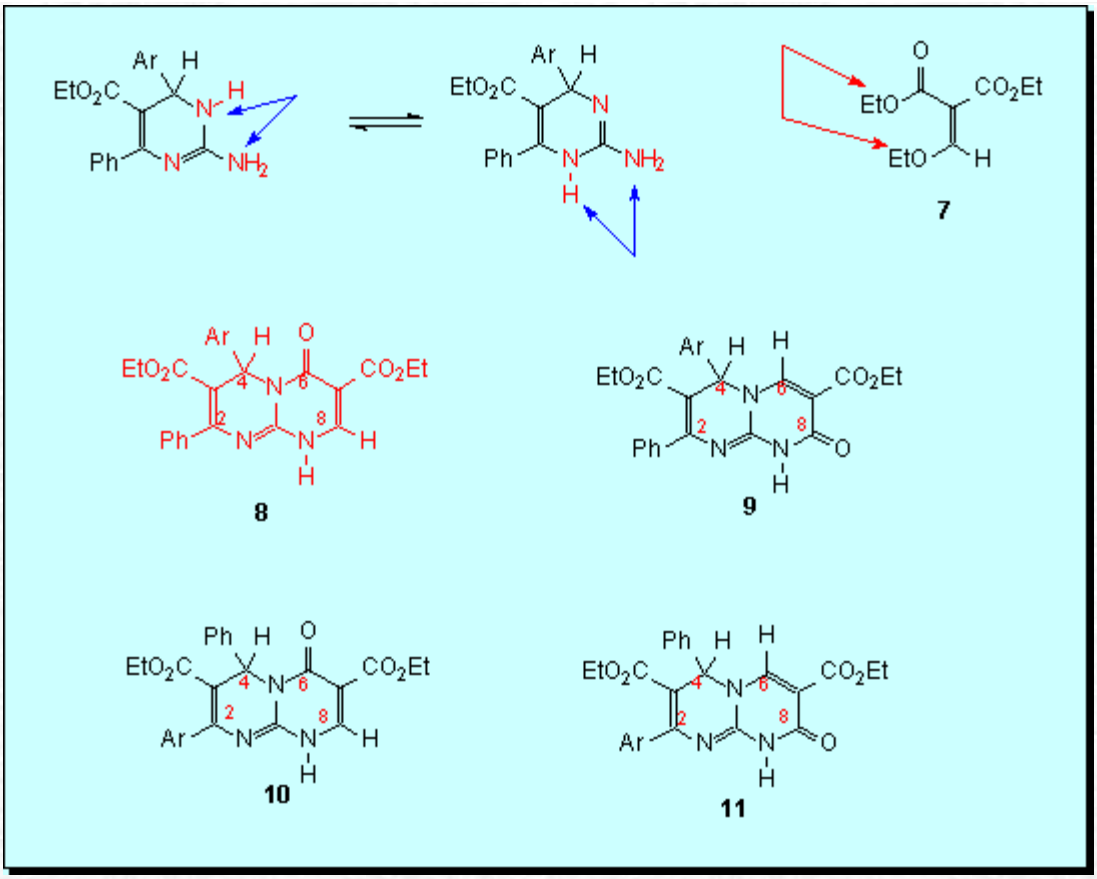
Isomers **5 (2*H*)** only are obtained (as indicated by the spectral data) when the reactants are heated in boiling ethanol for several hours. However, we felt unsatisfied with those experimental conditions and we decided to perform the reactions under microwave irradiation. [10] In that way, we isolated the same final products but advantageously in better yields, under solvent free conditions, and within a few minutes.



Scheme 2

*Reaction with diethyl (ethoxymethylene)malonate **7***

The situation is more complicated when derivatives **2** are allowed to react with diethyl (ethoxymethylene)malonate (**7**). Indeed, four series of isomeric pyrimido[1,2-a]pyrimidines can be formed (Scheme 3). Once again, when the reactions are conducted in boiling ethanol or under microwave irradiation, only one series of compounds is obtained. Their spectral data are indicating of a 6-oxo structure as found in **8** or **10** but we had no further argument to distinguish those isomers. Therefore we resorted to a X-ray analysis that revealed that the product formed by the interaction between **2c** and **7** is the 4-(4-methoxyphenyl)-2-phenyl derivative **8c**.



Scheme 3

Reaction pathways

We have not been able to isolate the monodehydrated intermediates when reducing microwave irradiation times, nor by performing the syntheses in a solvent at reflux or at room temperature. Anyway, the structure of the final products **5** indicates that they result from the nucleophilic attack of the exocyclic nitrogen atom on the formyl function of **4** and that the ring closure involves the N(3) nitrogen atom of the pyrimidine cycle. That situation parallels previous results indicating a greater susceptibility of the N(3) atom towards electrophiles, when compared to the N(1) atom. [1] Similarly, reactions performed from diethyl (ethoxymethylene)malonate involve the same exocyclic and N(3) nitrogen atoms of the starting heterocycles **2**.

Let us mention that, in agreement with the experimental results, AM1 calculations on the model compound **2a** (1,4- and 3,4-dihydro forms) reveal a greater electronic charge density on the nitrogen atom of the exocyclic amino group, followed by the N(3) atom, and finally the N(1) atom.

Conclusion

In this work, we demonstrated that ethyl 2-amino-4,6-diaryl-1,4-dihydropyrimidine-5-carboxylates (**2**) react regioselectively with 3-formylchromone or diethyl (ethoxymethylene)malonate to afford pyrimido[1,2-a]pyrimidines (**5** and **8** respectively) which had not been previously described. Interestingly, we observed that those bicyclic derivatives can advantageously be prepared in a microwave oven and in the absence of organic solvent, thus contributing to the promotion of economical and environmentally friendly experimental procedures.

References

1. Kappe, C.O. 100 Years of the Biginelli dihydropyrimidine synthesis. *Tetrahedron* **1993**, *49*, 6937-6963.
2. (a) Cho , H.; Ueda, M.; Shima, K.; Mizuno, A.; Hayashimatsu, M.; Ohnaka, Y.; Takeuchi, Y.; Hamaguchi, M.; Aisaka, K.; Hidaka, T.; Kawai, M.; Takeda, M.; Ishihara, T.; Funahashi, K.; Satoh, F.; Morita, M.; Noguchi. Dihydropyrimidines: novel calcium antagonists with potent and long-lasting vasodilative and antihypertensive activity. *J. Med. Chem.* **1989**, *32*, 2399-2406. (b) Atwal K.S.; Rovnyak, G.C.; Schwartz, J.; Moreland, S.; Hedberg, A.;

Gougoutas, J.Z.; Malley, M.F.; Floyd, D.M. Dihydropyrimidine calcium channel blockers: 2-heterosubstituted 4-aryl-1,4-dihydro-6-methyl-5-pyrimidinecarboxylic acid esters as potent mimics of dihydropyridines. *J. Med. Chem.* **1990**, *33*, 1510-1515. (c) Atwal K.S.; Rovnyak, G.C.; Kimball, S.D.; Floyd, D.M.; Moreland, S.; Swanson, B.N.; Gougoutas, J.Z.; Schwartz, J.; Smillie, K.M.; Malley, M.F.; Dihydropyrimidine calcium channel blockers. 2. 3-Substituted 4-aryl-1,4-dihydro-6-methyl-5-pyrimidinecarboxylic acid esters as potent mimics of dihydropyridines. *J. Med. Chem.* **1990**, *33*, 2629-2635. (d) Atwal, K.S.; Swanson, B.N.; Unger, S.E.; Floyd, D.M.; Moreland, S.; Hedberg, A.; O'Reilly, B.C. Dihydropyrimidine calcium channel blockers. 3. 3-Carbamoyl-4-aryl-1,2,3,4-tetrahydro-6-methylpyrimidinecarboxylic acid esters as orally effective antihypertensive agents. *J. Med. Chem.* **1991**, *34*, 806-811.

3. (a) Bossert, F.; Meyer, H.; Wehinger, E. 4-Aryldihydropyridines, a new class of highly active calcium antagonists. *Angew. Chem. Int. Ed. Engl.*, **1981**, *20*, 762-769. (b) Goldmann, S.; Stoltefuss, J. 1,4-Dihydropyridines: effects of chirality and conformation on the calcium antagonist and calcium agonist activities. *Angew. Chem. Int. Ed. Engl.*, **1991**, *30*, 1559-1578.

4. (a) Wipf, P.; Cunningham, A. A solid phase protocol of the Biginelli dihydropyrimidine synthesis suitable for combinatorial chemistry. *Tetrahedron Lett.*, **1995**, *36*, 7819-7822. (b) Kappe, C.O. Highly versatile solid phase synthesis of 4-aryl-3,4-dihydropyrimidines using resin-bound isothiourea building blocks and multidirectional resin cleavage. *Bioorg. Med. Chem. Lett.*, **2000**, *10*, 49-51.

5. (a) Kappe, C.O.; Kumar, D.; Varma, R.S. Microwave-assisted high-speed parallel synthesis of 4-aryl-3,4-dihydropyrimidin-2(1*H*)-ones using solventless biginelli condensation protocol. *Synthesis*, **1999**, 1799-1803. (b) Stadler, A.; Kappe, C.O. Microwave-mediated Biginelli reaction revisited. On the nature of rate and yield enhancements. *J. Chem. Soc., Perkin Trans. 2*, **2000**, in press.

6. Snider, B.B.; Shi, Z. Biomimetic syntheses of Crambines A, B, C1, and C2. Revision of the structures of Crambines B and C1. *J. Org. Chem.* **1993**, *58*, 3828-3839.

7. (a) Patil, A.D.; Kumar, N.V.; Kokke, W.C.; Bean, M.F.; Freyer, A.J.; De Brosse, C;; Mai, S.; Truneh, A.; Faulkner, D.J.; Carte, B.; Breen, A.L.; Hertzberg, R.P.; Johnson, R.K.; Westley, J.W.; Potts, B.C.M. Novel alkaloids from the sponge *Batzella* sp.: inhibitors of HIV gp 120-human CD4 binding. *J. Org. Chem.* **1995**, *60*, 1182-1188. (b) Franklin, A.S.; Ly, S.K.; Mackin, G.H.; Overman, L.E.; Shaka, A.J. Application of the tethered Biginelli reaction for enantioselective synthesis of Batzelladine alkaloids. Absolute configuration of the tricyclic guanidine portion of Batzelladine B. *J. Org. Chem.* **1999**, *64*, 1512-1519. (c) McDonald, A.I.; Overman, L.E. Tuning stereoselection in tethered Biginelli condensations. Synthesis of *cis*- or *trans*-1-oxo- and 1-iminohexahydropyrrolo[1,2-c]pyrimidines. *J. Org. Chem.* **1999**, *64*, 1520-1528.

8. Milcent, R.; Malanda, J.-C.; Barbier, G.; Vaissermann, J. *J. Heterocycl. Chem.* **1997**, *34*, 329-336.

9. Sabitha, G. 3-Formylchromone as a versatile synthon in heterocyclic chemistry. *Aldrichim. Acta* **1996**, *29*, 15-25.

10. Informations about microwave-mediated organic synthesis may be found, *i.a.*, on the following web sites: http://www-ang.kfunigraz.ac.at/~kappeco; http://www.umh.ac.be/~orgafs

---

All comments on this poster should be sent by e-mail to (mailto:ecsoc@listserv.ariz ona.edu) ecsoc@listserv.arizona.edu with **A0050** as the message subject of your e-mail.
