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ЭКСПЕРТНОЕ ЗАКЛЮЧЕНИЕ О ВОЗМОЖНОСТИ ОПУБЛИКОВАНИЯ

Руководитель-эксперт Федерального государственного бюджетного учреждения науки Института элементоорганических соединений им. А.Н.Несмеянова Российской академии наук, рассмотрев статью (Rinat S. Tukhvatshin, Alexander S. Kucherenko, Yulia V. Nelyubina, Sergei G. Zlotin, Conjugate Addition of Carbon acids to β,γ -Unsaturated α -Keto Esters: Product Tautomerism and Application for Asymmetric Synthesis of Benzo[a]phenazin-5-ol Derivatives) в журнал (Journal of Organic Chemistry) подтверждает, что в материале не содержатся сведения, предусмотренные Постановлением Правительства РФ №1233 от 30.11.1994г. и на публикацию материала не следует получать разрешение Минобрнауки России и/или Президиума РАН

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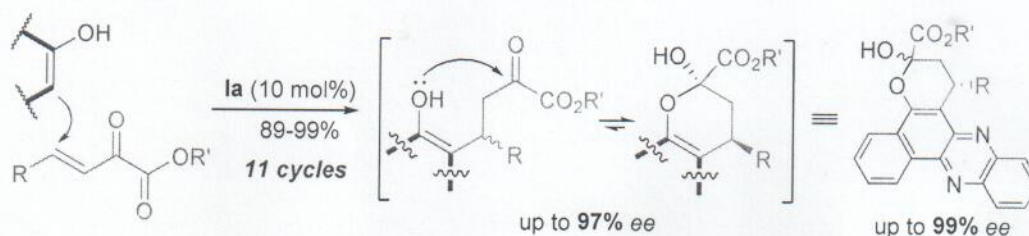
Conjugate Addition of Carbon acids to β,γ -Unsaturated α -Keto Esters: Product Tautomerism and Application for Asymmetric Synthesis of Benzo[*a*]phenazin-5-ol Derivatives

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ABSTRACT: A correlation between the equilibrium ratio of tautomeric products generated by the asymmetric Michael reactions of cyclic carbon acids with β,γ -unsaturated α -keto esters and the chemical shift of the α -proton in starting nucleophilic substrates was revealed which makes equilibration predictable. New tetrahydropyran-fused benzo[*a*]phenazins were enantioselectively (up to 99% *ee*) synthesized from β,γ -unsaturated α -keto esters and benzo[*a*]phenazin-5-ol, a powerful anti-cancer agent sAJM589. Facile recyclability of catalyst **Ia** in the catalytic reactions was demonstrated.

Introduction

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The ring-chain tautomerism of organic compounds is of great significance in Nature and organic chemistry.¹ A classic example of this phenomena is the gradual interconversion of linear carbohydrates into their cyclic forms, which results in the change in the optical rotation (mutarotation).² The capability of linear γ - and δ -hydroxycarbonyl compounds to transform reversibly into cyclic hemiacetals or hemiketals enables a large scale production of useful heterocyclic compounds, such as furaldehyde,³ chromanes, chromenes,⁴ β -nicotinamide riboside and its analogues⁵ etc.

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2 **Recycling procedure:** Catalyst **Ia** recovered by centrifugation was dried under reduced pressure
3 (60 °C, 50 Torr, 30 min). Then the fresh portions of the starting substrates **1a** (37.2 mg, 0.20
4 mmol) and **2a** (38.0 mg, 0.20 mmol) and THF (0.3 mL) were added to the catalyst and the
5 reaction was re-performed as described above.
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8 9 **ASSOCIATED CONTENT**

10 Supporting Information

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12 The Supporting Information is available free of charge on the ACS Publications website at DOI:
13 <http://pubs.acs.org>.

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15 Copies of ^1H , ^{13}C , and HPLC spectra (PDF)

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17 X-ray of **4b** (CIF)

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19 X-ray of **6a** (CIF)

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42 43 44 **Notes**

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46 The authors declare no competing financial interest

47 48 49 **Acknowledgements**

50
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52 53 54 **References**

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56 (1) (a) Raczyńska, E. D.; Kosińska, W.; Ośmiałowski, B.; Gawinecki, R. Tautomeric Equilibria
57 in Relation to Pi-Electron Delocalization. *Chem. Rev.* **2005**, *105*, 3561-3612. (b) Hok, L.;
58 Božičević, L.; Sremec, H.; Šakić, D.; Vrček, V. Racemization of oxazepam and chiral 1,4-
59
60