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# The Studies of the Reactions of 2, 4, 6-Triphenylpyrylium Tetrafluoroborate with Amino Acids

Shrong Shi LIN*, Xian Jing KONG, Jing Yuan LIU, Cheng Yong LI

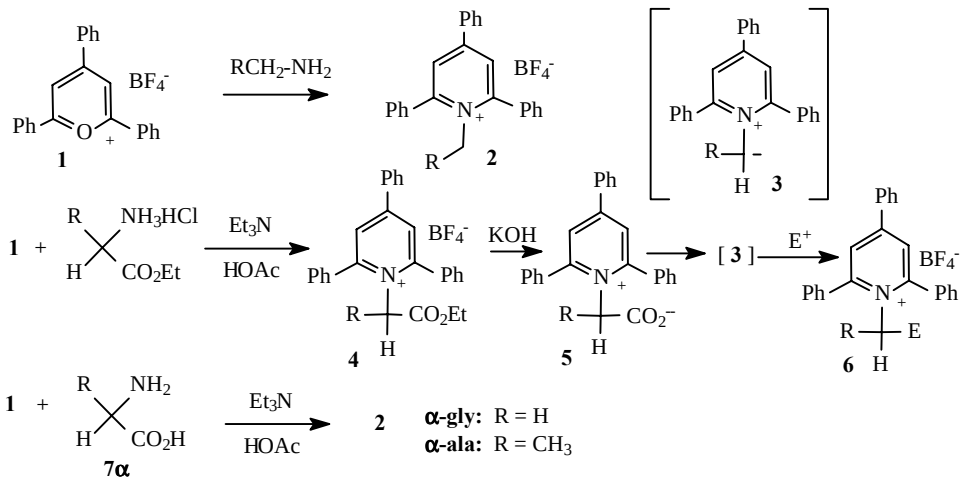
College of Chemical and Molecular Engineering, Peking University, Beijing 100871

**Abstract:** The reactions of triphenylpyrylium salt **1** with various amino acids were explored and compared. The reactions with most α-amino acids yielded decarboxylation products **2** *via* decarboxylation. The reactions with glutamic acid, lysine and ACC (1-aminocyclopropyl-carboxylic acid) gave triphenylpyridine **8**, dimer **9** and acid **5a-acc**, respectively. The reactions with β and γ-amino acids yielded triphenylpyridine by intramolecular elimination.

**Keywords:** Triphenylpyrylium salt, pyridinium betaine, pyridinium ylid, decarboxylation, amino acids, intramolecular elimination.

2, 4, 6-Triphenylpyrylium tetrafluoroborate **1** is known as a powerful reagent for converting primary amines to the analogous N-substituted pyridinium salts **2**[1]. We have carried out studies on the preparation of pyridininium betaines **5** from **1** and on the chemistry of **5** with electrophiles to form adduct **6** (**Scheme 1**)[2,3]. In this paper, we wish to report the reactions of pyrylium salt **1** with various amino acids and comparisons of their feasibility on the preparation of pyridinium betaines.

**Scheme 1**

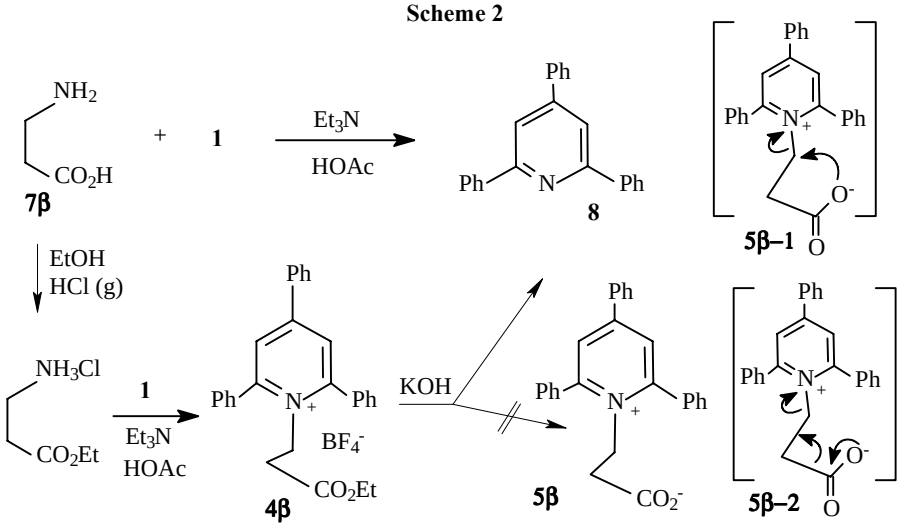



* E-mail: sslin@pku.edu.cn

The reactions of **1** with glycine or alanine in the presence of triethylamine and acetic acid are known to produce N-alkylpyridinium salt **2** *via* decarboxylation[4] (**Scheme 1**). Betaines **5** were not detected as reaction products. The driving force of decarboxylation was contributed to the formation of pyridinium ylids **3**.

Pyridinium betaine **5β** was expected for the reaction of β-alanine **7β** with pyrylium salt **1** (**Scheme 2**) since the formation of pyridinium ylid **3** was not probable. However, the reaction of **7β** and **1** (5 mmol, 1 eq.), stirred 2 hours at r.t. in the presence of $Et_3N$ and HOAc, provided no **5β** but triphenylpyridine **8**. The formation of **8** was rationalized by process shown in structure **5β-1** or **5β-2**. The driving force of such elimination was contributed to the good leaving group of triphenylpyridine **8**. Elimination *via* **5β-1** was favored at this stage since no $CO_2$ and ethylene were trapped with aqueous $Ba(OH)_2$ and $Br_2$, respectively. The hydrolysis of pyridinium ester **4β**, prepared by the reaction of β-alanine ethyl ester hydrochloride (20 mmol) and **1** (1 eq.) in $Et_3N$ and HOAc, at room temperature in ethanolic KOH (1.1 eq.) afforded no **5β** and **8** was obtained (**Scheme 2**).

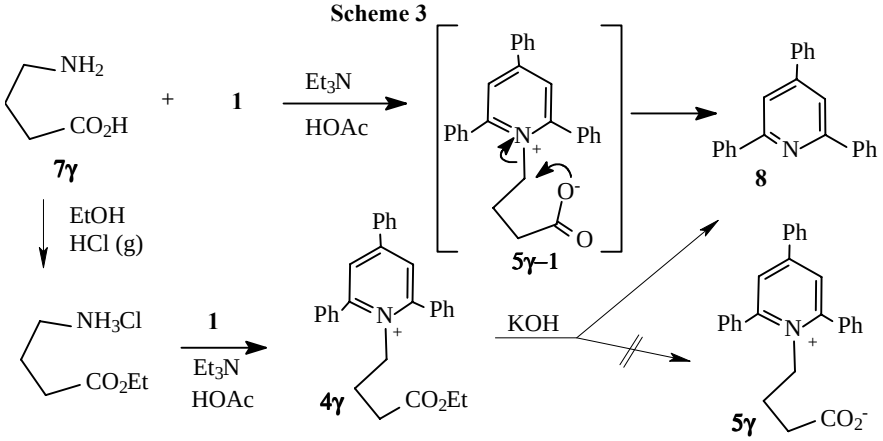
**Scheme 2**



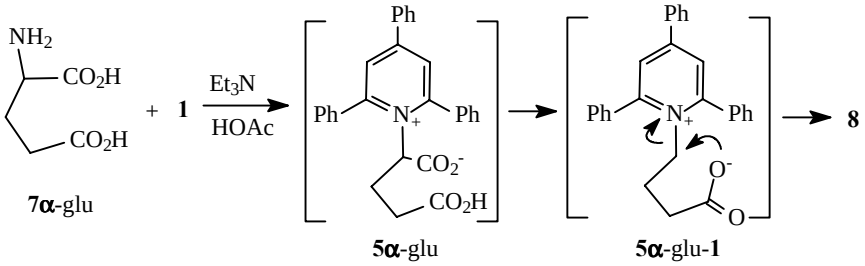

In order to confirm the elimination process, the reaction of γ-amino acid **7γ** and pyrylium salt **1** was investigated. The reaction of **7γ** (5 mmol) and **1** (1 eq.) with $Et_3N$ and HOAc at room temperature yielded no **5γ** and again triphenylpyridine **8** was formed (**Scheme 3**). The formation of **8** was expressed by the process shown in structure **5γ-1**. The hydrolysis of pyridinium ester **4γ** (1 mmol) by reaction of the ethyl ester hydrochloride of γ-amino acid with **1**, afforded no **5γ** and **8** was obtained (**Scheme 3**).

The reactions of **1** with more complicated α-amino acids were studied. The reactions of **1** (2 mmol) with glutamic acid **7α**-glu yielded **8** (86 %) again and no betaines **5α**-glu or **5α**-glu-**1** were detected (**Scheme 4**). The result was explained by the decarboxylation of betaine **5α**-glu to form **5α**-glu-**1** followed by elimination reaction of **5α**-glu-**1**. This was the first observation that triphenylpyridine **8** was generated for the reaction of **1** with α-amino acids.

**Scheme 3**

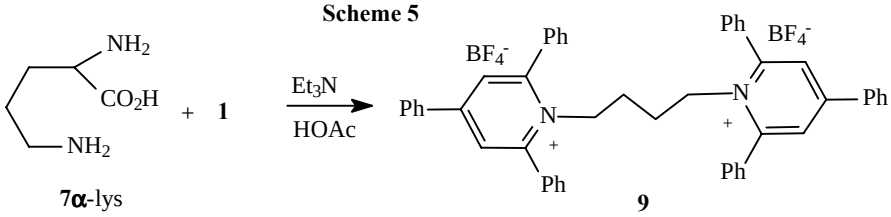



**Scheme 4**




The reaction of **1** with lysine **7α**-lys yielded dimer **9** as orange powder (84 %) and no betaines were detected (**Scheme 5**). The reaction was carried out by refluxing the mixture of **1** (2 mmol) and **7α**-lys (2.2 eq.) in $Et_3N$ and HOAc for 2 hours and the structure of product was confirmed by IR and NMR ($^1H$, $^{13}C$, DEPT, COSY) spectra. The result indicated that both amino groups of **7α**-lys reacted with **1** and decarboxylation took place during the reaction, which led to the formation of dimer **9**.

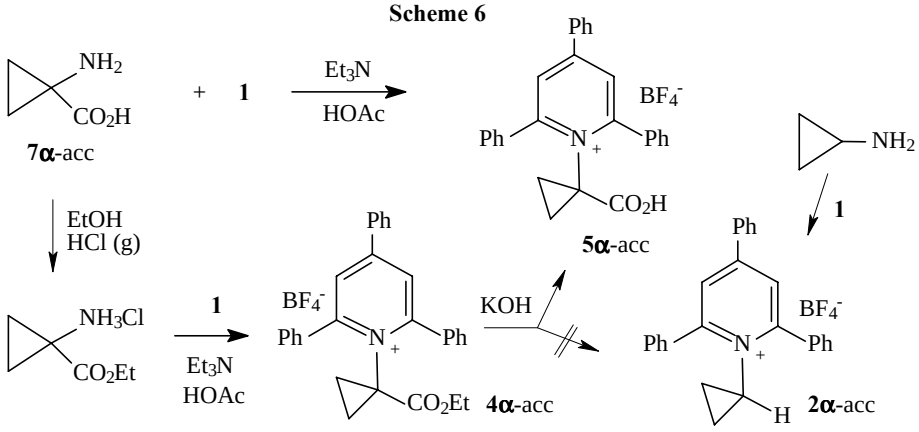
**Scheme 5**




The reaction of **1** (2 mmol) with 1-aminocyclopropanecarboxylic acid (ACC) **7α**-acc (1 eq.), refluxed 2 hours in $Et_3N$ and HOAc, afforded **5α**-acc as white solid (82 %); no decarboxylation product **2α**-acc was detected (**Scheme 6**). The structure of **5α**-acc was supported by spectral data in which C=O group was observed in IR and NMR. The spectra of **5α**-acc were compared with that of decarboxylation product **2α**-acc, which was prepared independently by reaction of **1** with cyclopropylamine, and the results showed

significant difference. This was the first example that no decarboxylation proceeded for the reaction of **1** with α-amino acids.

**Scheme 6**




In summary, it was demonstrated that 2, 4, 6-triphenylpyrylium tetrafluoroborate **1** reacted readily with amino group of various sources. The reactions with most α-amino acids, with the exception of ACC, accompanied decarboxylation due to the formation of pyridinium ylid. The reactions with β and γ-amino acids yielded triphenylpyridine by intramolecular elimination.

**Acknowledgment**

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**References and Notes**

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5. NMR data (300 MHz for $^1$H NMR and 75 MHz for $^{13}$C NMR, in $CDCl_3$, δppm) of compound **2α**-acc: $^1$H NMR: 0.62 (m, 4H, $CH_2$), 4.15 (m, 1H, CH), 7.55 (m, 9H, Ph), 7.80 (m, 2H, Ph), 7.91 (m, 6H, Ph). Compound **4β**: $^1$H NMR: 1.05 (t, 3H, J = 6.8 Hz, $CH_3$), 2.49 (t, 2H, J = 7.6 Hz, $CH_3$), 3.86 (q, 2H, J = 7.0 Hz, $CH_2$), 4.72 (t, 2H, J = 7.4 Hz, $CH_2$), 7.46-7.60 (m, 9H, Ph), 7.70-7.83 (m, 6H, Ph), 7.84 (s, 2H). Compound **4γ**: $^1$H NMR: 1.10 (t, 3H, J = 7.0 Hz, $CH_3$), 1.79 (m, 4H), 3.88 (q, 2H, J = 7.2 Hz, $CH_2$), 4.71 (m, 2H, $CH_2$), 7.51-7.63 (m, 9H, Ph), 7.72-7.81 (m, 6H, Ph), 7.84 (s, 2H). Compound **5α**-acc: $^1$H NMR: 0.55 (t, 2H, J = 2.8 Hz, $CH_2$), 1.31 (t, 2H, J = 2.6 Hz, $CH_2$), 7.49 (m, 9H, Ph), 7.67 (s, 2H, CH), 7.80 (m, 6H, Ph), $^{13}$C NMR: 21.20 ($CH_2$), 53.76 ($CH_2$), 126.40, 127.67, 128.94, 129.26, 129.82, 130.60, 132.04, 133.96, 134.18, 154.82, 159.21, 171.90 (CO). Compound **8**: $^1$H NMR: 7.43-7.46 (m, 8H), 7.66 (m, 3H), 7.82 (s, 2H), 8.15 (d, 4H, J = 8.2 Hz). Compound **9**: $^1$H NMR: 0.99 (t, 4H, J = 7.2 Hz, $CH_2$), 4.06 (t, 4H, J = 7.2 Hz, $CH_2N$), 7.26-7.67 (m, 30H, Ph), 7.72 (s, 4H, Pyr); $^{13}$C NMR: 28.16 ($CH_2$), 54.19 ($CH_2$), 126.60, 128.08, 128.99, 129.26, 129.66, 130.91, 132.08, 132.54, 133.89, 155.72, 156.37.

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