

## Michael Addition of Alkyl Amine to $\alpha,\beta$ -Unsaturated Carbonyl Compounds Catalyzed by $\text{KF}/\text{Al}_2\text{O}_3$

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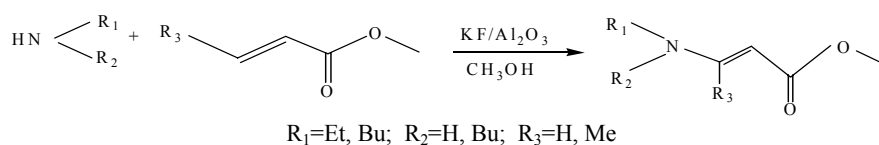
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**Abstract:** The  $\beta$ -aminocarboxylic acid derivatives were synthesized by Michael addition reaction of alkyl amine and  $\alpha,\beta$ -unsaturated carbonyl compounds in the presence of potassium fluoride on alumina.

**Keywords :** Michael addition,  $\beta$ -aminocarboxylic acid derivatives,  $\text{KF}/\text{Al}_2\text{O}_3$ .

The Michael addition reaction is one of the most efficient methods for carbon-carbon bond formation, the versatile reaction has numerous applications to remote functionalization in the synthesis of many complex molecules. Michael addition of nitroalkanes to  $\alpha, \beta$ -unsaturated carbonyl compounds has been extensively studied in heterogeneous systems<sup>1,2</sup>. The  $\beta$ -aminocarboxylic acid derivatives have been employed as an important intermediate in the preparation of medicines, their preparation procedures have been reported<sup>3,4</sup>. In this paper, we describe a simple and efficient heterogeneous procedure for preparation of  $\beta$ -aminocarboxylic acid derivatives by Michael reaction of alkyl amine with  $\alpha,\beta$ -unsaturated carbonyl compounds in the presence of  $\text{KF}/\text{Al}_2\text{O}_3$  (**Scheme 1**).

Scheme 1



### Experimental

Neutral  $\gamma$ - $\text{Al}_2\text{O}_3$  (100-200 mesh) for chromatography was used.  $\text{KF}/\text{Al}_2\text{O}_3$  samples at a load of  $1 \text{ mmol}\cdot\text{g}^{-1}$  were prepared by dissolving an appropriate amount of  $\text{KF}$  in 400 mL water, then 30 g  $\text{Al}_2\text{O}_3$  was added in it to form the slurry. The water was removed on a rotary evaporator to dryness. The samples were then dried in vacuum at 200 mmHg,  $180^\circ\text{C}$  for 8 h.

$\alpha,\beta$ -Unsaturated carbonyl compound (1 mol), sufficient amount of  $\text{KF}/\text{Al}_2\text{O}_3$  (30 g,

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the amount of  $F^-$  is about 0.1 mol), and methanol(1 mol) were added into a pyrex flask with stirring at room temperature, then the active amino compound(1 mol) was added dropwise with stirring. During the reaction, the temperature was controlled. After stirring for setting times, the mixture was separated from the catalyst by filtration and washed with methanoic acid. The solvent was evaporated, and the product was purified by distillation under vacuum. The b.p. was: 43°C/6 mmHg(40°C/5 mmHg<sup>5</sup>), 58°C/6 mmHg(55°C /5 mmHg<sup>5</sup>), 60°C /6 mmHg(58°C/5 mmHg<sup>5</sup>), 74°C/6 mmHg(70°C/4 mmHg<sup>5</sup>). The yields of the products were determined with a gas chromatograph and were calculated on the basis of Michael substrates.

## Results and Discussion

Representative results are summarized in **Table 1**.

**Table 1** The structure of the products and the yields

Entry	Alkyl Amine	Michael Substrate	Time/h	T/	Yield/%
1	HN(CH <sub>2</sub> CH <sub>3</sub> ) <sub>2</sub>	CH <sub>2</sub> CH=COOCH <sub>3</sub>	1	25	93
2	HN(CH <sub>2</sub> CH <sub>3</sub> ) <sub>2</sub>	CH <sub>3</sub> CH=CHCOOCH <sub>3</sub>	2	55	89.3
3	H <sub>2</sub> NCH <sub>2</sub> CH <sub>2</sub> CH <sub>2</sub> CH <sub>3</sub>	CH <sub>3</sub> CH=CHCOOCH <sub>3</sub>	2	50	86.9
4	HN(CH <sub>2</sub> CH <sub>2</sub> CH <sub>2</sub> CH <sub>3</sub> ) <sub>3</sub>	CH <sub>3</sub> CH=CHCOOCH <sub>3</sub>	4	65	85.7

Primary and secondary amine could be used as the nucleophile and gave the corresponding products in good yields. But secondary amines, which have steric hindrance, need higher reaction temperature. If excess primary amines were used, the products were in near quantitative yield.

The samples of KF/ Al<sub>2</sub>O<sub>3</sub> at different loadings (from 0.6 to 5.0 mmol·g<sup>-1</sup>) were studied. We have found that a loading of fluoride corresponding to 1 mmol·g<sup>-1</sup> gives excellent results. Further increase of the loading amount of KF beyond 5 mmol·g<sup>-1</sup> led to decrease of the catalytic activity. This phenomenon seems to suggest that the active basic sites were species, which formed by interreaction of F<sup>-</sup> and the hydroxylated surface of alumina.

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Received 8 July, 2003