Conjugated Addition of Amines to Electron Deficient Alkenes: A Green Approach

A very simple approach has been developed for conjugate addition of a variety of aliphatic and aromatic amines to electron deficient alkenes in presence of a strong base or acid [8, 9]. Several methods are available in the literature by using different catalysts such as Yb(OTf)₃ [10], CeCl₃·7H₂O-NaI [11], InCl₃ [12], Cu(OTf)₂ [13, 14], CAN [15], KF/alumina [16,17], LiClO₄ [18], Bi(OTf)₃ [19], Bi(NO₃)₃ [20], SmI₂ [21], Cu(acac)₂/ionic liquid [22], ionic liquid/quaternary ammonium salt [23, 24], boric acid [25], borax [26], ZrOCl₂·8H₂O [27],...
Results and discussion

First of all, we prepared the required tea extract. In a typical experimental procedure, 2 g of tea leaves were dissolved in 20 mL of water and boiled it for 10–15 min. After filtration we got the extract which was used for the said reactions. It was observed that 2 mL of tea extract is sufficient to get the best result. Several structurally varied amines were coupled with the wide range of α, β-ethylenic compounds and the results are summarized in Table 1. A variety of aliphatic amines was examined to prove the general applicability of this present procedure and the corresponding Michael adducts were isolated in excellent yields within a short reaction time. The aliphatic primary amines such as benzylamine, butylamine and cyclohexylamine were treated with different Michael acceptors and corresponding monoadducts were isolated in good yields (Table 1, entries 1–5). The reaction of open chain bulky secondary amine like diisopropylamine proceeded very well (entries 6, 7). Cyclic secondary amines such as piperidine and morpholine underwent facile additions with acrylonitrile and acrylic esters respectively (Table 1, entries 6, 7). Aromatic amines are less reactive than aliphatic amines and took long reaction time. Both activated and weakly activated anilines were investigated. The reactions proceeded smoothly at room temperature and the products were isolated in excellent yields (Table 1, entries 6, 7).
obtained in excellent yields. Several substituted anilines such as methyl and methoxy anilines underwent efficient additions with acrylonitrile and methyl acrylate giving only monoadduct in high yields under present reaction conditions (Table 1, entries 10–14). Acid sensitive functional group in aniline such as 3,4-(methylenedioxy)aniline also reacted well to give the desired product in good

| Entry | Amine     | Alkene    | Product         | Time [min (h)] | Yield (%)b |
|-------|-----------|-----------|-----------------|----------------|------------|
| 1     | PhCH₂NH₂  | CN        | PhCH₂NH₂CN      | 20             | 92         |
| 2     | PhCH₂NH₂  | COOMe     | PhCH₂NH₂CO₂Me   | 40             | 90         |
| 3     | NH₂       | CN        |                | 20             | 96         |
| 4     | NH₂       | CN        |                | 20             | 96         |
| 5     | NH₂       | COOMe     |                | 50             | 90         |
| 6     | NH₂       | CN        |                | 15             | 95         |
| 7     | NH₂       | COOMe     |                | 20             | 94         |
| 8     |            | CN        |                | 10             | 96         |
| 9     |            | COOMe     |                | 20             | 90         |
| 10    | PhNH₂     | CN        | PhNH₂CN        | (18)           | 75         |
| 11    | PhNH₂     | CO₂Me     | PhNH₂CO₂Me     | (20)           | 85         |
| 12    | 4-(OMe)-C₆H₄NH₂ | CN | 4-(OMe)-C₆H₄NH₂CN | (24)           | 75         |
| 13    | 4-Me-C₆H₄NH₂ | CN | 4-Me-C₆H₄NH₂CN   | (24)           | 80         |
| 14    | O-PhNH₂   | COOMe     | O-PhNH₂COOMe   | (12)           | 88         |

*aReaction conditions: 2 mmol of amine and 2 mmol of alkene were stirred in 2 mL of tea extract at room temperature; bIsolated yields.
yields keeping methylenedioxy group unaffected (Table 1, entry 14). With regard to Michael acceptors, a wide range of structurally diverse electron deficient alkenes was used such as α, β-unsaturated nitrile and carboxylic ester. In general, the reactions are very clean. Both aliphatic and aromatic amines give the products in equally fair yields. In particular, in the case of primary amines the method produces the corresponding β-amino derivatives without the problem of double-conjugate addition. We have not observed any by-products for all reaction combinations which are supported by high yields of the protocol. All of the known synthesized compounds have been characterized by spectral data and the new compounds by spectral and analytical data.

**Conclusions**

In conclusion, we have developed a tea extract-mediated a highly efficient methodology for the synthesis of β-amino derivatives under milder reaction conditions at room temperature. General applicability, operational simplicity, aqueous media, mild reaction conditions, environment friendly, high yields, and applications of inexpensive and easily available catalyst are the advantages of the present procedure. We believe this aza-Michael reactions are of significant importance in both synthetic chemistry and industrial processes for the synthesis of β-amino derivatives.

**Experimental**

**General:** $^1$H NMR (300 MHz) and $^{13}$C NMR (75 MHz) spectra were run in CDCl$_3$ solutions. IR spectra were taken as KBr plates. Elemental analyses were done by Perkin-Elmer autoanalyzer. Column chromatography was performed on silica gel (60–120 mesh, SRL, India). MnCl$_2$4H$_2$O was purchased from NICE Chemicals, India. Tea leaves were purchased from market. Amines and alkenes are all commercial materials. All liquid reagents were distilled before use.

**Preparation of tea extract:** 2 g of tea leaves (any marketed) were dissolved in 20 mL of water and boiled it for 10–15 min. After filtration we got the extract which was used for the reactions.

**General procedure for the synthesis of β-amino derivatives:** A mixture of amine (2 mmol) and alkene (2 mmol) was stirred in 2 mL of tea extract at room temperature as required for completion (TLC). After completion of the reaction the reaction mixture was extracted with ethyl acetate (40 mL). The extract was washed with water (2 × 10 mL) and brine solution (1 × 10 mL) and dried over anhydrous sodium sulphate. Evaporation of solvent followed by short column chromatography of the crude product over silica gel (hexane/ethyl acetate) furnished the analytically pure product. The known compounds have been identified by comparison of spectra data (IR and NMR). The spectral and analytical data of the compounds which are not readily found provided below.

**3-(Cyclohexylamino)propanenitrile** (Table 1, entry 4): Colorless oil; IR2928, 2246, 1722, 1666, 1558, 1455 cm$^{-1}$; $^1$H NMR δ 2.85 (t, $J = 5.1$ Hz, 2H), 2.45 (t, $J = 5.1$ Hz, 2H), 2.43 (m, 1H) 1.80–1.63 (m, 5H), 1.25–1.16 (m, 6H). Calculated for
C\textsubscript{9}H\textsubscript{16}N\textsubscript{2}; C, 71.01; H, 10.59; N, 18.40 %. Found: C, 60.82; H, 10.35; N, 18.13 %.

3-(4-Methoxy-phenylamino)-propenenitrile (Table 1, entry 12): Colorless liquid; IR\textsuperscript{3377}, 2244, 1842, 1617, 1514, 1289 cm\textsuperscript{-1}; \textsuperscript{1}H NMR δ 6.80 (d, J = 5.1 Hz, 2H), 6.61 (d, J = 5.1 Hz, 2H), 3.75 (s, 3H), 3.47 (t, J = 4.8 Hz, 2H), 2.61 (t, J = 4.8 Hz, 2H), (N-H) not identified; \textsuperscript{13}C NMR δ 152.9, 140.3, 118.5, 115.1 (2C), 114.8 (2C), 55.8, 40.8, 18.2. Calculated for C\textsubscript{10}H\textsubscript{12}N\textsubscript{2}O: C, 68.16; H, 6.86; N, 15.90 %. Found: C, 67.98; H, 6.53; N, 15.62 %.

3-(4-Methyl-phenylamino)-propenenitrile (Table 1, entry 13): Colorless liquid; IR\textsuperscript{3559}, 2253, 1615, 1522, 1404 cm\textsuperscript{-1}; \textsuperscript{1}H NMR δ 7.00 (d, J = 6.0 Hz, 2H), 6.53 (d, J = 6.0 Hz, 2H), 3.47 (d, J = 5.1 Hz, 2H), 2.60 (d, J = 5.1 Hz, 2H), 2.24 (s, 3H). (N-H) not identified; \textsuperscript{13}C NMR δ 143.9, 130.2 (2C), 127.7, 118.5, 113.2 (2C), 40.0, 20.4, 18.0. Calculated for C\textsubscript{10}H\textsubscript{12}N\textsubscript{2}: C, 74.97; H, 7.55; N, 17.48 %. Found: C, 74.63; H, 7.38; N, 17.16 %.

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