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Synthesis of Schiff bases of 2-amino benzo[d]thiazole from higher hetero aldehydes and ketones using Mo-Al_2O_3 composite-based organocatalyst

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A new metal supported organo catalyst has been successfully employed to carry out the high yield Schiff's base reaction at ambient temperature. This methodology has the benefits of straightforward conditions, excellent yields, no work-up, environmental benign process and reusable solid catalyst. The catalyst speeds up the Schiff base reaction with less time and several Schiff bases have been synthesized and characterized with IR, ^{1}H and ^{13}C NMR techniques.

Keywords: *E*-Imines, Mo-Al_2O_3composite, Environmentally benign condensation, organocatalyst

Catalysts in heterogeneous-based organic transformations typically have exhibited good activity, high surface area, stability, and recyclability. Furthermore, mesoporous materials modified with various metal ions (M_x^+) and metal oxides (M_xO_y) have been used as solid acidic catalysts for various industrially significant organic transformations[1] like Mannich reactions[1d], Schiff base reaction[1e], Prins reaction[1f], and ester condensation reaction[1g].

The chemistry of Schiff base compounds has proven to be a fascinating area of research in previous years. Compounds with imine or azomethine (-C=N-) functional groups in their structure are known as Schiff bases. The extensible imine group is a part of the molecule that is active and results in diverse biologically active molecules. Schiff bases demonstrate beneficial biological processes such as anti-bacterial, anti-tubercular, anti-cancer, anti-inflammatory, pain-relieving, and anti-glycation properties. Additionally, Schiff's bases are utilized as corrosion inhibitors, dyes, pigments, intermediates in organic synthesis, stabilizers for polymers, and catalysts.

The method of synthesizing imines first described by Schiff involved the condensation of carbonyl compounds and primary amines followed by azeotropic distillation to remove the generated water. Molecular sieves[2] are used to remove the formed water in the reaction. Recently, in-situ dehydrating agents are developed like trimethyl orthoformate[3], tetraethyl orthosilicate[4], PPTS[5], P_2O_5/Al_2O_3[6], $B(OCH_2CF_3)_3$[7], Al_2O_3[8] and SiO_2[9]. In the recent literature, there were Schiff base reactions with reagents like $MgSO_4$ & $CuSO_4$[10], $Er(OTf)_3$[11], $Yb(OTf)_3$[12], Piperidine[13], $Ti(OR)_4$[14], K-10[15], Magnesium perchlorate[16], CaO[17], ionic liquids[18], Fly-ash:H_2SO_4[19], perchloric acid[20], SiO_2-H_3PO_4[21], tungsten oxide modified AlTUD-1 mesoporous acid[22], solid acidic $FeCl_3$/Bentonite[23], $SOCl_2$/Ether[24], ethanol[25], silica supported[26] and using some mechanical grinding[27] and water suspension methods[28], although most of these reports are ineffective for more potent aromatic and hetero aldehydes.

The reported methods have numerous drawbacks, such as high reaction temperatures, prolonged reaction durations, expensive chemicals, moisture-sensitive catalysts, and special equipment requirements. Additionally, the reported reaction is applicable to strong nucleophilic amines and higher carbonyl compounds. Therefore, it is in our interest to report on a Schiff's base reaction involving a bulky heterocyclic base, higher aromatic and heterocyclic aldehydes, and certain ketones.

Experimental Details

Materials and methods

Each reaction was conducted at room temperature under magnetic stirring conditions. The chemicals are purchased from Sigma-Aldrich, Alfa Aesar, and E.Merck. Silica gel $60F_{254}$ TLC plates are used for analytical thin-layer chromatography. UV light is used to perform the resolution of the established chromatogram (254 nm). Using the Mettler FP51

instrument, the melting points of each Schiff base have been determined in open glass capillaries. Infrared spectra (KBr, 4000-400 cm^{-1}) were captured on an OMNIC Fourier transform spectrophotometer. Bruker AV 400 & 500 NMR spectrometers operating at 500 MHz & 100 MHz were used to record ^{1}H, ^{13}C NMR spectra in $CDCl_3$ solvent, using TMS as the internal standard.

Preparation of Mo-Al_2O_3 composite

A conical flask was filled with around 20 mL of ethanol, to which 5 mmol (0.98 g) NH_4MoO_3 was added, and the mixture was then sonicated to create the colloidal suspension. 20 mL of ethanol containing basic alumina (Al_2O_3) (5 mmol, 0.51 g) was added to another conical flask and sonicated to get a colloidal suspension. The two solutions were mixed dropwise using a separating funnel and agitated with a magnetic stirrer for 24 h to create a homogeneous mixture. Once the Mo-Al_2O_3 composites had been made, the mixture was sonicated to make a fine powder. The mixture was stirred for 4 h at room temperature. The solution is filtered with a Buchner funnel using Whatman filter paper at room temperature. The obtained solid is dried at 110°C for 5 h in an oven and grind with a pestle and mortar, afforded the Mo-Al_2O_3 composites as a fine powder. This catalyst was calcined at 400°C for 2 h using a muffle furnace.

General synthesis procedure for the Schiff base compound

5 mL of methanol as a solvent was taken in a round bottom flask. Then 2-amino benzo[d]thiazole (0.46 g, 5 mmol), aromatic aldehyde (5 mmol) was added and stirred for 2 min then to the flask, (0.5 mmol, 0.23 g) Mo-Al_2O_3 composite (5 mol%) (5% with respect to the weight of aromatic aldehyde) and *p*-toluene sulphonic acid (7.5 mmol, 1.291 g) were added into the reaction mixture. The reaction was maintained with constant stirring at room temperature (30°C) for 4 h. At the end of the reaction, 20 mL of ethyl acetate was added to the reaction, and the catalyst was recovered from the reaction mass by filtration. The ethyl acetate layer was collected and recrystallized with hexane/ethyl acetate to get the pure product. In this condensation, the utilized reactants, reaction time and yields are presented in Table 1. The product was characterized to IR, H^1 and ^{13}C NMR spectra. Preparation and characterization of the catalyst and NMR and IR spectra of the synthesized product are given in Supplementary Information. The complete characterization data of all synthesized Schiff bases are summarized below.

(*E*)-N-(benzo[d]thiazol-2-yl)-1-(6-methoxy-naphthalen-1-yl) methanimine (3a): Yield, 91%; yellow colour solid; m.p. 206-209°C; ^{1}H NMR (500 MHz, $CDCl_3$) δ ppm: 9.05 (s, 1H), 8.13 (s, 1H), 7.78-7.68 (m, 4H), 7.36-7.30 (d, 2H), 7.19-7.03 (m, 3H), 3.85 (s, 3H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 169.39, 160.26, 138.25, 134.25, 132.61, 130.97, 129.11, 127.70, 125.86, 123.48, 121.84, 120.00, 115.29, 106.41, 55.61. IR ($CHCl_3$) υ 3307, 2929, 2846, 2780, 2353, 2162, 1975, 1849, 1694, 1618, 1466, 1325, 1266, 1162, 1095, 1010, 900, 810, 748, 672 cm^{-1}.

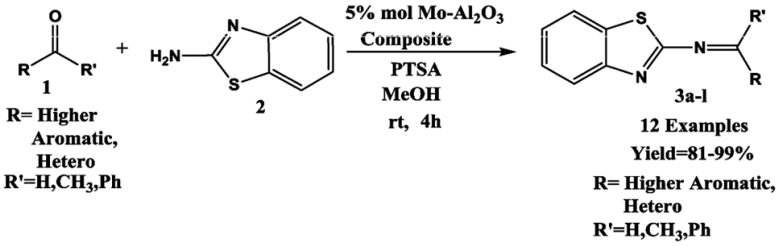
(*E*)-1-(anthracen-9-yl)-N-(benzo[d]thiazol-2-yl) methanimine (3b): Yield, 89%; dark red colour solid; m.p. 214-216°C; ^{1}H NMR (500 MHz, $CDCl_3$) δ ppm: 8.88-8.86 (s, 1H), 8.51-8.47 (s, 1H), 7.93-7.91 (m, 3H), 7.60-7.58 (d, 2H), 7.47-7.45 (d, 2H), 7.36-7.25 (d, 2H), 7.19-7.17 (d, 2H), 7.15-7.05 (d, 2H), 7.04-7.01 (s, 1H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 168.57, 145.13, 140.91, 135.17, 134.02, 132.33, 131.15, 129.42, 127.43, 127.08, 125.62, 123.42, 121.38, 116.55. IR ($CHCl_3$) υ 3323, 2901, 2842, 2806, 1975, 1623, 1548, 1451, 1325, 1252, 1154, 1049, 908, 767, 720 cm^{-1}.

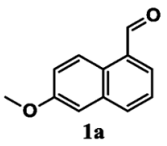
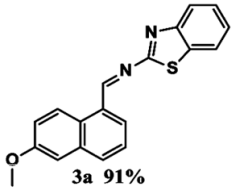
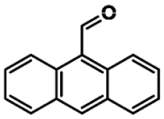
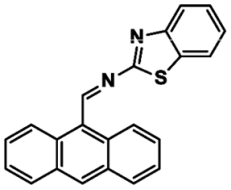
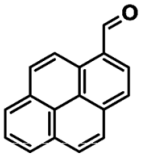
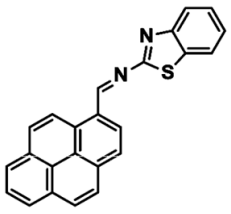
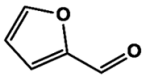
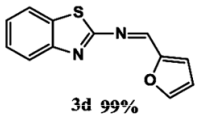
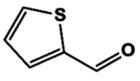
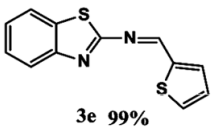
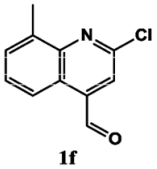
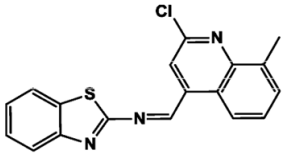
(*E*)-N-(benzo[d]thiazol-2-yl)-1-(pyren-1-yl)meth-animine (3c): Yield, 81%; light yellow colour solid; m.p. 221-223°C; ^{1}H NMR (500 MHz, $CDCl_3$) δ ppm: 9.24 (s, 1H), 8.29-8.27 (s, 1H), 8.19-8.17 (m, 4H), 8.14-8.07 (d, 2H), 8.00-7.90 (s, 1H), 7.90-7.86 (s, 1H), 7.41-7.09 (m, 3H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 168.94, 143.02, 136.68, 135.48, 131.65, 131.06, 127.08, 126.88, 124.36, 123.69, 122.77, 121.63, 115.93. IR ($CHCl_3$) υ 3050, 2916, 2870, 2330, 2158, 2085, 2001, 1928, 1823, 1767, 1595, 1525, 1443, 1356, 1330, 1235, 1158, 900, 810, 748, 700 cm^{-1}.

(*E*)-N-(benzo[d]thiazol-2-yl)-1-(furan-2-yl)meth-animine (3d): Yield, 99%; black colour solid; m.p. 163-165°C; ^{1}H NMR (500 MHz, $CDCl_3$) δ ppm: 8.95 (s, 1H), 7.81 (s, 1H), 7.56-7.50 (d, 2H), 7.46-7.26 (d, 2H), 7.14-7.02 (d, 2H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 167.70, 149.13, 141.20, 140.76, 129.76, 129.08, 126.17, 122.42, 121.05, 117.77. IR ($CHCl_3$) υ 3299, 3050, 2916, 2846, 2749, 2612, 2338, 2158, 2018, 1713, 1607, 1561, 1517, 1443, 1314, 1266, 1201, 1114, 1036, 928, 884, 740, 697 cm^{-1}.

(*E*)-N-(benzo[d]thiazol-2-yl)-1-(thiophen-2-yl) methanimine (3e): Yield, 99%; yellow colour solid; m.p. 172-173°C; ^{1}H NMR (500 MHz, $CDCl_3$) δ ppm: 9.12 (s, 1H), 7.91-7.76 (m, 3H), 7.75-7.50 (s, 1H),

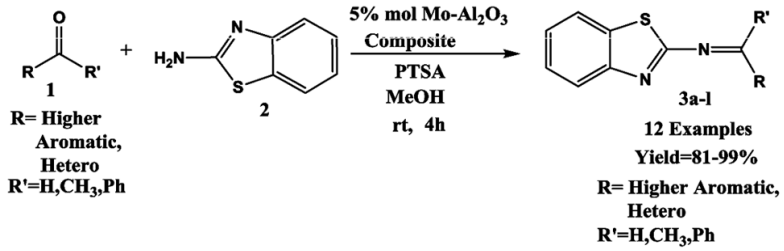
Table 1 — The utilized reactants, reaction time and yields for Mo-Al_2O_3-PTSA assisted condensation

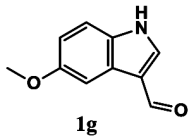
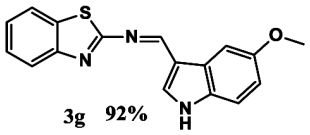
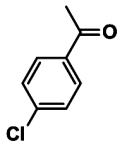
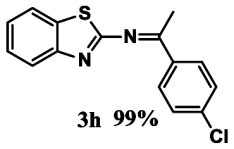
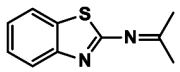
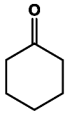
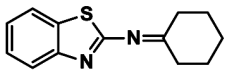
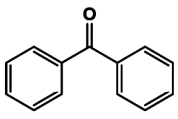
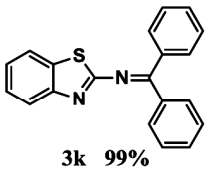
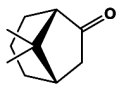
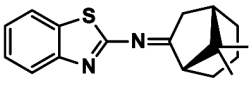


S. No.	Aldehyde/Ketone	Schiff's base product	Yield (%)
1	 1a	 3a 91%	91
2	 1b	 3b 89%	89
3	 1c	 3c 81%	81
4	 1d	 3d 99%	99
5	 1e	 3e 99%	99
6	 1f	 3f 99%	99

(*Contd.*)

Table 1 — The utilized reactants, reaction time and yields for Mo-Al_2O_3-PTSA assisted condensation



S. No.	Aldehyde/Ketone	Schiff's base product	Yield (%)
7	 1g	 3g 92%	92
8	 1h	 3h 99%	99
9	 1i	 3i 99%	99
10	 1j	 3j 99%	99
11	 1k	 3k 99%	99
12	 1l	 3l 90%	90

7.26-7.15 (d, 2H), 7.07-7.00 (s, 1H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 167.39, 158.57, 150.06, 136.68, 135.33, 130.28, 128.95, 128.49, 126.13, 122.37, 120.96, 118.22. IR ($CHCl_3$) υ 3319, 3273, 2964, 2932, 2859, 2167, 1947, 1759, 1635, 1545, 1455, 1407, 1314, 1247, 1131, 1049, 1005, 920, 892, 754, 723, 677 cm^{-1}.

(*E*)-N-(benzo[d]thiazol-2-yl)-1-(2-chloro-8-methylquinolin-4-yl) methanimine (3f): Yield, 99%; dark red colour solid; m.p. 190-192°C; ^{1}H NMR (500 MHz, $CDCl_3$) δ ppm: 8.32 (s, 1H), 8.22-7.39 (m, 6H), 7.31-7.08 (d, 1H), 5.69-5.59 (s, 1H), 2.72-2.62 (s, 3H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 168.30, 148.28,

146.75, 137.50, 136.44, 130.92, 129.09, 128.85, 127.09, 126.99, 126.93, 126.80, 125.98, 125.91, 125.57, 123.59, 121.55, 116.44, 100.49, 53.82. IR ($CHCl_3$) υ 3323, 3163, 3053, 2996, 2963, 2918, 2372, 2082, 1801, 1626, 1595, 1531, 1446, 1395, 1325, 1252, 1174, 1084, 979, 935, 885, 812, 750, 682 cm^{-1}.

(*E*)-N-(benzo[d]thiazol-2-yl)-1-(5-methoxy-3H-indol-3-yl) methanimine (3g): Yield, 92%; black colour solid; m.p. 187-189°C; ^1H NMR (500 MHz, $CDCl_3$) δ ppm: 8.97 (s, 1H), 7.83-7.70 (m, 4H), 7.43-7.29 (m, 4H), 3.82 (s, 3H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 168.48, 156.22, 144.00, 140.89, 131.76, 129.32, 126.88, 125.96, 123.51, 121.48, 116.38, 114.37, 113.08, 55.69. IR ($CHCl_3$) υ 3315, 3155, 3104, 2910, 2834, 2698, 2507, 2150, 1959, 1857, 1631, 1579, 1541, 1474, 1412, 1368, 1302, 1240, 1201, 1139, 1075, 942, 838, 794, 717, 681 cm^{-1}.

(*E*)-N-(benzo[d]thiazol-2-yl)-1-(4-chlorophenyl) ethan-1-imine (3h): Yield, 99%; white colour solid; m.p. 108°C; ^1H NMR (500 MHz, $CDCl_3$) δ ppm: 8.26-8.12 (d, 2H), 8.10-7.86 (t, 3H), 7.50-7.44 (d, 1H), 7.33-7.18 (d, 2H), 2.67 (s, 3H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 168.57, 143.52, 141.33, 131.83, 130.35, 129.41, 126.94, 125.74, 123.53, 121.64, 116.23, 29.43. IR ($CHCl_3$) υ 3312, 3108, 2910, 2834, 1764, 1694, 1607, 1517, 1474, 1322, 1229, 1139, 1083, 1005, 962, 861, 736, 704 cm^{-1}.

(*E*)-N-(benzo[d]thiazol-2-yl) propan-2-imine (3i): Yield, 99%; white colour solid; m.p. 98-99°C; ^1H NMR (500 MHz, $CDCl_3$) δ ppm: 7.47-7.30 (d, 2H), 7.29-7.12 (s, 1H), 7.11-7.03 (s, 1H), 1.25 (s, 6H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 167.05, 148.40, 128.88, 126.30, 123.06, 120.87, 117.60, 29.31. IR ($CHCl_3$) υ 3397, 3265, 3065, 2901, 2865, 2710, 2366, 2158, 1913, 1717, 1615, 1548, 1446, 1361, 1294, 1185, 1119, 1032, 1013, 931, 888, 736, 677 cm^{-1}.

(*E*)-N-(benzo[d]thiazol-2-yl) cyclohexanimine (3j): Yield, 99%; black colour solid; m.p. 112-113°C; ^1H NMR (500 MHz, $CDCl_3$) δ ppm: 7.45-7.42 (d, 2H), 7.23-7.08 (s, 1H), 7.78-7.68 (m, 4H), 7.05-7.00 (s, 1H), 2.59-2.24 (m, 3H), 1.86-1.69 (d, 2H), 1.26 (s, 6H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 167.46, 149.41, 128.86, 126.32, 122.13, 121.14, 117.60, 41.78, 29.96, 27.05. IR ($CHCl_3$) υ 3369, 3191, 2995, 2924, 2859, 2252, 2049, 1736, 1623, 1536, 1240, 1100, 1049, 915, 857, 731, 689 cm^{-1}.

(*E*)-N-(benzo[d]thiazol-2-yl)-1,1-diphenylmeth-animine (3k): Yield, 99%; red colour solid; m.p. 119-120°C; ^1H NMR (500 MHz, $CDCl_3$) δ ppm: 7.78-7.60 (m, 4H), 7.57-7.46 (d, 2H), 7.45-7.30 (m, 6H), 7.36-7.30 (d, 2H), 7.27-7.24 (s, 1H), 7.13-7.05 (s, 1H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 167.41, 149.42, 137.22, 132.06, 129.86, 127.88, 125.68, 122.14, 120.87, 117.96. IR ($CHCl_3$) υ 3299, 3202, 3073, 2924, 2859, 2162, 2045, 1990, 1720, 1618, 1522, 1432, 1381, 1314, 1266, 1181, 1126, 1049, 951, 903, 810, 767, 697 cm^{-1}.

(*E*)-(1S,5S)-N-(benzo[d]thiazol-2-yl)-8,8-dimeth-ylbicyclo [3.2.1] octan-6-imine (3l): Yield, 90%; light red colour solid; m.p. 221-223°C; ^1H NMR (500 MHz, $CDCl_3$) δ ppm: 7.97-7.92 (s, 1H), 7.53-7.43 (s, 1H), 7.26-7.13 (d, 2H), 3.11-3.04 (d, 2H), 2.72-2.65 (dd, 1H), 2.46-2.28 (m, 3H), 2.07-2.04 (d, 2H), 1.26 (s, 8H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 169.71, 140.83, 136.57, 133.26, 129.03, 128.55, 128.12, 125.74, 127.43, 125.86, 124.34, 122.22, 114.86, 37.58, 33.53, 31.90, 29.56. IR ($CHCl_3$) υ 3045, 2986, 2901, 2784, 2648, 2167, 1967, 1810, 1685, 1623, 1579, 1466, 1373, 1280, 1193, 1052, 965, 864, 723, 681 cm^{-1}.

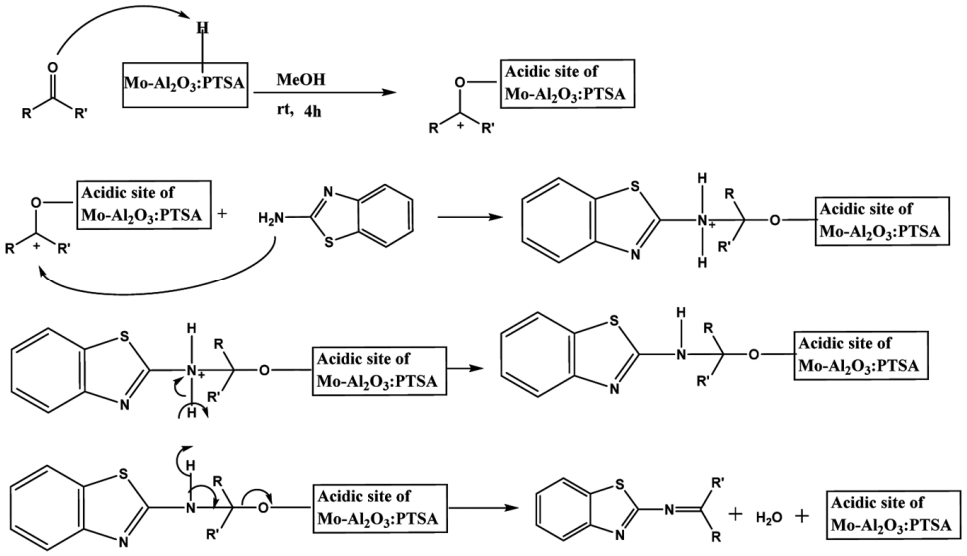
Results and Discussion

Mechanism of the condensation reaction

The condensation followed a well-known acid catalyzed mechanism as shown in Scheme 1. The amine nucleophile attacks of carbonyl carbon of aldehyde or ketone followed by elimination of water give the Schiff bases. The first step was the acidic site of the catalyst bonded with the carbonyl oxygen of the carbonyl group of aldehyde or ketone, and carbocation is formed. This carbocation is then attacked by the amine nucleophile to form an intermediate with a N-atom carrying a positive charge. This positive charge is neutralized by the removal of proton. Further the catalyst is removed and the elimination of water molecule results in the formation of the Schiff base.

Optimization of reaction conditions

In the synthesis, 2-chloro-8-methylquinoline-4-carbaldehyde **(1f)** was reacted with 2-amino benzo[d]thiazole **(2)** on different temperatures and times using the various catalysts affording N-(benzo[d]thiazol-2-yl)-1-(2-chloro-8-methylquinolin-4-yl) methanimine **(3f)** as a reference reaction. We experimented with strong acids like HCl, H_2SO_4, weak acids like CH_3COOH, Lewis acids like $ZnCl_2$, amphoteric salts like Al_2O_3,$(NH_4)_2MoO_3$ and catalysts like *p*-TSA, *p*-TSA/Al_2O_3 in different conditions in solvents like H_2O, CH_2Cl_2, THF, EtOH, MeOH and



Scheme 1 — Mechanism of synthesis of Schiff's bases by$Mo\text{-}Al_2O_3$-PTSA assisted condensation of amine and carbonyl compounds

Table 2 — Optimization of catalyst

Entry	Catalyst	Solvent	Temp (°C)	Time (h)	Yield (%)
1	no catalyst added	Methanol	rt	24h	nr
2	HCl	H_2O	rt	24h	nr
3	Trimethyl ortho formate	THF	80°C	24h	nr
4	$ZnCl_2$	Toulene	100°C	24h	nr
5	Al_2O_3	CH_2Cl_2	rt	24h	nr
6	$(NH4)_2MoO_3+Al_2O_3$	CH_2Cl_2	rt	24h	nr
7	p-TSA	CH_2Cl_2	rt	24h	<1
8	Al_2O_3/p-TSA	Methanol	rt	24h	2
9	CH_3COOH	Ethanol	80°C	24h	5
10	$Mo\text{-}Al_2O_3$ composites in *p*-TSA	Methanol	rt	4h	99

toluene and the results are shown in Table 2. We found that the reaction 2-chloro-8-methylquinoline-4-carbaldehyde **(1f)** with 2-amino benzo[d]thiazole **(2)** at room temperature (30°C) in the presence of $Mo\text{-}Al_2O_3$ composites in *p*-TSA in Methanol (Table 2, entry 10) as the good conditions to afforded N-(benzo[d]thiazol-2-yl)-1-(2-chloro-8-methylquinolin-4-yl) methanimine **(3f)** in the high yields (Table 2, entry 10). Without a catalyst, no reaction is seen and the initial ingredients are recovered and unchanged (Table 2, entry 1).

Optimization of the solvent

The yields of the direct Schiff base reaction catalyzed by 5 mol% $Mo\text{-}Al_2O_3$composites in presence of a *p*-TSA catalyst is observed in different solvents like H_2O, DMSO, DMF, CH_2Cl_2, $CHCl_3$, Toulene, THF, EtOH, MeOH as

Table 3 — Optimization of solvent

Entry	Solvent	Time (h)	Yield (%)
1	no solvent added	8h	nr
2	H_2O	8h	nr
3	DMSO	8h	nr
4	DMF	8h	nr
5	CH_2Cl_2	8h	nr
6	$CHCl_3$	8h	nr
7	Toulene	8h	nr
8	THF	8h	nr
9	EtOH	8h	81
10	MeOH	4h	99

Table 4 — Effect of loading of catalyst

Entry	Catalyst mol (%)	Temperature (T)	Time (h)	Yield[a] (%)
1	1.0	rt	24h	20
2	2.0	rt	24h	32
3	5.0	rt	4h	99
4	8.0	rt	24h	75

presented in Table 3. It is observed that the reaction was not adequate for polar aprotic solvents like DMSO, DMF, THF, Toulene, $CHCl_3$, and CH_2Cl_2. We found that the reaction is effective in polar protic solvents like EtOH, MeOH, and methanol is a suitable solvent for this condensation reaction (Table 3, entry 10).

Loading of the catalyst

The reaction was carried out with various mol% of the catalyst, and the yields are presented in Table 4. For the preparation of $Mo\text{-}Al_2O_3$ composites, we have taken $(NH_4)_2MoO_3$ and Al_2O_3 in 1:2 ratios in

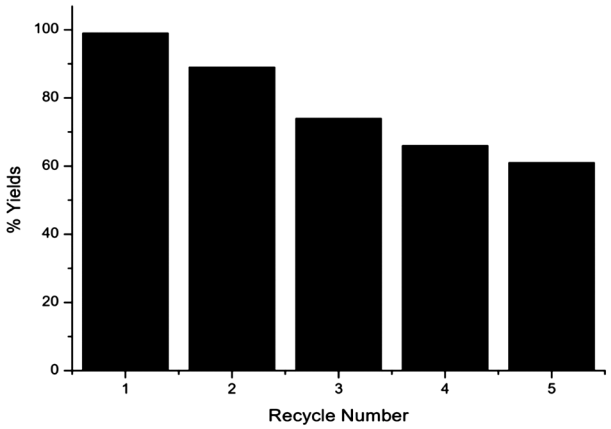


Fig. 1 — Catalyst recycling of Mo-Al_2O_3/p-TSA catalyst for Schiff's base reaction. [Reaction condition: 2-chloro-8-methylquinoline-4-carbaldehyde (5f): 2-amino benzo[d]thiazole (6), 1:1 (5 mmole ratio), Mo-Al_2O_3Composites (0.25 mmol, 0.11 g) and *p*-TSA (7.5 mmol, 1.29 g) at room temperature (30°C)]

methanol. Lower ratios (0.5:1, 0.1:1, etc.) are not successful in conducting this reaction.

Reusability of the catalyst

The reaction of 2-chloro-8-methylquinoline-4-carbaldehyde **(1f)** with 2-amino benzo[d]thiazole **(2)** was performed in presence of 5% of Mo-Al_2O_3/p-TSA catalyst for 4 h at room temperature. The filtered Mo-Al_2O_3/p-TSA catalyst is dried and reused because of its activity for five consecutive reactions, yielding the product in 60-65% yields. The reusability of the catalyst is shown in Fig. 1.

Conclusion

In conclusion, Schiff base reactions of various higher aromatic and hetero aldehydes **(1a-l)** with 2-amino benzo[d]thiazole **(2)** in presence of Mo-Al_2O_3/*p*-TSA catalyst in methanol are reported. The reported method has the advantages of (a) mild procedure; (b) air-free and solid catalyst; (c) low cost and less workup; (d) the reusability of the catalyst. Moreover, this method is applicable to the synthesis of a wide range of Schiff bases.

Supplementary Information

Supplementary information is available in the website http://nopr.niscpr.res.in/handle/123456789/58776.

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