Basic Alumina as an Efficient Catalyst for Preparation of Semicarbazones in Solvent Free Conditions

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An efficient and simple procedure for conversion of different classes of aldehydes and ketones into the corresponding semicarbazones with semicarbazide hydrochloride using basic alumina is studied.

Keywords: Carbonyl; Aldehyde; Ketone; Semicarbazones; Basic alumina; Solvent free.

INTRODUCTION

Synthetic chemists continue to explore new methods to carry out chemical transformations.[1] One of these new methods is to run reactions on the surface of solids. As the surfaces have properties that are not duplicated in the solution or gas phase, entirely new chemistry may occur. Even in the absence of new chemistry, a surface reaction may be more desirable than a solution counterpart, because the reaction is more convenient to run, or a high yield of product is attained. For these reasons, synthetic surface organic chemistry is a rapidly growing field of study.[1]

Alumina (Al_2O_3) is a key industrial material with numerous applications in refining and petrochemistry.[2] This metal oxide is widely used industrially as filler, adsorbent, drying agent, catalyst, catalyst support and reagent. γ-Alumina is the transition alumina with a basic property most commonly utilized to carry out surface organic chemistry.[3] In contrast to clays and zeolites, this material does not contain accessible channels or cavities and shows a large surface area and highly porous exteriors available to substrates.

Protection of carbonyl compounds as semicarbazones is of great interest to organic chemists as they are readily prepared and highly stable compounds.[4] Semicarbazones are extensively used for purification and characterization of carbonyl compounds.[5] The most common method for the preparation of semicarbazone derivatives is the reaction of aldehydes and ketones with semicarbazide in the presence of base or acid as catalyst.[5-7] In 1999, a report by Hajipour et al.[6] outlined the application of SiO_2/NaOH as a catalyst for protection of carbonyl compounds as semicarbazone. Very recently we reported protection of carbonyl groups as semicarbazone using sodium acetate supported on silica gel under solvent free conditions.[7] Herein we report a solid state method for synthesis of semicarbazone derivatives from the corresponding aldehydes and ketones.

RESULTS AND DISCUSSION

It is shown that for efficient protection of a carbonyl compound to the corresponding semicarbazone (Scheme I), application of inorganic solid support is essential. Among several mineral supports examined, basic alumina was found to give the best results. The optimum molar ratio of the substrate to the reagent is found to be 1:1.5.

Different types of aldehydes and ketones were subjected to the protection as semicarbazone in the presence of basic alumina under solvent free conditions. The process in its entirety involves a simple mixing of aldehydes or ketones and semicarbazide in the presence of basic alumina. The mixture was then ground for the time specified in Table 1. As shown in Table 1, the isolated yields of the reactions are good to excellent (74-90%) and the reaction times are exceedingly short (4-10 min). It is proved that for rapid and

Scheme I

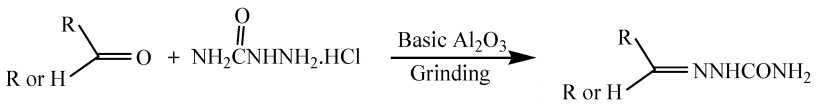
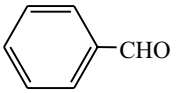
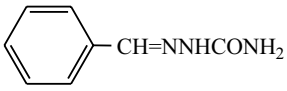
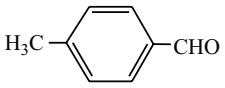
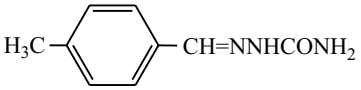
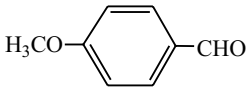
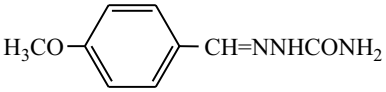
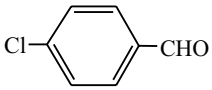
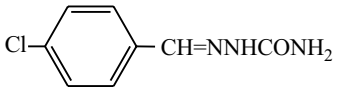
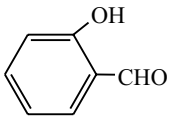
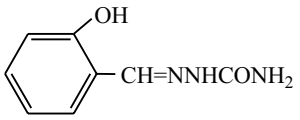
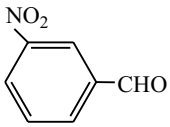
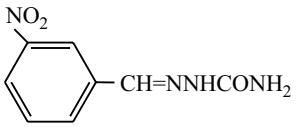
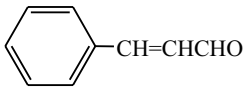
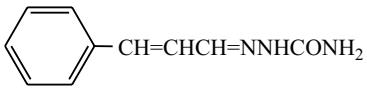
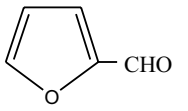
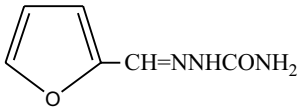
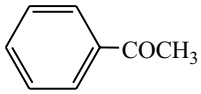
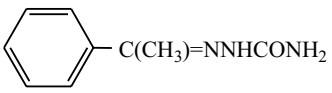
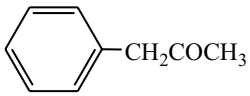
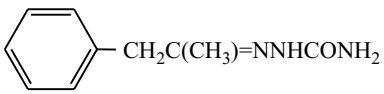
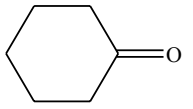
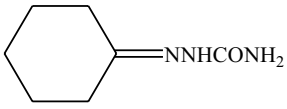
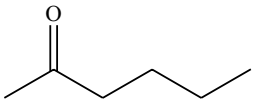
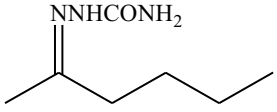


Table 1. Protection of carbonyl compounds as semicarbazones using basic alumina under solvent free conditions[a,b]

No	Substrate	Product	Time (min)	Yield (%)	M.P. Found (lit.[9])
1			5	89	221 (222)
2			6	85	219 (221)
3			5	83	212 (210)
4			4	88	227 (230)
5			4	76	229 (231)
6			8	74	242 (246)
7			5	90	215 (215)
8			5	77	200 (202)
9			10	74	198 (198)
10			8	87	195 (198)
11			6	80	165 (166)
12			4	85	120 (122)

[a] Yields refer to isolated products. [b] Products were characterized by comparison of their physical data, IR, and NMR spectra with known samples.

clean conversion of carbonyl compounds to semicarbazones, addition of a few drops of t-BuOH and water in the reaction media is essential. It can be emphasized that the reaction is clean, the work-up is straightforward and, from

economical and environmental points of view, use of solvent free conditions is favorable.

In conclusion, we have demonstrated an efficient, mild and novel protection methodology of carbonyl group using semicarbazide hydrochloride in the presence of basic alumina under solvent free conditions. We believe that the present procedure provides an easy, mild, efficient, versatile and general methodology for the protection of different classes of carbonyl compounds, and we feel that it may be a suitable addition to methodologies already present in the literature.

EXPERIMENTAL

General

Chemicals such as carbonyl compounds, semicarbazide hydrochloride and basic alumina were purchased from the Fluka, Merck and Aldrich chemicals companies. All products are known compounds and are identified by comparison of their physical and spectral data with those of authentic samples.[8] The purity determination of the products and reaction monitoring were accomplished by TLC on silica gel polygram SILG/UV 254 plates.

General procedure for the protection of carbonyl compounds as semicarbazones

Protection was carried out by mixing the carbonyl compound (1 mmol), semicarbazide hydrochloride (1.5 mmol), basic alumina (2 g) and a few drops of t-BuOH and water. The reaction mixture was ground for the time specified in the Table 1. The progress of the reaction was monitored by TLC using ether-CCl_4. On completion of the reaction, the reaction mixture was poured into methanol (20 mL). The solid was filtered off by sinter glass and the solvent evaporated under reduced pressure to give the product which was recrystallized from a suitable solvent and afforded the TLC and ^{1}H NMR pure products in 74-90% isolated yields.

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