SYNLETT Spotlight 100

Malononitrile

Compiled by Anil Saikia

This feature focuses on a reagent chosen by a postgraduate, highlighting the uses and preparation of the reagent in current research

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The weak cyanocarbon malononitrile [$\text{CH}_2(\text{CN})_2$] is a colourless solid with a melting range of 32–34 °C and a boiling range of 218–219 °C. It is a versatile compound of exceptional reactivity. Malononitrile can be prepared in 80–96% yield by the reaction of cyanoacetamide and POCl_3 or PCl_5 in presence of inorganic salts.^{1–2} Due to the presence of active methylene protons, the reagent is found to be more useful in carbon–carbon bond formation reac-

tions. It is used extensively³ as a reactant or reaction intermediate, since the methylene group and one or both cyano groups can take part in condensation reactions to give a variety of addition products and heterocyclic compounds. This unique reactivity makes malononitrile an important chemical in research and in medical, industrial and agricultural chemistry applications.

Abstracts

(A) A three-component reaction of sulfonium salt, malononitrile, and aldehyde in the ionic liquid 1-butyl-3-methylimidazolium hexafluorophosphate ($[\text{BMIM}][\text{PF}_6]$), or in ethanol in the presence of triethyl amine, is a convenient one-pot method for the synthesis of substituted 1,1-dicyanocyclopropanes. This reaction involves stereoselectivity to form substituted trans cyclopropanes.⁴

(B) A clean one-pot synthesis⁵ of tetrabenzo[b]pyran derivatives can be achieved from aromatic aldehyde, malononitrile and 5,5-dimethyl-1,3-cyclohexadione. The reaction uses hexadecyltrimethyl ammonium bromide (HTMAB) as a catalyst in aqueous media.

(C) Maggi et al.⁶ have reported an efficient and selective synthesis of substituted 2-amino-2-chromones by reaction of malononitrile, α -naphthol and aromatic aldehydes in water using basic alumina as heterogeneous and reusable catalyst.

(D) Malononitrile is an efficient reagent for the synthesis of 1,6-diketo compounds⁷ via a three-component Michael addition reaction. This reaction proceeds via initial condensation of an α -bromoketone with malononitrile to afford a β,β -dicyanoketone which undergoes in situ Michael addition reaction with α,β -unsaturated ketones.

(E) A new high-yielding multicomponent reaction⁸ providing multifunctionalized pyrido[2,3,d]pyrimidines has been accomplished in a microwave-assisted one-pot cyclocondensation of α,β -unsaturated esters, amidine systems and malononitrile.

(F) Condensation of carbonyl derivatives with active methylene compounds, such as malononitrile, is achieved within 3–15 minutes by a solvent-free reaction. Under microwave irradiation in the presence of carefully adjusted amounts of piperidine, Knoevenagel products⁹ are obtained in good to excellent yield.

(G) D-ring annelated pyridines are synthesized¹⁰ by the condensation of β -formyl enamides with cyanomethylenes such as malononitrile under microwave irradiation. This reaction has been successfully extended to acyclic and aromatic β -formyl enamides.

(H) A highly efficient palladium carbene complex catalytic system has been developed and successfully employed for cross-coupling of arylhalides with malononitrile anion.¹¹

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