Biological Forum – An International Journal **14(2): 1190-1193(2022)**

ISSN No. (Print): 0975-1130
ISSN No. (Online): 2249-3239

Different Methods of Nano-magnesium Synthesis: A Future Fertilizer Source

Akshay Kumar Kurdekar[1]*, Jayadeva H.M.[2], Sandeep S.N.[3], T. Gangadhara[4], Vinay Kumar, M.I.[5] and P. Laxman Rao[6]

[1]Ph.D. Scholar, Department of Agronomy, University of Agricultural Sciences, Raichur (Karnataka), India.
[2]Professor and Head, Department of Agronomy, University of Agricultural Sciences, Bangalore (Karnataka), India.
[3]Ph.D. Scholar, Department of Agronomy, University of Agricultural Sciences, Bangalore (Karnataka), India.
[4]M.Sc. Scholar, Department of Agronomy, Sardarkrushinagar Dantiwada Agricultural University (Gujarat), India.
[5]Ph.D. Scholar Department of Agronomy, University of Agricultural Sciences, Raichur (Karnataka), India.
[6]Associate Professor, Department of Soil Science & Agril. Chemistry, Agricultural College, Aswraraopet, PJTSAU, (Telangana), India.

(Corresponding author: Akshay Kumar Kurdekar)*
(Received 29 March 2022, Accepted 30 May, 2022)
(Published by Research Trend, Website: www.researchtrend.net)

ABSTRACT: Nano magnesium has a wide range of applications due to its unique properties. Various chemical (bottom-up) and physical (top-down) approaches can be used to make nano structured Magnesium. Depending on the reaction conditions, basic starting materials or concentrations, desired result (e.g., band gap, crystallite size and shape) can be obtained. Magnesium nano particles are potentially of interest not only because of their unique material properties, but also because of their low toxicity and environmental friendliness, they can be used in a wide range of medical and biotechnological applications. Current trends indicate a significant increase in interest in green synthesis of nano particles but challenging task here is to maintain the size of synthesized nano particles. Since the focus is on shape, it is possible to synthesize MgO in a variety of ways. The most common structures are particle-like, but rod-like, flat-like, and tubular structures are also found.

Keywords: Magnesium nano particles, bottom-up, top-down and green synthesis.

INTRODUCTION

Nanotechnology will have a significant impact on our country's overall development. Nanotechnology is the fabrication, manipulation, and application of submicron objects, particularly those between 1 and 100 nanometers in size. Nanotechnology will allow for the production of high-quality products at a low cost and in a short amount of time. It is commonly referred to as a generic technology that provides better-built, safer, longer-lasting, low-cost, and smart products for use in the home, communications, medicine, agriculture, and the food industry, among other applications. Excessive use of conventional fertilizers in modern agriculture has resulted in several serious issues such as soil degradation, loss of soil organic matter and carbon content, and increased soil compaction. To overcome this problem use of nano fertilizers would be the solutions. But among various chemical, physical and biological methods of synthesis, green method for synthesizing nanoparticles with plant extracts is simple, convenient, environment friendly and require less reaction time. Nanomaterials made using eco - friendly green synthesis method have the potential to improve agriculture's fertilization process. Furthermore, they reduce the amount of harmful chemicals released into the environment. As a result, this technology aids in the reduction of environmental pollutants, resulting in a more sustainable approach.

Magnesium is a key component of chlorophyll, which helps plants absorb light during photosynthesis. Magnesium is necessary for phosphate metabolism and acts as a phosphorus carrier in plants. Photosynthesis, as the central process for crop production, is influenced by the Mg status of the plant in several ways. High light interception by the light harvesting complexes (LHCs) attached to photosystems I and II is required for efficient carbohydrate formation (PSI, PSII). Use of Nano magnesium fertilizers instead of conventional fertilizers has additional advantages because of its unique physicochemical behaviors such as outstanding refractive index, economically feasible with high surface are resulting in greater advantages. Among the chemical, physical and biological methods of synthesis of nano magnesium particles the biological approach would be ecofriendly and easy to synthesize the

particles. Hence this review help us to find the best method in synthesizing the nano magnesium particles that can be used as a fertilizer source or other applications.

Different methods of synthesis of nano magnesium fertilizer

• There are mainly two method of synthesis of nano particles mainly the bottom up approach and top down approach

1. Bottom-up approach

• A bottom-up approach is when a material is built up from the ground up, atom by atom, molecule by molecule, or cluster by cluster.

• Assembling nanomaterials atom-by-atom or molecule-by-molecule (self-assembling)

• This aims to combine smaller components into larger assemblies.

• The bottom-up approach has the advantage of obtaining nanostructures with fewer defects and more uniform chemical compositions.

2. Top-down approach

• Slicing or successive cutting of a bulk material to obtain nano-sized particles is referred to as a top down approach.

• Breaking down larger materials physically or chemically to create nanoscale materials

•These aim to make smaller devices by directing the assembly of larger ones.

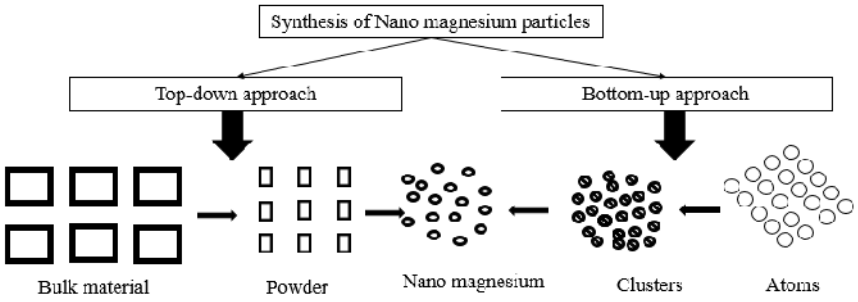

Fig. 1. Approach in synthesis of Nano magnesium particles.

Physical method of synthesis Nano magnesium particles. Physical methods generate magnesium nanoparticles by causing material abrasion, melting, evaporation, or condensation with mechanical pressure, high-energy radiations, thermal energy, or electrical energy. These methods are advantageous because they produce uniform monodisperse nanoparticles and are based on a top-down strategy. Different physical method of synthesis such as ball milling, physical vapour deposition, molecular beam epitaxy, sputtering, laser ablation, electric arc deposition, etching, lithography among these few references are reported. Praditaet *al*., 2017 reported that synthesis of Nano magnesium can be done using spray pyrolysis using precursor as $Mg(NO_3)_2.6H_2O$. Han Wang *et al*., 2015 reported that magnesium nanowires were prepared at 703 ^oK for 30 min in a high vacuum level of 104 Pa by physical vapor deposition method. For the preparation of nanoparticles, laser ablation in liquid has been considered an appealing technique. Tran X. Phuoc *et al*., 2008 studied that synthesis of $Mg(OH)_2$, MgO, and Mg nanoparticles using laser ablation of magnesium in water and solvents and reported that particles were about 20–30 nm and particles with rod-like, triangular, and plate-like shapes were also observed.

Chemical methods of synthesis of Nano magenesium particles. Different chemical methods followed in synthesis of Mg nanoparticles such as microemulsion technique, sol–gel method, temperature assisted synthesis polyol synthesis, hydrothermal synthesis, chemical vapour synthesis and plasma enhanced chemical vapour deposition technique are some of the most commonly used chemical methods for the synthesis of Mg nanoparticles. Tamilselvi *et al*., 2021 reported that Magnesium oxide nanoparticles can be synthesized by employing a simple sol-gel method using angelating agent using magnesium nitrate [Mg (NO_3)] as precursor the average size of the synthesized nanoparticles is 12 nm. Microwave-assisted synthesis of Mg nanoparticles is another chemical method which is widely used. This method promotes uniform dispersion of small molecules and is both cost-effective and environmentally friendly. Gajengi *et al*. (2017) studied microwave mediated synthesis in the presence of benzylamine, which forms an intermediated complex of $Mg(OH)_2$ due to the reducing agent's action. Selvam *et al*., (2011) synthesized microwave-promoted MgO nanoparticles in the presence of urea. They also studied that microwave mediated synthesis is less energy consuming than the traditional combustion synthesis method. Pei *et al*., 2010 reported low temperature assisted synthesis is easy and environmentally friendly approach of synthesis of Mg nanoparticles which can be used as fertilizer sources. Furthermore, Shimpi *et al.* (2009) reported synthesis of Mg nanoparticles using

hydrothermal method at low temperature (155°C) is easy and synthesized particles were spherical in shape.

Biosynthesis of Nano magnesium particles. For the past decade, scientists have been interested in producing Mg nanoparticles using biological methods. The use of fewer chemicals, cost-effectiveness, and environmental friendliness have all played a role in the evolution and importance of this field. Traditional chemical or physical methods of nanoparticle synthesis are less convenient, less cost-effective, and less environmentally friendly than green synthesis as reported by Das *et al*. (2017). Plants, bacteria, fungus, and algae are some of the biological substrates that are commonly used instead of chemical solvents and stabilisers to reduce the product's toxicity. In Biosynthesis approach the substrate used is either microorganism or plant extract. Plants are the most common biological substrate for Mg nanoparticles because they are cost-effective, environmentally friendly, easy to process, handle, and safer than microorganisms. Bandeira *et al*. (2020) reported that plant extracts acquired from various parts of the plants including root, bark, leaves, flowers, fruit pulp, peels etc. are used for synthesizing Mg nanoparticles. Singh *et al*. (2019) have reported that the biomolecules present in the plant extract are considered responsible for the reduction of of Mg^{2+} ions to Mg^{0} valency state.

Table 1: Review of green synthesis method of Nano magnesium particles.

Substrate used	Particle size analysis (nm)	Remarks	References
Aloe barbadensis	8.6	The shape of particles were rock shaped flakes. They utilized it for antibacterial study	Anantharaman *et al.* (2016)
Murraya koenigii	20	The shape of particle was spherical and utilized it for photocatalytic study	Kumara *et al.* (2016)
Ocimum sanctum	70	Particle shape were in the form of flakes the utilized it for antibacterial study.	Premlatha *et al.* (2018)
Orange peel extract	20	Particle were spherical in shape. And they utilized it for antimicrobial and antibacterial study	Munjal *et al*. (2017)
Aspergillus niger	70	Particles were sphere shaped and utilized it for antibacterial study	Ibrahem *et al.* (2017)
Lactobacillus sporogenes	30	Particles were cubic in shaped and it was utilized for anticancer study	Mohanasrinivasan *et al*. (2017)

CONCLUSION

Scientist have developed different methods of synthesis of Nano magnesium particles but to what extent that synthesized particles can be utilized as fertilizer source is matter of research. Physical and chemical method of synthesizing the particles is easy but during the synthesizing process it release various hazardous chemicals into the environment hence it is better to go with green synthesis approach. As magnesium is one of the most important micronutrient required for growth and development of plant shifting from the conventional magnesium fertilizer to Nano magnesium fertilizer can be an approach to attain potential yield.

FUTURE SCOPE

There is multidisciplinary application of magnesium nano particles in different fields. There is potential for synthesized magnesium particles to be used as a source of fertilizer in agriculture to help us overcome various Mg deficiency symptoms in crops.

Conflict of interest. None.

REFERENCES

Anantharaman, A., Sathyabhama, S. & George, M. (2016). Green synthesis of magnesium oxide nanoparticles using Aloe Vera and its applications. *International Journal for Scientific Research & Development*. *4*(9): 337-341.

Bandeira, M., Giovanela, M., Roesch-Ely, M., Devine, D. M. & Da Silva Crespo, J. (2020). Green synthesis of zinc oxide nanoparticles: A review of the synthesis methodology and mechanism of formation. *Sustainable Chemistry and Pharmacy*. *15*(3): 100223.

Das, B., Moumita, S., Ghosh, S., Khan, M. I., Indira, D., Jayabalan, R., Tripathy, S.K., Mishra, A. & Balasubramanian, P. (2018). Biosynthesis of magnesium oxide (MgO) nanoflakes by using leaf extract of *Bauhinia purpurea* and evaluation of its antibacterial property against Staphylococcus aureus. *Materials Science and Engineering, C, 91*(6): 436-444.

Das, R. K., Pachapur, V. L., Lonappan, L., Naghdi, M., Pulicharla, R., Maiti, S., Cledon, M., Dalila, L. M. A., Sarma, S. J. & Brar, S. K. (2017). Biological synthesis of metallic nanoparticles: plants, animals and microbial aspects. *Nanotechnology for Environmental Engineering*, *2*(1): 1-21.

Gajengi, A. L., Sasaki, T. & Bhanage, B. M. (2017). Mechanistic aspects of formation of MgO nanoparticles under microwave irradiation and its catalytic application. *Advanced Powder Technology*, *28*(4): 1185-1192.

Wang, H., Song, X., You, L. & Zhang, B. (2015). Oriented growth of magnesium nanowires by physical vapor deposition in high vacuum. *Scripta Materialia*, *108*: 68-71.

Ibrahem, E. J., Thalij, K. M. & Badawy, A. S. (2017). Antibacterial potential of magnesium oxide

nanoparticles synthesized by *Aspergillus niger*. *Biotechnology journal international*, *18*(1): 1-7.

Kumara, K. N. S., Nagaswarupa, H. P., Mahesh, K. R. V., Mylarappa, M., Prashantha, S. C., Siddeshwara, D. M. K. & Raghavendra, N. (2016). Synthesis and characterization of zno/mgonano particles by curry leaves through green approach and their photocatalytic applications. *International journal of current advanced research*, *4*(10): 1958-1962.

Tamilselvi, P., Yelilarasi, A., Hema, M. & Anbarasan, R. (2013). Synthesis of hierarchical structured MgO by sol-gel method. *Nano Bulletin*, *2*(1): 130106.

Mohanasrinivasan, V., Subathra Devi, C., Mehra, A., Prakash, S., Agarwal, A., Selvarajan, E. &JemimahNaine, S. (2018). Biosynthesis of MgO nanoparticles using *Lactobacillus sp*. and its activity against human leukemia cell lines HL-60. *Bio Nano Science*, *8*(1): 249-253.

Munjal, S., Singh, A. & Kumar. Vipin (2017). Synthesis and characterization of MgO nanoparticles by orange fruit waste through green method. *International Journal of Advanced Research in Chemical Science*, *4*(9), 36–42.

Khanna, P., Kaur, A. & Goyal, D. (2019). Algae-based metallic nanoparticles: Synthesis, characterization and applications. *Journal of Microbiological Methods*, *163*: 105656.

Pei, L. Z., Yin, W. Y., Wang, J. F., Chen, J., Fan, C. G. & Zhang, Q. F. (2010). Low temperature synthesis of magnesium oxide and spinel powders by a sol-gel process. *Materials Research*, *13* (3): 339–343.

Pradita, T., Shih, S. J., Aji, B. B. &Sudibyo. (2017). Synthesis of MgO powder from magnesium nitrate using spray pyrolysis. *AIP Conference Proceedings* (Vol. 1823, No. 1: 020016).

Premlatha, S.T. & Preethika, M. (2018). Synthesis and characterisation of MgO nanoparticles using *Ocimum sanctum* and its application. *World Journal of Pharmaceutical Research*, *7*(07): 285–294.

Selvam, N. C. S., Kumar, R. T., Kennedy, L. J. & Vijaya, J. J. (2011). Comparative study of microwave and conventional methods for the preparation and optical properties of novel MgO-micro and nano-structures. *Journal of Alloys and Compounds*, *509*(41): 9809-9815.

Shimpi, P., Gao, P. X., Goberman, D. G. & Ding, Y. (2009). Low temperature synthesis and characterization of MgO/ZnO composite nanowire arrays. *Nanotechnology*, *20*(12): 125608.

Singh, A., Joshi, N. C. & Ramola, M. (2019). Magnesium oxide nanoparticles (MgONps): green synthesis, characterizations and antimicrobial activity. *Research Journal of Pharmacy and Technology*, *12*(10): 4644-4646.

Tran X. Phuoc., Bret. H. Howard., Donald V. Martello, Yee Soong., & Minking K. Chyu. (2008) Synthesis of $Mg(OH)_2$, MgO, and Mg nanoparticles using laser ablation of magnesium in water and solvents. *Opt. Lasers. Eng*., *46*(07): 829-834.

How to cite this article: Akshay Kumar Kurdekar, Jayadeva H.M., Sandeep S.N., T. Gangadhara, Vinay Kumar, M.I. and P. Laxman Rao (2022). Different Methods of Nano-magnesium Synthesis: A Future Fertilizer Source. *Biological Forum – An International Journal*, *14*(2): 1190-1193.