International Journal of Current Science Research and Review
ISSN: 2581-8341
Volume 09 Issue 11 November 2026
DOI: 10.47191/ijcsrr/V9-i11-31, Impact Factor: 8.048
IJCSRR @ 2026
www.ijcsrr.org

Sustainable Synthesis of Bismuth Vanadate Nanomaterials: A Critical Comparison of Plant-Assisted and Conventional Routes for Visible-Light Water Treatment

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ABSTRACT: Bismuth vanadate ($BiVO_4$) is a visible-light-responsive semiconductor widely investigated for photocatalytic oxidation and photoelectrochemical applications. Plant-assisted synthesis has attracted interest as a potential means of modifying precursor chemistry and reducing dependence on selected synthetic additives. Nevertheless, biological origin alone is not evidence of environmental superiority. This critical narrative review evaluates plant-assisted and conventional $BiVO_4$ synthesis through a route–material–function framework, considering precursor chemistry, phase formation, morphology, optical response, photocatalytic test quality, reproducibility, process inputs, and environmental safety. Published reviews document plant-mediated $BiVO_4$ preparations using different botanical extracts, while conventional precipitation, hydrothermal, solvothermal, and sol–gel approaches provide established means of controlling crystallisation and morphology. The evidence also shows why route labels cannot be used as proxies for sustainability: plant-assisted preparations may require extraction, washing, drying, and high-temperature annealing, whereas conventional processes vary substantially in reagent hazards, yield, energy demand, and purification requirements. Reported photocatalytic efficiencies are difficult to compare directly because studies use different pollutants, concentrations, catalyst loadings, light sources, and analytical endpoints. In particular, loss of a dye absorbance peak is not equivalent to mineralisation or detoxification. We propose a transparent comparison framework based on verified product characteristics, matched treatment conditions, measured process inputs and outputs, catalyst recovery, leaching, and an explicitly defined functional unit. The literature supports the feasibility of plant-assisted $BiVO_4$ synthesis, but the available evidence does not justify a general conclusion that it is inherently greener or more effective than conventional synthesis. Future work should prioritise direct route-to-route comparisons, reproducible extract characterisation, realistic water matrices, and quantitative environmental inventories.

KEYWORDS: bismuth vanadate; $BiVO_4$; plant-assisted synthesis; green chemistry; photocatalysis; wastewater treatment; reproducibility; life-cycle assessment

1. INTRODUCTION

Persistent organic contaminants in water—including dyes, pharmaceutical residues, and industrial chemicals—have motivated the development of treatment technologies that can transform pollutants rather than merely transfer them between phases. Semiconductor photocatalysis is one candidate because absorbed photons can generate electron–hole pairs that drive surface redox reactions. The practical performance of a photocatalyst, however, depends on more than its nominal chemical formula: crystal phase, morphology, surface area, defect chemistry, charge-carrier dynamics, solution chemistry, and illumination conditions all influence the observed outcome [1–4].

$BiVO_4$ is of interest because its monoclinic scheelite phase absorbs a substantial portion of visible light and has been studied for organic-pollutant degradation and photoelectrochemical reactions. Its limitations include inefficient charge transport and electron–hole recombination, so absorption alone cannot establish catalytic effectiveness [2–5]. Research has therefore explored changes in synthesis conditions, morphology, composites, heterojunctions, cocatalysts, and other forms of material engineering. Results from

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photoelectrochemical water splitting should nevertheless be distinguished from results for pollutant degradation because the reaction pathways, reactor configurations, and performance metrics are not interchangeable [4,5].

Plant-assisted synthesis is often described as a greener alternative because extracts can contain polyphenols, sugars, organic acids, proteins, and other constituents that interact with precursor species or influence particle nucleation and growth. For $BiVO_4$, the role of an extract is system-dependent: the bismuth and vanadium precursors still determine the inorganic composition, while extract constituents may affect complexation, pH, aggregation, or surface residues. The use of a plant extract does not by itself establish that the process avoids hazardous reagents, reduces energy use, or produces a safer final material. Some plant-assisted routes include substantial post-synthesis heating; for example, a reported Hyphaene thebaica-assisted $BiVO_4$ preparation included annealing at 500 °C for two hours [6].

Existing reviews have discussed eco-friendly $BiVO_4$ synthesis, synthesis methodologies, photocatalytic degradation, and photoelectrochemical applications [1–5]. The contribution of the present review is narrower and comparative: it considers how synthesis route, final-material attributes, photocatalytic evidence, and process burdens should be evaluated together. Rather than assume that either plant-assisted or conventional synthesis is superior, we ask: under what conditions can a plant-assisted route deliver reproducible $BiVO_4$ and equivalent treatment function with a demonstrable environmental advantage over a realistic conventional benchmark?



Fig 1: Synthesis Methods of $BiVO_4$

2. REVIEW SCOPE AND APPROACH

This article is a critical narrative review, not a registered systematic review or meta-analysis. The initial manuscript was based on targeted literature searches and a limited set of sources. For this revised draft, additional published reviews and primary studies were identified through targeted searches of scholarly publisher and indexing pages, with emphasis on $BiVO_4$ synthesis, plant-assisted preparation, photocatalytic pollutant degradation, and environmental assessment. The cited literature includes reviews of eco-friendly $BiVO_4$ synthesis and photocatalysis, a plant-assisted primary study, and recent work on $BiVO_4$-based photocatalytic and photoelectrochemical systems [7].

Because the search was not conducted as a fully reproducible systematic review, no claim of exhaustive coverage is made. Before submission, the author should rerun and document searches in databases required by the target journal (for example, Scopus, Web of Science, or an appropriate multidisciplinary database), state the exact final search date and search strings, apply explicit inclusion and exclusion criteria, and verify every reference against the publisher record. Any study count, pooled statistic, or numerical trend must be added only after a documented screening and data-extraction process.

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The comparison framework used here has four linked levels: (i) process inputs and unit operations; (ii) verified product attributes; (iii) performance under defined treatment conditions; and (iv) environmental and operational implications. These levels are considered together because a synthesis route cannot be judged independently of the material it produces or the treatment function that material performs.

3. $BiVO_4$ STRUCTURE AND PHOTOCATALYTIC FUNCTION

3.1 Crystal phase and optical response

$BiVO_4$ occurs in more than one crystal structure, including monoclinic scheelite and tetragonal forms. The monoclinic scheelite phase is frequently associated with visible-light photocatalytic activity, but phase identity and purity should be established experimentally rather than inferred from colour or a single optical spectrum [8]. X-ray diffraction (XRD), ideally supported by appropriate reference patterns and careful consideration of secondary phases, is central to phase identification. Where crystallinity or phase fractions are important to the argument, refinement or complementary Raman analysis can strengthen interpretation [9].

$BiVO_4$ is commonly reported to have an optical band gap in the visible-light range, often around 2.4–2.6 eV depending on phase, preparation, measurement, and analysis. This range should not be treated as a universal constant for every sample. Optical band gaps inferred from diffuse-reflectance data depend on the transformation used, the assumed transition type, and the fitting interval. A comparison should therefore report the measurement method and calculation assumptions and should avoid attributing differences solely to synthesis route when morphology, defects, or phase composition also differ [10].

3.2 Charge carriers and surface reactions

Following absorption of a photon with sufficient energy, an electron is promoted to the conduction band, leaving a hole in the valence band. The carriers may recombine in the bulk or at the surface, or migrate to surface sites where they participate in redox reactions. Consequently, a broad absorption edge or reduced apparent band gap does not necessarily mean a higher reaction rate. Charge separation, carrier mobility, surface adsorption, reactive-species formation, and pollutant accessibility also contribute to the measured response [2–5].

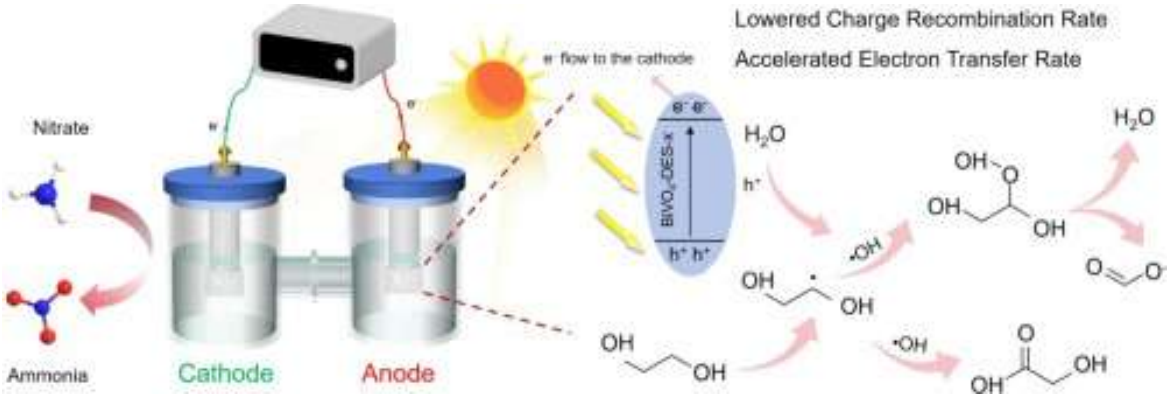


Fig 2: Charge carriers and surface reactions of Bismuth vanadate nanomaterials

Mechanistic claims should be proportional to the evidence. Photoluminescence, electrochemical impedance, photocurrent, radical-scavenging tests, and electron paramagnetic resonance can provide complementary information, but no single measurement proves a complete reaction mechanism. In addition, results from water oxidation or photoelectrochemical water splitting should not be used as direct evidence of pollutant mineralisation unless the relevant pollutant-treatment experiments were performed.

4. SYNTHESIS ROUTES AND THEIR PROCESS IMPLICATIONS

4.1 Conventional routes

Precipitation, hydrothermal, solvothermal, and sol–gel methods are widely used to prepare $BiVO_4$. These routes differ in precursor mixing, solvent environment, pH control, temperature, pressure, reaction duration, and crystallisation pathway. Precipitation can be operationally straightforward but may require control of local pH and subsequent heat treatment. Hydrothermal and solvothermal approaches can promote crystallisation and morphology control under sealed conditions, while sol–gel routes can provide intimate

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precursor mixing but may require solvent removal and calcination. Microwave-assisted methods may shorten reaction times in some systems, but their energy and environmental performance must be measured rather than assumed [11].

Potential advantages of conventional methods include defined reagent concentrations, relatively straightforward parameter control, and the ability to design reproducible experiments. Potential burdens include precursor production, solvent and pH-adjusting reagents, heating, pressurised equipment, washing, drying, calcination, and waste treatment. The magnitude of these burdens depends on the actual recipe, yield, scale, energy source, solvent recovery, and purification needs. Thus, 'conventional synthesis' is not a single environmental category and should be broken down into its unit operations.

4.2 Plant-assisted and bio-inspired routes

Plant-assisted synthesis introduces an extract or plant-derived material into precursor processing. Depending on the system, extract constituents may complex metal ions, alter nucleation and growth, influence pH, or modify particle aggregation and surface chemistry. However, these effects cannot be assigned to a specific molecule without appropriate evidence. Broad FTIR bands or a description of known plant phytochemicals are not sufficient to prove that a particular compound directs crystal growth or remains on the final surface.

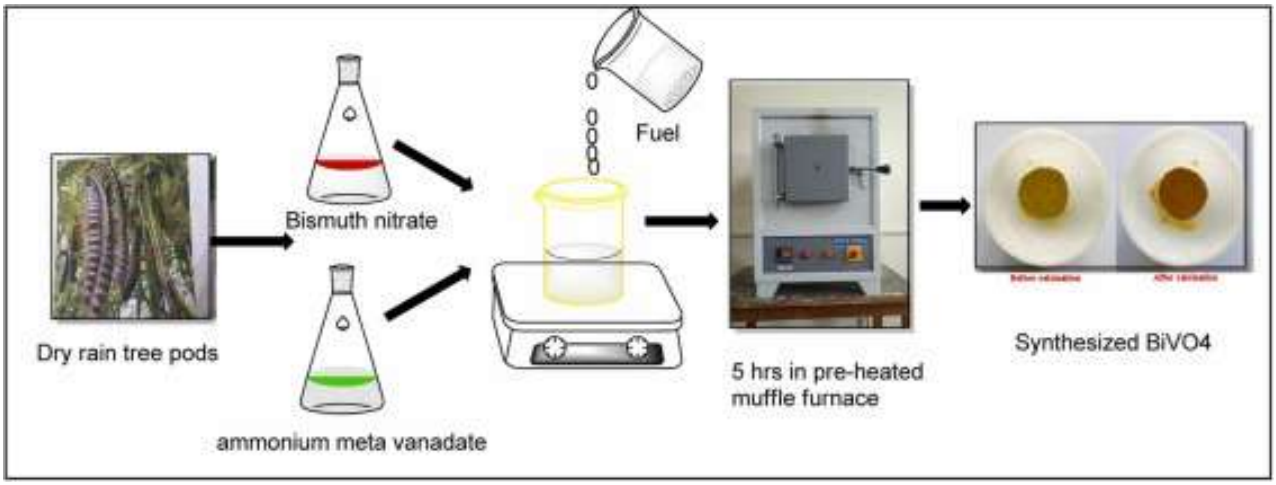


Fig 3: Synthesis of Bismuth vanadate nanomaterials

Reproducible reporting should include botanical identity, plant part, provenance, collection season where relevant, storage, extraction solvent, solid-to-liquid ratio, extraction temperature and time, extract yield, filtration procedure, extract-to-precursor ratio, pH, mixing, ageing, washing, drying, and any calcination. If batch variability is a central concern, the extract should be characterised using a suitable fingerprinting or compositional method. The final powder should be examined for phase, morphology, elemental composition, and residual organics as relevant to the intended application.

A published example using Hyphaene thebaica fruit extract demonstrates the feasibility of plant-assisted $BiVO_4$ nanorod preparation, but the reported process also included annealing at 500 °C for two hours [12]. This example should not be interpreted as evidence that all plant-assisted routes are energy-intensive; rather, it illustrates why the complete process, including post-treatment, must be included in any comparison. Reviews also report plant-assisted $BiVO_4$ preparations using different extracts and morphologies, but reported photocatalytic percentages are not directly rankable when experimental conditions differ [13].

4.3 Route-to-product comparison

Table 1 summarises the dimensions that should be compared. It is a framework for extracting evidence from individual studies, not a claim that one route performs better. The author should populate the final submission version with data from verified primary papers and identify missing information explicitly.

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Comparison dimension	Plant-assisted route: questions to resolve	Conventional route: questions to resolve
Feedstock and reagents	Which plant, part, extraction solvent, extract yield, and precursor chemicals are used?	Which precursors, solvents, surfactants, and pH modifiers are used?
Process conditions	What are the extraction, reaction, drying, and calcination requirements?	What are the reaction temperature, time, pressure, drying, and calcination requirements?
Product identity	Is phase purity demonstrated by XRD and supported by complementary characterisation?	Are phase and secondary phases verified with equivalent rigour?
Material attributes	Are morphology, size distribution, surface chemistry, and residual organics reported?	Are morphology, size distribution, surface chemistry, and residues reported?
Treatment performance	Are controls, light conditions, pollutant concentrations, and endpoints adequately described?	Are the same performance metrics and test conditions available?
Reproducibility	Are independent synthesis batches and extract variability evaluated?	Are independent batches and process control evaluated?
Environmental burden	Are extraction, water use, heating, purification, yield, and waste measured?	Are reagent manufacture, solvent use, energy, yield, and waste measured?
End of use	Are recovery, reuse, leaching, and residual particles assessed?	Are recovery, reuse, leaching, and residual particles assessed?

5. CHARACTERISATION AND EVIDENCE QUALITY

A defensible comparison requires a characterisation package matched to the claim being made. XRD establishes phase information; electron microscopy provides morphology and particle dimensions; elemental methods assess composition; optical measurements characterise absorption; and surface-sensitive or thermal methods may be needed to evaluate oxidation states and residual plant-derived material. No single technique establishes all these properties. Representative image selection, uncertainty, and data-processing procedures should be described transparently.

For morphology, the author should report how many fields or particles were analysed and how size distributions were calculated. For optical properties, the sample preparation, instrument configuration, baseline correction, and band-gap fitting procedure should be reported. For plant-assisted materials, residual organic matter and possible precursor-derived residues deserve attention because they may affect both measured activity and environmental exposure. Post-use characterisation is also important where repeated use, phase stability, particle release, or leaching is claimed.

Claims such as 'pure $BiVO_4$', 'complete stabilisation by plant biomolecules', or 'improved charge separation' should be reserved for cases where the supporting measurements justify them. The presence of a major XRD phase does not exclude low-level impurities, and a change in optical absorption does not independently establish a charge-transfer mechanism.

6. COMPARING PHOTOCATALYTIC PERFORMANCE

6.1 Minimum experimental information

Photocatalytic removal percentages are strongly dependent on experimental conditions. At minimum, studies should report pollutant identity and initial concentration, solution volume and pH, catalyst mass and concentration, reactor geometry, mixing, light-source type and spectrum, irradiance or photon flux, distance from the reactor, exposure time, sampling procedure, and analytical calibration. A dark adsorption period and a catalyst-free illuminated control are needed to distinguish adsorption and direct photolysis from catalyst-mediated transformation. Replicate experiments should be independent where possible, and uncertainty should be reported.

For kinetic analysis, the model and fitting interval should be stated. Apparent pseudo-first-order constants may be useful for comparison only when the model is appropriate and the test conditions are sufficiently similar. A higher percentage removal after a longer irradiation period cannot be interpreted as superior activity without accounting for initial concentration, catalyst dose, photon input, and reactor configuration.

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6.2 Decolourisation, degradation, and mineralisation

A decrease in a dye's absorbance peak can arise from adsorption, photolysis, chromophore transformation, or chemical degradation. It does not, by itself, prove complete mineralisation or detoxification. Where the research question concerns mineralisation, total organic carbon (TOC) or another appropriate carbon-balance method should be considered. Where persistent intermediates or risk reduction are important, product identification and toxicity assessment may be required. The endpoint should match the claim: decolourisation, parent-compound disappearance, mineralisation, and detoxification are distinct outcomes [14].

6.3 Designing a fair head-to-head comparison

A robust comparison would prepare plant-assisted and conventional $BiVO_4$ against a pre-defined target specification and test both materials using the same pollutant, initial concentration, solution chemistry, catalyst loading, reactor, illumination, sampling schedule, and analytical method. If the materials differ in surface area, morphology, or composition, those differences should be reported and included in interpretation. Matching catalyst mass alone may not be sufficient where the materials have substantially different accessible surface areas or treatment performance [15,16].

Results should be reported with uncertainty and, where possible, normalised to a clearly stated functional basis. For an environmental treatment claim, a useful functional unit might be the treatment of a specified volume of water to a defined pollutant endpoint under a stated energy input. Such a basis can reveal trade-offs that are obscured by reporting only the mass of catalyst or the percentage of dye removed.

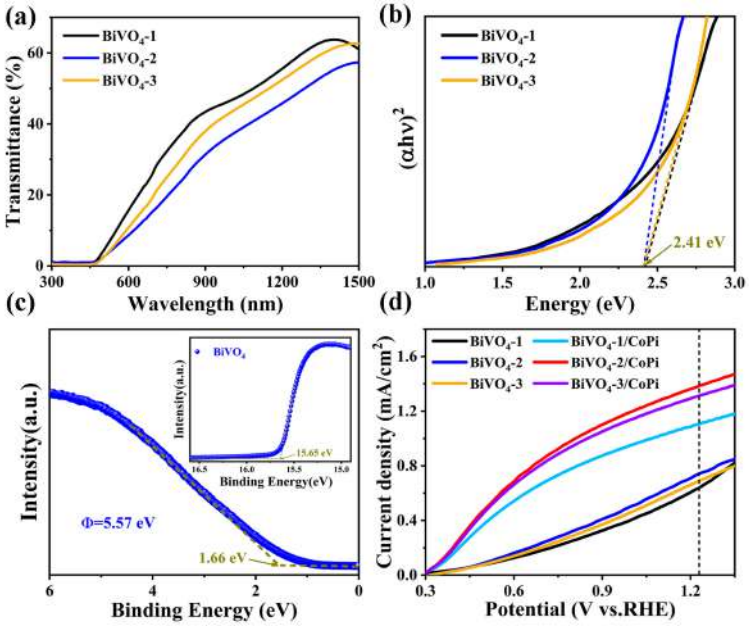


Fig 4: Charge Transport Enhancement in $BiVO_4$ Photoanode

7. SUSTAINABILITY, SAFETY, AND SCALE-UP

Plant-assisted synthesis may provide advantages where a responsibly sourced, low-value biomass stream replaces a more burdensome input, or where the route demonstrably reduces hazardous reagents or process energy. These are hypotheses to be tested, not automatic consequences of using an extract. A fair environmental comparison should account for bismuth and vanadium precursor production, plant cultivation or collection, transport, extraction, solvents, process water, reaction heating, calcination, purification, product yield, waste treatment, and catalyst service life.

Environmental comparisons should define the system boundary and functional unit before calculations are performed. A gate-to-gate inventory may be useful for comparing laboratory synthesis steps, but it does not represent the full life cycle unless upstream precursor production and downstream use are included. If the study claims a lower environmental burden per treatment outcome, the inventory must also account for differences in catalyst dose, treatment time, energy input, recovery, and reuse. Where reliable data are absent, the correct conclusion is that sustainability remains undetermined.

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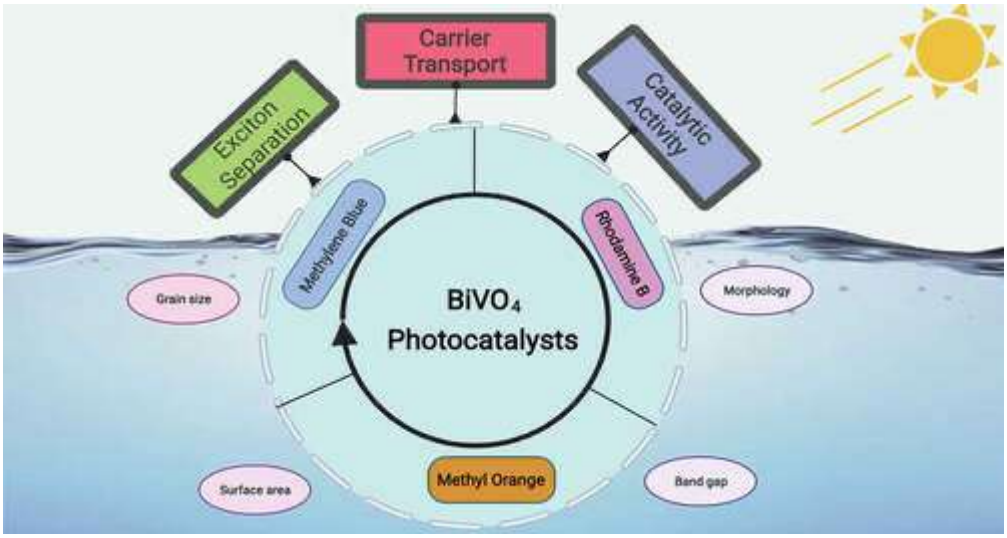


Fig 5: Recent progress on morphology and photocatalytic dye of $BiVO_4$ photocatalysts

Safety is similarly broader than synthesis origin. $BiVO_4$ powders may release particles or dissolved elements under some conditions, and the possibility of residual precursors or transformation products should be evaluated for water-treatment applications. Catalyst recovery, leaching, particle retention, reuse, and appropriate waste management are therefore central to environmental claims. Laboratory dye tests alone do not demonstrate readiness for real wastewater, where salts, natural organic matter, suspended solids, and competing contaminants can change performance.

Scale-up introduces additional issues: plant-extract supply and composition may vary; batch mixing and heat transfer may change with reactor size; and washing or drying may dominate resource consumption. A method that is convenient at milligram scale may not retain the same yield, quality, or environmental profile at larger scale. Scale-up claims should therefore be supported by process data rather than inferred from a successful laboratory synthesis.

8. RESEARCH PRIORITIES

1. Standardise botanical inputs by documenting plant identity, part, provenance, extraction conditions, extract yield, and a suitable compositional fingerprint.
2. Link extract chemistry to product attributes through controlled experiments rather than relying only on broad mechanistic assumptions.
3. Conduct direct plant-assisted versus conventional comparisons using comparable target material specifications and matched photocatalytic protocols.
4. Report independent synthesis batches, uncertainty, and transparent image and spectral analysis procedures.
5. Improve photocatalytic endpoints by distinguishing adsorption, photolysis, parent-pollutant disappearance, mineralisation, and toxicity reduction.
6. Measure process inputs and outputs, including reagent and water use, energy, product yield, purification, and waste generation.
7. Assess catalyst recovery, repeated-use stability, leaching, residual particles, and performance in realistic water matrices.
8. Separate pollutant degradation from disinfection and photoelectrochemical water splitting, which require different performance measures.
9. Use a clearly stated functional unit and system boundary for any quantitative environmental comparison.

9. LIMITATIONS OF THE PRESENT REVIEW

This article is a critical narrative review and does not claim exhaustive systematic coverage. The literature base must be expanded and screened using a documented database strategy before submission. The comparative framework identifies the information needed for a defensible assessment, but published studies do not always report all required process and performance data.

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Consequently, the present review does not calculate a pooled photocatalytic ranking or claim a quantified life-cycle advantage for either synthesis route.

10. CONCLUSIONS

$BiVO_4$ is an important visible-light-responsive semiconductor investigated for photocatalytic pollutant degradation and photoelectrochemical applications. Both conventional and plant-assisted routes have been reported, and plant-derived materials can influence precursor chemistry and particle formation. However, a biological feedstock does not, by itself, demonstrate lower energy demand, reduced hazard, greater reproducibility, or improved treatment performance. Plant-assisted routes must be assessed together with extraction, washing, drying, calcination, product yield, and waste treatment, while conventional methods must be evaluated according to their actual reagents and operating conditions.

The most meaningful comparison is route-to-product-to-function. Researchers should verify the final phase and surface characteristics, compare photocatalytic performance under matched conditions, distinguish decolourisation from mineralisation, and evaluate catalyst recovery and leaching. A sustainability advantage should be claimed only when the process inventory and treatment function support it. On the evidence considered here, plant-assisted synthesis is a promising research direction, but its general environmental superiority over conventional $BiVO_4$ synthesis remains unproven. Progress will depend on transparent methods, reproducible materials, realistic treatment tests, and quantitative comparisons against credible alternatives.

REFERENCES

1. Alijani, H. Q., Iravani, S., & Varma, R. S. (2023). Bismuth vanadate ($BiVO_4$) nanostructures: Eco-friendly synthesis and their photocatalytic applications. Catalysts, 13, 59. https://doi.org/10.3390/catal13010059
2. Kamble, G. S., Natarajan, T. S., Patil, S. S., Thomas, M., Chougule, R. K., Sanadi, P. D., Siddharth, U. S., & Ling, Y.-C. (2023). $BiVO_4$ as a sustainable and emerging photocatalyst: Synthesis methodologies, engineering properties, and its volatile organic compounds degradation efficiency. Nanomaterials, 13, 1528. https://doi.org/10.3390/nano13091528
3. Zhang, Y., Li, H., & Yin, D. (2025). Recent progress in bismuth vanadate based photocatalysts for photodegradation applications. Nanomaterials, 15, 331. https://doi.org/10.3390/nano15050331
4. Guan, B., Chen, J., Li, Z., Huang, Z., Chen, Y., Ma, Z., Hou, J., Guo, C., Guo, Z., Hu, X., Zhao, S., Dang, H., Chen, L., Shin, K., Guo, Z., Bai, S., Fu, Y., Li, Y., Hu, J., & Huang, Z. (2024). Review on synthesis, modification, morphology, and combination of $BiVO_4$-based catalysts for photocatalysis: Status, advances, and perspectives. Energy & Fuels, 38, 806–853. https://doi.org/10.1021/acs.energyfuels.3c03932
5. Navarrete-Cevallos, L. E., Vargas, R., & Espinoza-Montero, P. J. (2025). Environmental and industrial applications of bismuth vanadate for photoelectrocatalysis. npj Clean Water, 8, 87. https://doi.org/10.1038/s41545-025-00511-0
6. Mohamed, E. S., Afridi, S., Khalil, A. T., Zohra, T., Alam, M. M., Ikram, A., Shinwari, Z. K., & Maaza, M. (2019). Phytosynthesis of $BiVO_4$ nanorods using Hyphaene thebaica for diverse biomedical applications. AMB Express, 9, 200. https://doi.org/10.1186/s13568-019-0923-1
7. Lotfi, S., El Ouardi, M., Arab, M., Assani, A., Baqais, A., Haspel, H., Kónya, Z., & Ait Ahsaine, H. (2025). Polycrystalline $BiVO_4$: Visible-light photocatalytic activity: Rietveld refinement, microstructural, vibrational, and photocatalytic properties. Oxford Open Materials Science, 5, itaf005. https://doi.org/10.1093/oxfmat/itaf005
8. Nikam, S., Bhorde, A. A., Hain, G., Patil, G. E., Jadkar, S. R., Patole, S. P., & Sartale, S. D. (2026). Visible-light-induced photocatalytic behaviour of bismuth vanadate nanoparticles via mechanochemical milling. Materials Letters, 140355.
9. Bai, Y., Fang, Z., Fang, Y., Lin, C., Bai, H., & Fan, W. (2025). Recent advances in $BiVO_4$-based heterostructure photocatalysts for energy and environmental applications. Chemical Communications, 61, 5264–5280. https://doi.org/10.1039/D4CC058C
10. Xiao, C., Assavachin, S., Hahn, W., Wang, L., van Benthem, K., & Osterloh, F. E. (2025). Flux synthesis of single crystal bismuth vanadate ($BiVO_4$) nanowires and their visible light driven photocatalytic water oxidation properties. Journal of Materials Chemistry A, 13, 7834–7844. https://doi.org/10.1039/D4TA08318K
11. Phurangrat, A., Wannapop, S., Sakhon, T., Kuntalue, B., Thongtem, T., & Thongtem, S. (2023). Characterization and photocatalytic properties of $BiVO_4$ synthesized by combustion method. Journal of Molecular Structure, 1274, 134422.

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12. Zhang, Y., Li, H., & Yin, D. (2025). Recent progress in bismuth vanadate-based photocatalysts for photodegradation applications. Nanomaterials, 15(5), 331.
13. Ghotekar, S. K. (2020). A review on eco-friendly synthesis of $BiVO_4$ nanoparticle and its catalytic applications. Advanced Journal of Science and Engineering.
14. Kausar, S., Mustafa, R., Munir, Iqbal, T., Afsheen, S., Mansha, M. S., Ali, A. M., & Khan, S. A. (2025). Comprehensive study on synthesis and photocatalytic properties of pure bismuth vanadate: Characterization and theoretical analysis. Inorganic Chemistry Communications, 172, 113654.
15. Patil, B., Bansal, A., Gupta, R., & Mittal, S. K. (2024). $BiVO_4$-based heterogeneous nanophotocatalysts for water splitting and organic pollutant degradation: A comprehensive review of photocatalytic innovation. Reviews in Inorganic Chemistry, 44(4), 495–519.
16. Huang, S., Liu, J., Jingxin, K., Zhang, Q., Wang, J., Wang, Y., & Xiao, Q. (2024). Enhanced visible light photocatalytic performance of Er, Mn co-doped monoclinic $BiVO_4$ for efficient organic pollutant degradation. Reaction Chemistry & Engineering, 9(6), 1418–1432.
17. Hu, Y., Gao, Y., Liu, F., Tian, Y., Wang, Q., Zeng, D., Shen, T., Song, J., Guan, R., & Yuan, H. (2023). The {0 1 0} and {1 1 0} facets of $BiVO_4$ were selectively modified by Cu and g-C_3N_4 to enhance its visible light photocatalytic performance. Separation and Purification Technology, 323, 124431.

Cite this Article: Raju, K. V. S. N., Vamsi Krishna, B.V.,. SriRamudu, B., RamaMohan, T.V., Hanumanthu, J. (2026). Sustainable Synthesis of Bismuth Vanadate Nanomaterials: A Critical Comparison of Plant-Assisted and Conventional Routes for Visible-Light Water Treatments. International Journal of Current Science Research and Review, 9(11), pp. 5825-5833. DOI: https://doi.org/10.47191/ijcsrr/V9-i11-31