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I_2/TBHP in PEG-400: A green approach for the synthesis of organoselenium-decorated imidazo[1,2-*a*]pyrimidines

Caroline S. Gomes, Lucas E. B. Iarocz, Leonardo Rocha, Ricardo H. Bartz, Stella Q. Fernandes, Carolina A. Oliveira, Eder J. Lenardão, Márcio S. Silva,* and Gelson Perin*

Laboratório de Síntese Orgânica Limpa (LASOL), Centro de Ciências Químicas, Farmacêuticas e de Alimentos (CCQFA), Universidade Federal de Pelotas (UFPel) - P.O. Box 354 - 96010-900, Pelotas, RS, Brazil
E-mail: silva.ms@ufpel.edu.br; gelson_perin@ufpel.edu.br

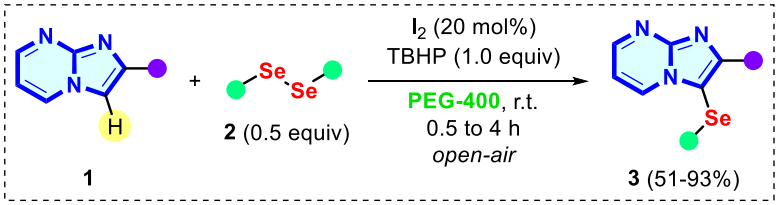
This article is dedicated to Professor Teodoro S. Kaufman, for his outstanding contribution to synthetic organic chemistry

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Abstract

In this work, we developed an efficient and green approach for the synthesis of 3-(organoselanyl)imidazo[1,2-*a*]pyrimidines *via* electrophilic aromatic substitution (EAS) reactions between 2-aryl-imidazo[1,2-*a*]pyrimidines and diorganyl diselenides under mild conditions. The reactions are mediated by an oxidative system composed of molecular iodine and *tert*-butyl hydroperoxide (I_2/TBHP), which promotes the *in situ* generation of selenium-based electrophiles in PEG-400 as a green solvent. Under these conditions, fifteen derivatives were synthesized (fourteen novel), with reaction times ranging from 0.5 to 4 h and isolated yields ranging from 51% to 93%.



- *Uses a sustainable alternative solvent (PEG-400)*
- *Yields up to 93%*
- *14 Unprecedented Se-decorated imidazo-1,2-[a]pirymidines*
- *Csp²-Se Bond formation under mild conditions*

Keywords: Imidazo[1,2-*a*]pyrimidine, organoselenium, molecular iodine, *tert*-butyl hydroperoxide, green chemistry, PEG-400

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Introduction

N-based heterocycles represent an important class of compounds with widespread applications in the pharmaceutical industry with a broad spectrum of biological activities.[1-6] Among these, imidazopyrimidines have attracted considerable attention due to their fused bicyclic scaffold, which combines imidazole and pyrimidine moieties, providing a versatile platform for molecular diversification and biological interaction.[7-9] These heterocycles exhibit several isomeric forms,[10] including imidazo[1,2-*a*]pyrimidine,[11] imidazo[1,2-*c*]pyrimidine,[12] imidazo[1,5-*a*]pyrimidine,[13] and imidazo[1,5-*c*]pyrimidine[14] (Figure 1). The existence of these isomeric frameworks expands their chemical reactivity and synthetic potential while enabling the exploration of diverse biological activities.[11-14]

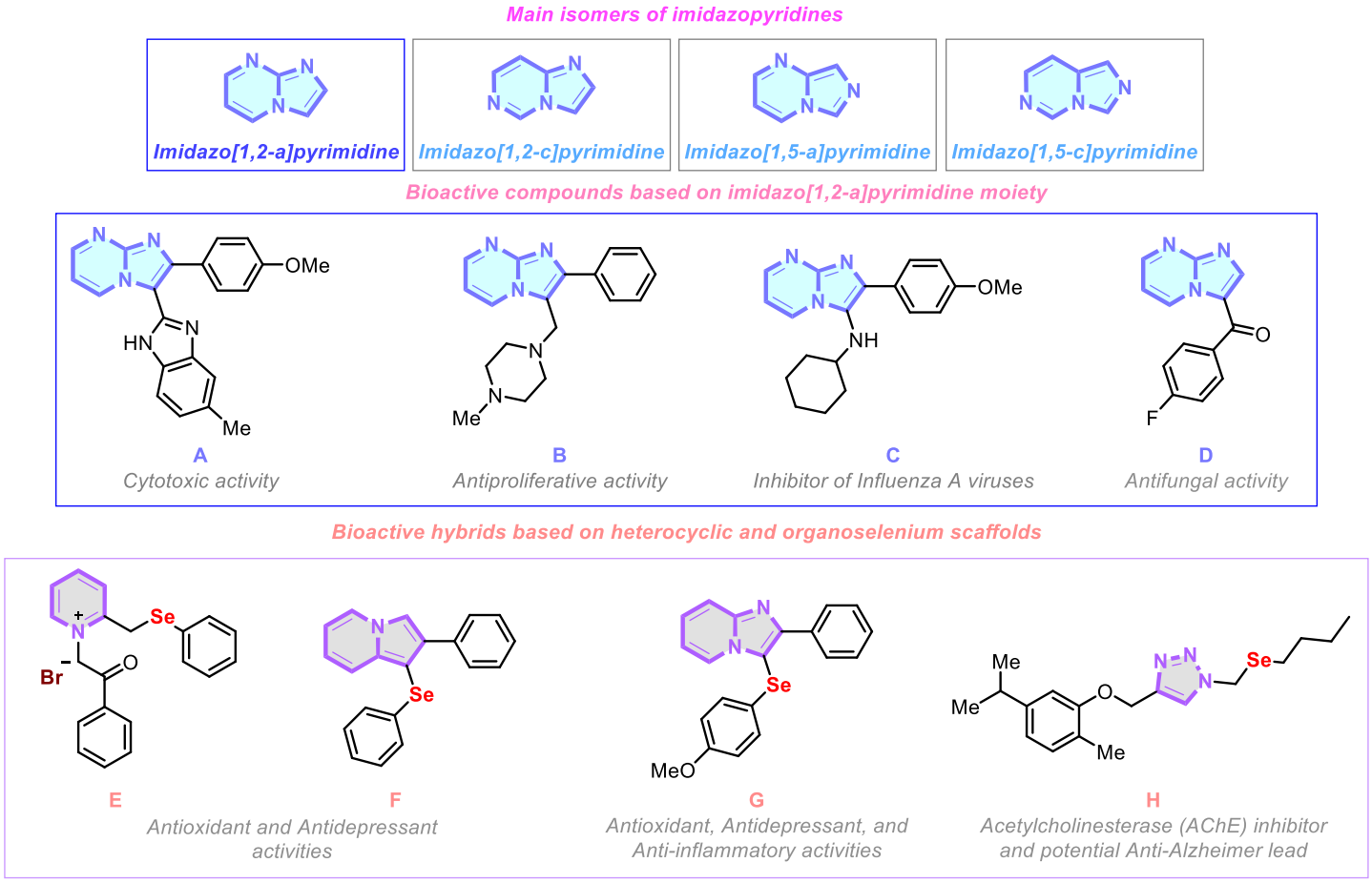


Figure 1. Bioactive imidazo[1,2-*a*]pyrimidines and heterocycle-based organoselenium hybrids

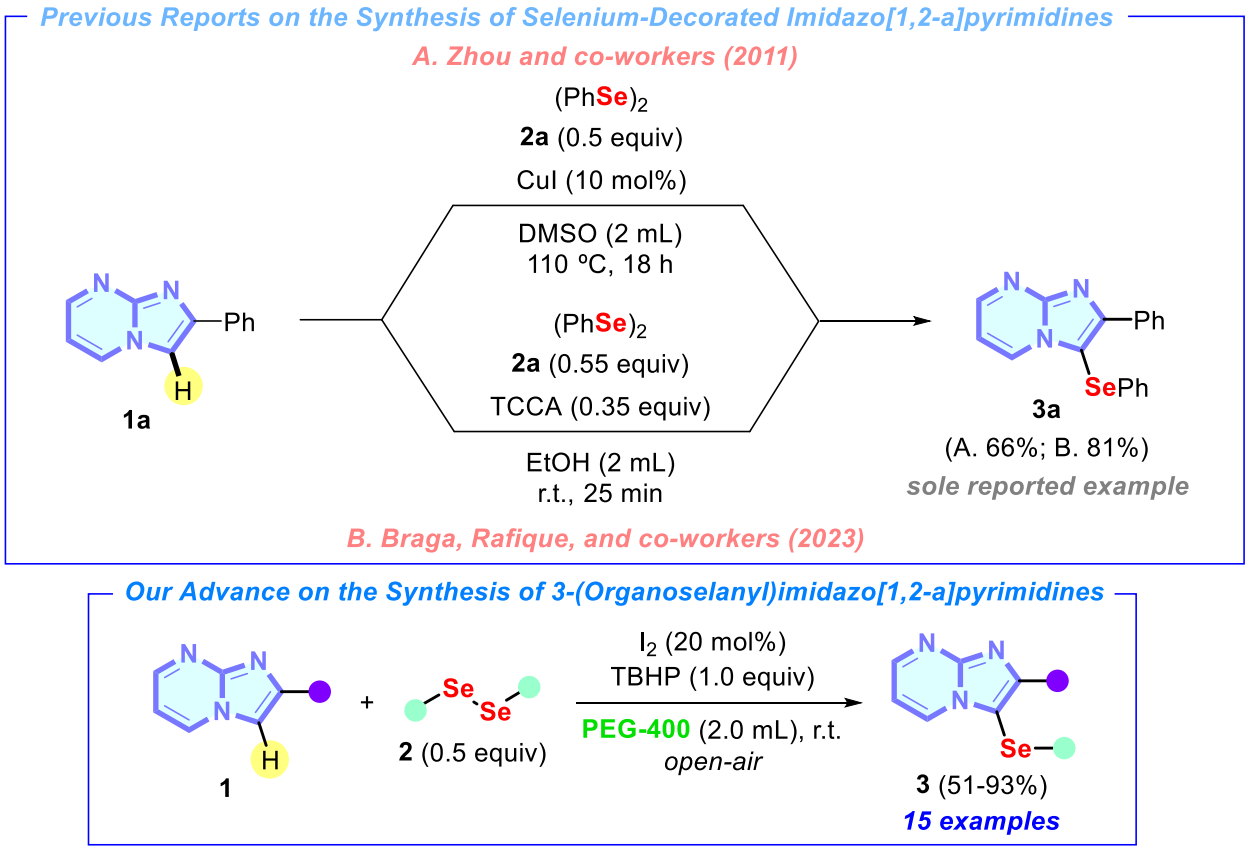
A wide range of compounds derived from imidazo[1,2-*a*]pyrimidine core exhibit remarkable biological activity, highlighting its significance as a privileged scaffold in medicinal chemistry (Figure 1).[8] For instance, compound **A** demonstrates antitumor activity against A-549 (lung) cancer cells line, exhibiting a satisfactory cytotoxic effects.[15] Similarly, compound **B** showed antiproliferative activity against HeLa (cervical cancer), Panc-1 (pancreatic cancer), and MDA-MB-231 (triple-negative breast cancer) cell lines.[16] Additionally, compound **C** demonstrated potential for antiviral therapy, as it exhibited activity against both oseltamivir-sensitive and oseltamivir-resistant strains of influenza A viruses.[17] Finally, compound **D** showed antifungal activity against *Candida guilliermondii* and *C. glabrata*, comparable to fluconazole and ketoconazole[18] (Figure

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1). These findings highlight the broad pharmacological potential of the imidazo[1,2-a]pyrimidine scaffold and reinforce its importance in the development of new bioactive molecules.

From this perspective, organoselenium compounds have gained prominence and become well established in chemistry due to their applications in both synthesis and pharmacology.[19-29] Molecular hybridization strategies combining heterocycles with organoselenium moieties have gained attention in drug design.[24-27,30-36] These hybrids enhance biological activity by integrating pharmacophoric features from both scaffolds, which can lead to improved efficacy and selectivity. In this context, some selenium-based pyridinium salts (Compounds **E** and its derivatives) have shown potential as antioxidant and antidepressant agents,[37,38] and several organoselenium-substituted indolizines (Compounds **F** and its derivatives),[39-42] as well as an imidazo[1,2-*a*]pyridine derivative (Compound **G**),[43] have demonstrated antidepressant, antioxidant and anti-inflammatory activities. Additionally, the carvacrol-based organoselenium hybrid (Compound **H**) has potential as an anticholinesterase and antioxidant candidate for Alzheimer's therapy[44] (Figure 1).

Considering the above, it is imperative to develop efficient and general strategies to obtain hybrid compounds combining organoselenium moieties with imidazo[1,2-*a*]pyrimidines. Motivated by our ongoing interest in sustainable organoselenium chemistry, we have recently developed a series of green and efficient methodologies for the preparation of organoselenium-functionalized imidazo[1,2-*a*]pyridines.[45–48] Nevertheless, the corresponding organoselenium-functionalized imidazo[1,2-*a*]pyrimidines have received considerably less attention, and studies addressing their synthesis and reactivity remain scarce.[49,50]



Scheme 1. Previous approaches for the synthesis of organoselenium-imidazo[1,2-*a*]pyrimidine hybrids and the current work.

To the best of our knowledge, only two methodologies have been reported for the synthesis of these compounds, one developed by Zhou and co-workers in 2011,[49] and another by Braga, Rafique, and co-workers in 2023[50] (Scheme 1). In both cases, only 2-phenyl-3-(phenylselanyl)imidazo[1,2-*a*]pyrimidine **3a** was

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prepared, through an electrophilic aromatic substitution (EAS) reaction between 2-phenyl-imidazo[1,2-*a*]pyrimidine **1a** and diphenyl diselenide **2a**. The method reported by Zhou and co-workers involves the reaction of substrates **1a** and **2a** under CuI catalysis in DMSO as solvent, at 110 °C for 18 h, affording **3a** in 66% yield[49] (Scheme 1). On the other hand, Braga, Rafique, and co-workers employed trichloroisocyanuric acid (TCCA) in EtOH to promote the *in situ* generation of electrophilic selenium species, affording **3a** in 81% yield[50] (Scheme 1). Although only one example was reported in each study, these approaches provided useful precedents for this transformation. The method developed by Zhou and co-workers employs a metal catalyst, elevated temperature, and a prolonged reaction time, whereas Braga, Rafique, and co-workers reported milder reaction conditions, with cyanuric acid formed as a byproduct.

In this regard, our group has recently directed efforts toward the use of I_2/TBHP catalytic system as a green, cost-effective, and user-friendly approach for the formation of electrophilic chalcogen species *in situ*.[51,52] This methodology combines operational simplicity with inexpensive and readily available reagents, mild reaction conditions, short reaction times, and ethanol as a green solvent, providing an efficient and environmentally friendly strategy for the construction of C–Se bonds.[51-52] Therefore, this work discloses a sustainable protocol for the synthesis of 3-(organoselanyl)imidazo[1,2-*a*]pyrimidines **3** *via* the reaction of 2-aryl-imidazo[1,2-*a*]pyrimidines **1** with diorganyl diselenides **2** (Scheme 1). The method employs the I_2/TBHP system to generate electrophilic selenium species *in situ* using PEG-400 as a green solvent. Overall, this strategy allows the direct transformation of a Csp^2–H bond to a Csp^2–Se bond under mild and green conditions.

Results and Discussion

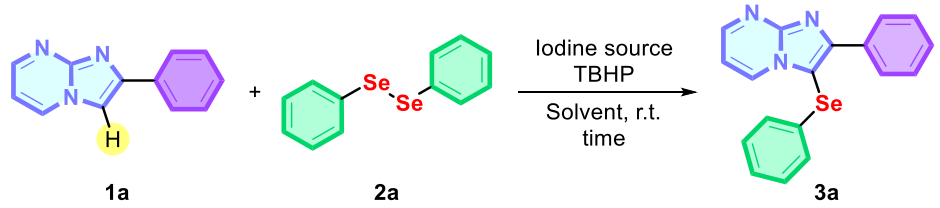
Based on our previous report employing I_2/TBHP as oxidative system in electrophilic aromatic substitution (EAS) reactions,[52] an optimization study was conducted to synthesize 3-(phenylselanyl)imidazo[1,2-*a*]pyrimidine **3a** using 2-phenyl-imidazo[1,2-*a*]pyrimidine **1a** (0.250 mmol) and diphenyl diselenide **2a** (0.125 mmol) as standard reactants (Table 1). Notably, employing 0.050 mmol (20 mol%) of molecular iodine (I_2) as the catalyst and 0.250 mmol (1.0 equiv) of *tert*-butyl hydroperoxide (TBHP) as the oxidant, in 2.0 mL of ethanol (EtOH) at room temperature under ambient atmosphere, led to the formation of 3-(phenylselanyl)imidazo[1,2-*a*]pyrimidine **3a** in a good yield of 70% after 0.5 h (Table 1, entry 1). Encouraged by this promising outcome, we decided to proceed with further studies aimed at improving the reaction yield by optimizing the conditions. At the outset, the solvent scope was explored using solvents with distinct profiles (Table 1, entries 2-7). The reaction times were adjusted based on the complete consumption of **1a**, which was monitored by TLC. The reactions performed in DMSO, DMF and MeCN allowed the synthesis of **3a** in yields of 69%, 82%, and 67%, respectively (Table 1, entries 2-4). Gratifyingly, excellent results were achieved with MeOH and PEG-400, affording compound **3a** in 90% and 93% yield, respectively after 0.5 h (Table 1, entries 5 and 6). In contrast, the desired product was not detected (N.D.) when H_2O was used as the solvent (Table 1, entry 7). Based on these findings, PEG-400 was selected as the optimal solvent for the reaction not only due to providing the best yield, but also because it is classified as a biodegradable, non-toxic and eco-friendlier solvent for organic synthesis.[53-56] In the next step, NaI, KI, and HI were evaluated as iodine sources (Table 1, entries 8-10), but the yields decreased to 75%, 61%, and 78%, respectively.

The effect of iodine loading was also investigated (Table 1, entries 11-13). When the iodine amount was reduced to 10 and 5 mol%, the yields of **3a** were 91% and 90%, respectively, in a reaction time of 2 h (Table 1, entries 11 and 12). In contrast, decreasing the loading to 2 mol% led to a longer reaction time of 5 h, affording **3a** in 80% yield (Table 1, entry 13). It is worth noting that reducing the I_2 loading from 20 to 5 mol% resulted in a similar yield (Table 1, entry 12), however, the reaction time increased to 2 h. Although entries 6

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and 12 afforded similar yields, we selected the higher iodine loading to shorten the reaction time. This choice also considered that reducing the iodine loading could compromise yields for other substrates, whereas the reaction time can be adjusted individually for each substrate. Decreasing the amount of TBHP to 0.125 mmol (0.5 equiv) resulted in a lower yield of **3a** (60%), whereas increasing it to 0.375 mmol (1.5 equiv) led to a slightly reduced yield of 86%, with both reactions conducted for 0.5 h (Table 1, entries 14 and 15). Increasing the amount of diphenyl diselenide **2a** to 0.15 mmol (1.2 equiv) led to a slight improvement in yield, from 93% to 95%, although this change was not particularly effective (Table 1, entry 16).

Table 1. Optimization study for the synthesis of 2-phenyl-3-(phenylselanyl)imidazo[1,2-*a*]pyrimidine **3a**.[a,b]



1a **2a** **3a**

Entry	**2a** (mmol)	TBHP (mmol)	Iodine Source (mol%)	Solvent	Time (h)	Yield of **3a** (%)[c]
1	0.125	0.250	I_2 (20)	EtOH	0.5	70
2	0.125	0.250	I_2 (20)	DMSO	0.5	69
3	0.125	0.250	I_2 (20)	DMF	0.5	82
4	0.125	0.250	I_2 (20)	MeCN	1	67
5	0.125	0.250	I_2 (20)	MeOH	0.5	90
6	0.125	0.250	**I_2 (20)**	**PEG-400**	**0.5**	**93**
7	0.125	0.250	I_2 (20)	H_2O	24	N.D.
8	0.125	0.250	NaI (20)	PEG-400	1	75
9	0.125	0.250	KI (20)	PEG-400	0.5	61
10	0.125	0.250	HI (20)	PEG-400	0.5	78
11	0.125	0.250	I_2 (10)	PEG-400	2	91
12	0.125	0.250	I_2 (5)	PEG-400	2	90
13	0.125	0.250	I_2 (2)	PEG-400	5	80
14	0.125	0.125	I_2 (20)	PEG-400	0.5	60
15	0.125	0.375	I_2 (20)	PEG-400	0.5	86
16	0.150	0.250	I_2 (20)	PEG-400	0.5	95

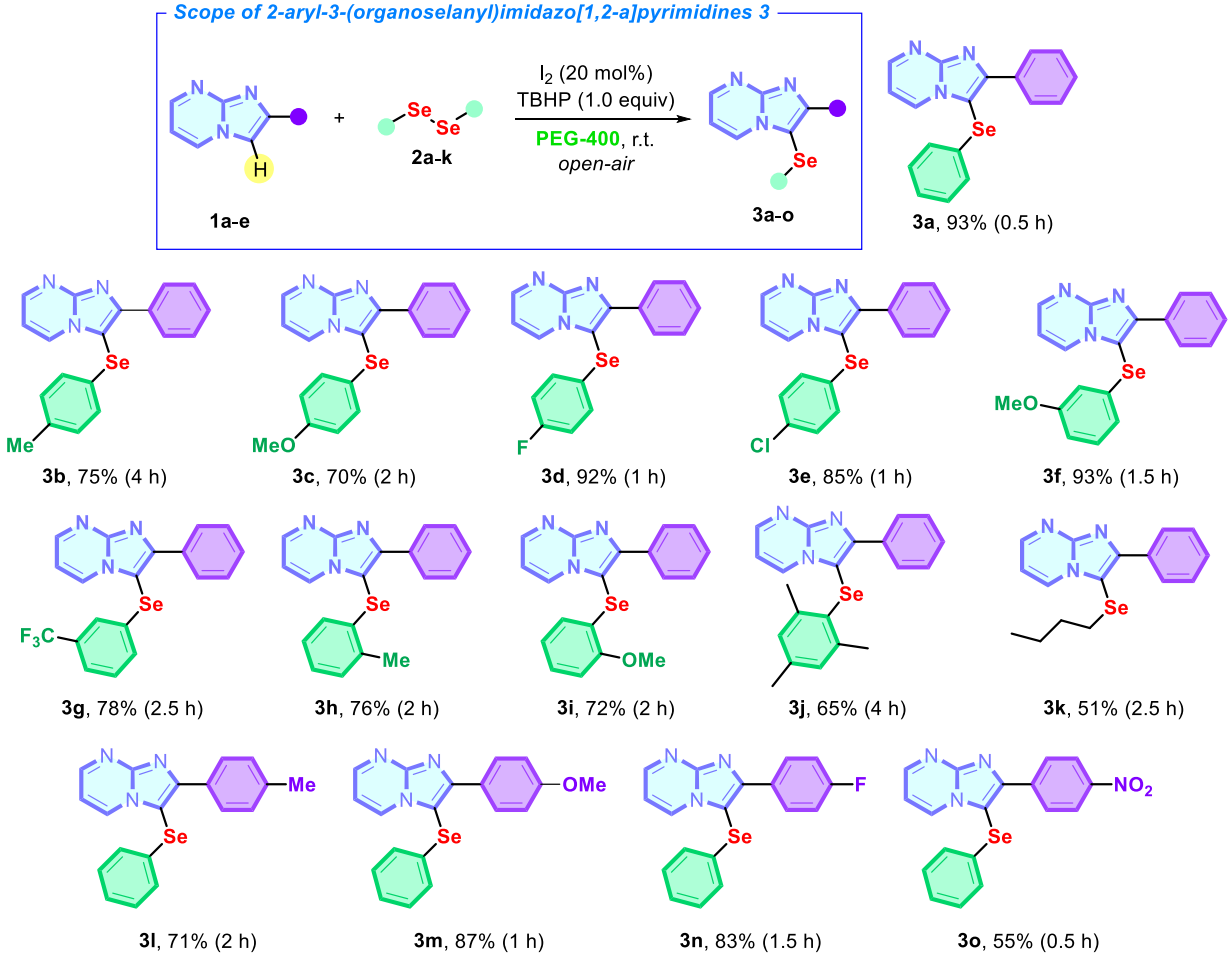
[a] A mixture of **1a** (0.250 mmol) and **2a** (0.125 mmol), iodine source (mol%) and TBHP (equiv) in the respective solvent (2.0 mL) was stirred at room temperature (r.t.) for the time indicated. [b] The reaction was considered complete upon the full consumption of the limiting reagent **1a** monitored by thin layer chromatography (TLC). [c] The resulting product **3a** was purified by column chromatography (hexane:ethyl acetate 3:2). N.D. = Not Detected.

Based on the optimization studies, the optimal reaction conditions involved stirring a mixture of 0.250 mmol of 2-phenyl-imidazo[1,2-*a*]pyrimidine **1a**, 0.125 mmol of diphenyl diselenide **2a**, 20 mol% of I_2 as catalyst, and 0.250 mmol of TBHP as oxidant in 2.0 mL of PEG-400 at room temperature (r.t.) and open-air conditions for 0.5 h. Under these optimized conditions, 2-phenyl-3-(phenylselanyl)imidazo[1,2-*a*]pyrimidine **3a** was obtained in 93% yield (Table 1, entry 6). With the optimized conditions in hand, a scope study was conducted using various 2-aryl-imidazo[1,2-*a*]pyrimidines **1** and diorganyl diselenides **2**, demonstrating the generality as well as the limitations of this synthetic methodology to access selenium-decorated imidazo[1,2-*a*]pyrimidines (Scheme 2).

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Initially, using substrate **1a**, a range of diorganyl diselenides **2b-i** was evaluated under the optimal conditions, affording the corresponding 2-phenyl-3-(organoselanyl)imidazo[1,2-*a*]pyrimidines **3b-i**. As shown in Scheme 2, the reaction proceeded efficiently in the presence of diselenides **2b** and **2c** bearing 4-Me and 4-OMe groups, affording the desired products **3b** and **3c** in 75% and 70% yield after 4 h and 2 h, respectively. Subsequently, substrate **1a** was reacted with halogenated diaryl diselenides **2d** (4-F) and **2e** (4-Cl) under the optimized conditions, affording compounds **3d** and **3e** in 92% and 85% yield after 1 h of reaction (Scheme 2). This preliminary result suggests that reactions involving diaryl diselenides **2d-e** bearing a 4-EWG provide higher yields than those **2-b-c** containing a 4-EDG, likely due to the electronic effects of the substituents, which enhance the electrophilicity of the selenium center. To further investigate this electronic effect, *meta*-substituted diselenides **2f-g** were also evaluated. Replacement of the *para*-substituted diselenides with the corresponding *meta*-methoxy (3-OMe) and *meta*-trifluoromethyl (3-CF_3) derivatives **2f** and **2g** furnished products **3f** and **3g** in 93% and 78% yield after 1.5 and 2.5 h, respectively. Although the *meta*-trifluoromethyl substituent is significantly more electron-withdrawing than *meta*-methoxy, the latter afforded a higher yield in a shorter reaction time. This result indicates that the electronic nature of the substituent alone does not fully account for the observed reactivity, suggesting that additional factors, such as the stabilization of intermediates species, may also contribute to the reaction outcome.

Scheme 2. Scope and generality in the synthesis of 2-aryl-3-(organoselanyl)imidazo[1,2-*a*]pyrimidines **3**.[a,b]

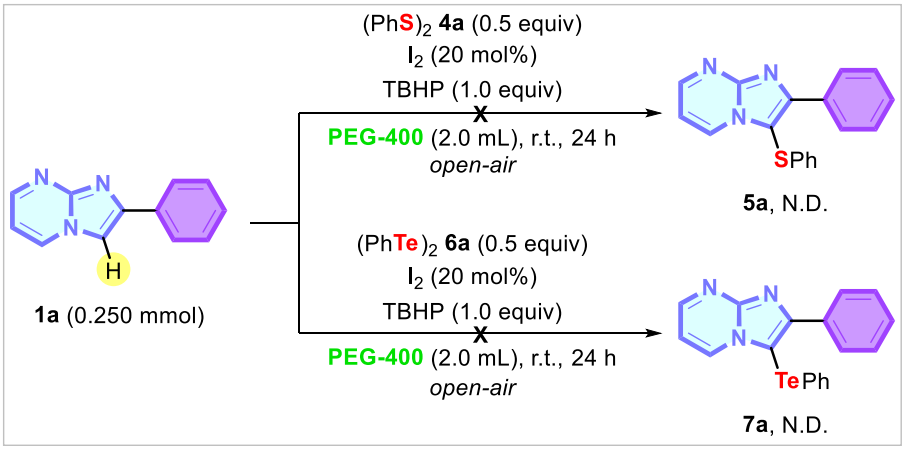


[a] A mixture of **1** (0.250 mmol) and **2** (0.125 mmol), TBHP (0.250 mmol), and I_2 (20 mol%) in PEG-400 (2.0 mL) was stirred at room temperature (r.t.) for the time indicated. [b] The products were purified by column chromatography (hexane:ethyl acetate 3:2).

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Notably, *ortho*-substituted counterparts, 2-methyl and 2-methoxy-substituted diselenides **2h** and **2i**, enabled the synthesis of the target compounds **3h** and **3i** in 76% and 72% yield after 2 h of reaction in both cases (Scheme 2). Compared with their *para*-substituted counterparts, the lower yields observed for these derivatives **2h-i** may be attributed to increased steric hindrance around the selenium center, which can hinder the approach of the diselenide to the reaction partners. These results further indicate that steric factors also play an role in determining the reaction efficiency. In agreement with this trend, dimesityl diselenide **2j**, which presents greater steric hindrance around the selenium center, afforded product **3j** in 65% yield after 4 h of reaction. The longer reaction time required and the moderate yield obtained further support the influence of steric effects on the reactivity of diaryl diselenides.[47,48,52] Finally, the use of dibutyl diselenide **2k** as the substrate led to a significant decrease in yield, providing the corresponding product **3k** in only 51% yield after 2.5 h. This lower efficiency may be associated with the distinct reactivity of dibutyl diselenide **2k** compared with diaryl diselenides **2a-j**, particularly regarding the activation of the Se-Se bond and the generation of intermediate species. In the next step, the substrate scope was investigated by examining various starting materials **1b**-**e** in the presence of diphenyl diselenide **2a** (Scheme 2).

The behavior of different 2-aryl-imidazo[1,2-*a*]pyrimidines **1** in the reaction with diphenyl diselenide **2a** was examined. Thus, 2-aryl-imidazo[1,2-*a*]pyrimidines bearing *para*-methyl **1b** and *para*-methoxy substituents **1c** afforded the corresponding products **3l** and **3m** in 71% and 87% yield after 2 h and 1 h of reaction, respectively. In a similar way, substrates containing *para*-fluoro and *para*-nitro substituents, **1d** and **1e**, allowed the synthesis of compounds **3n** (83% yield, 1.5 h) and **3o** (55% yield, 0.5 h), respectively (Scheme 2). However, for the para-substituted derivatives **3l–3o**, the observed trend suggests that changes in the electron density of the aryl ring influence the reactivity of 2-arylimidazo[1,2-a]pyrimidines **1**. This effect is particularly pronounced for **3o**, whose strongly electron-withdrawing substituent substantially reduces the electron density of the ring, contributing to the lower isolated yield (Scheme 2; 55%). Our study was further extended to evaluate the reactivity diphenyl disulfide **4a** and diphenyl ditelluride **6a** with substrate **1a**. Unfortunately, our attempts to prepare the sulfur- and tellurium-substituted derivatives **5a** and **7a** were unsuccessful (Scheme 3).

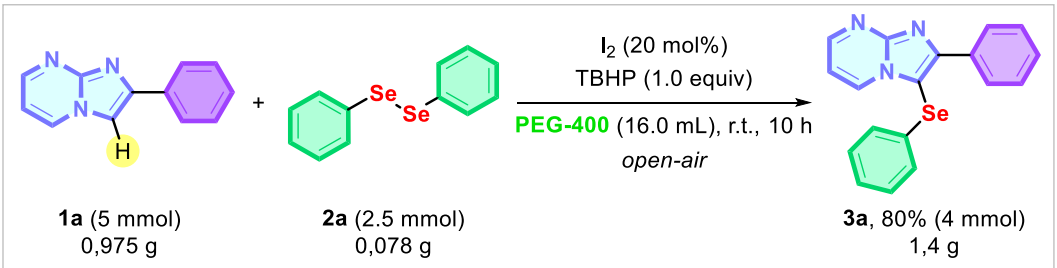


Scheme 3. Attempt to prepare sulfur- and tellurium-substituted derivatives **5a** and **7a**

Furthermore, the reaction was performed on a 20-fold larger laboratory scale to assess whether this increase affected the reaction outcome. In this experiment, 5.0 mmol of **1a** and 2.5 mmol of **2a** were reacted in the presence of 1.0 mmol (20 mol%) of I_2 and 5.0 mmol (1.0 equiv) of TBHP employng 16.0 mL of PEG-400.

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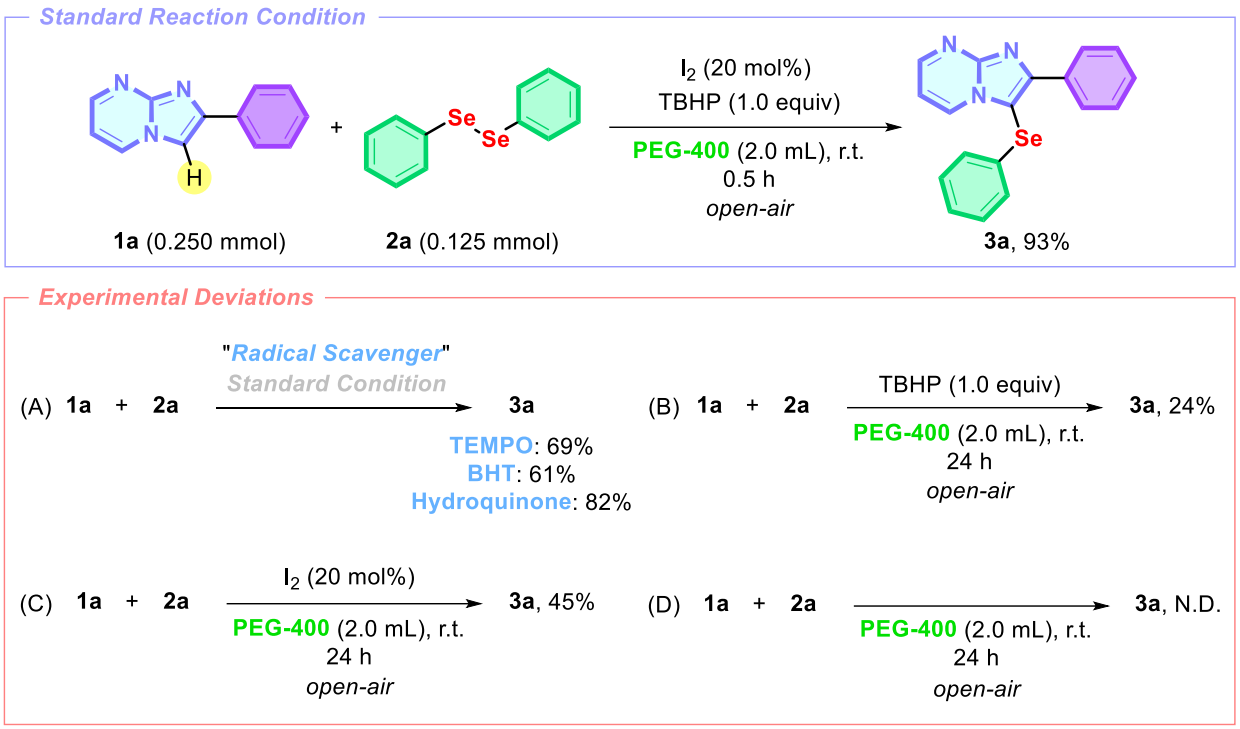
After stirring the resulting mixture for 10 h, the desired product **3a** was obtained in 80% yield (Scheme 4). These conditions offer green chemistry advantages, including the use of PEG-400 as an alternative solvent, catalytic iodine, room temperature, and no inert atmosphere. Nevertheless, further scale-up requires careful consideration of the hazards associated with TBHP. Although a broad range of organoselenium compounds exhibit low toxicity under specific conditions,[57] appropriate handling and disposal of selenium-containing residues remain necessary.



Scheme 4. Scale-up evaluation in the synthesis of compound **3a**

To elucidate the mechanism involved in these reactions, a series of control experiments was carried out (Scheme 5). When the reaction was performed in the presence of the radical scavengers TEMPO (2,2,6,6-tetramethylpiperidin-1-oxyl), BHT (2,6-di-*tert*-butyl-4-methylphenol), or hydroquinone (benzene-1,4-diol) under the optimized reaction conditions, no significant decrease in the formation of product **3a** was observed (Scheme 5A). These results indicate that the reaction proceeds predominantly through an ionic pathway rather than a radical one. Finally, the reaction was conducted in the absence of I_2, TBHP, or both (Scheme 5B-D). When I_2 was omitted, product **3a** was isolated in only 24% yield after 24 h (Scheme 5B). In the absence of TBHP, the reaction afforded **3a** in 45% yield after 24 h (Scheme 5C). In contrast, when both iodine and TBHP were excluded, no product was detected even after 24 h of reaction time. These findings indicate that both molecular iodine and TBHP are required to efficiently promote the reaction (Scheme 5D).

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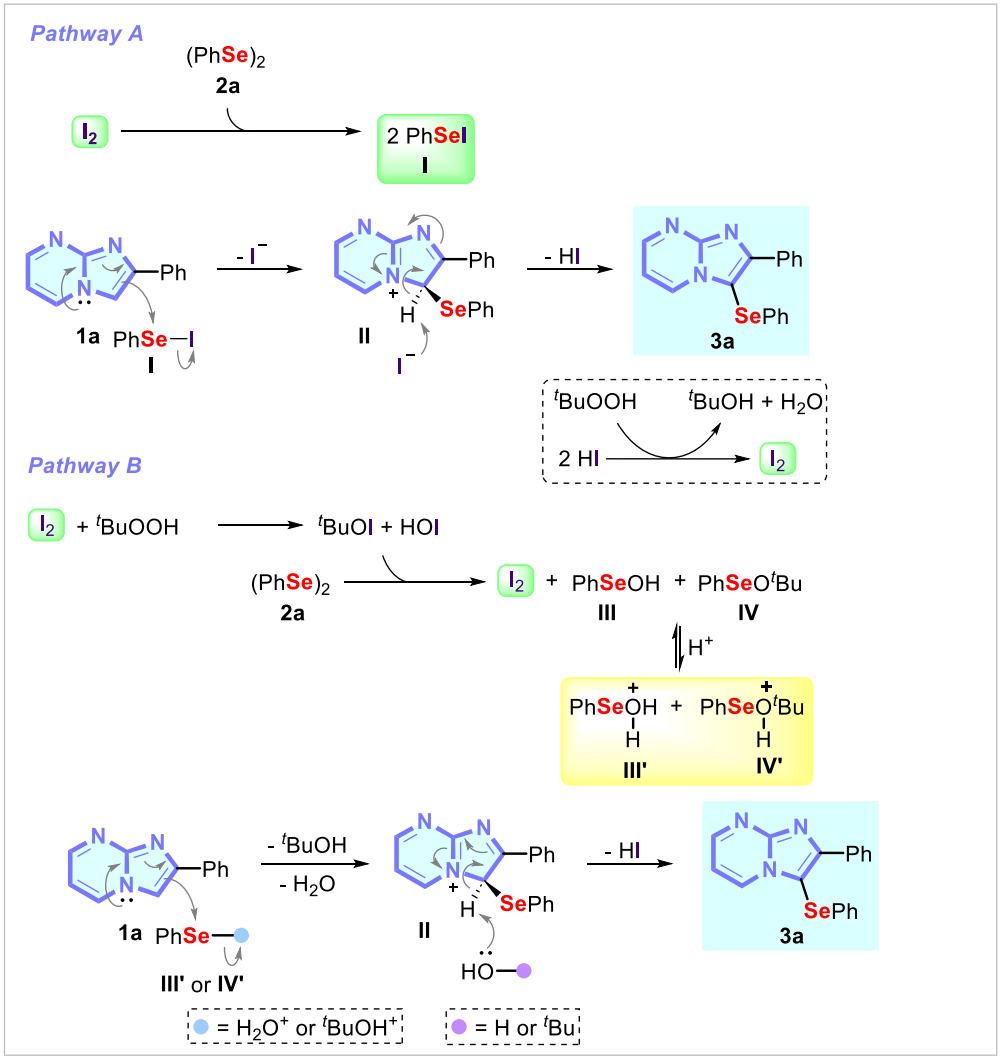


Scheme 5. Control experiments for mechanistic insights.

In this regard, based on the control experiments and previous literature reports,[51,52,58-60] two possible mechanisms involving electrophilic selenium species are proposed (Scheme 6). In the pathway A, molecular iodine reacts with diphenyl diselenide **2a** to generate two equivalents of the electrophilic phenylselenyl iodide **I** Subsequently, PhSeI **I** reacts with 2-phenylimidazo[1,2-*a*]pyrimidine **1a** *via* an electrophilic aromatic substitution (EAS), affording cationic intermediate **II**. These initial intermediates were not detected under the reaction conditions, possibly owing to their instability and/or rapid conversion into subsequent intermediates. Finally, a deprotonation step of **II** by the iodide ion (I^-) restores the aromaticity of the imidazo[1,2-*a*]pyrimidine core, leading to the formation of product **3a** and HI. Furthermore, HI generated during the process is oxidized by *tert*-butyl hydroperoxide, regenerating the I_2 catalyst and producing H_2O and *tert*-butanol as byproducts (Scheme 6).

In the pathway B, molecular iodine is firstly oxidized by *tert*-butyl hydroperoxide, producing *tert*-butyl hypoiodite (^{t}BuOI) and hypoiodous acid (HOI). Subsequently, diphenyl diselenide **2a** reacts with these iodine species, generating the electrophilic selenium species **III** and **IV** according to ^{77}Se{^{1}H} NMR analysis previously reported,[51] while regenerating the catalytic iodine species. These intermediates may undergo protonation by H^+ present in the reaction medium, generating the more reactive species **III'** and **IV'**. Finally, **III'** and **IV'** react with nucleophile **1a**, ultimately leading to the formation of product **3a** (Scheme 6).

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Scheme 6. Proposed reaction mechanisms

Conclusions

We have developed a green and operationally simple method for the synthesis of 2-aryl-3-(organoselanyl)imidazo[1,2-*a*]pyrimidines through the reaction between 2-aryl-imidazo[1,2-*a*]pyrimidine derivatives and diorganyl diselenides. This protocol represents an efficient, general, and environmentally friendly transition metal-free approach, employing PEG-400 as a green solvent and the I_2/TBHP oxidant system at room temperature for the generation of electrophilic selenium species *in situ*. Overall, fifteen selenium-decorated imidazo[1,2-*a*]pyrimidines were synthesized within reaction times ranging from 0.5 to 4 h and in yields of 51% to 93%. Additionally, fourteen of the synthesized products are reported for the first time.

Experimental Section

General. ^{1}H NMR, ^{13}C NMR, ^{19}F and ^{77}Se were recorded on a Bruker Avance III HD 400 (^{1}H: 400 MHz, ^{13}C: 100 MHz, ^{19}F: 376 MHz, ^{77}Se: 76 MHz), using solvent peak as internal reference or apparatus SR. The chemical

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shifts (δ) and coupling constants (J) are expressed in ppm and hertz respectively. Abbreviations to denote the multiplicity of a particular signal are s (singlet), d (doublet), dd (doublet of doublet), t (triplet), q (quartet), and m (multiplet). Mass spectra (MS) were obtained on a gas chromatograph coupled to a Shimadzu GCMS-QP2010 mass spectrometer. High-resolution mass spectra (HRMS) were recorded in positive ion mode (APCI) using a Q-TOF spectrometer. Melting points were determined by using a Marte PFD III instrument apparatus. Merck silica gel (0.040-0.063 mm) was used for flash chromatography. The solvent used in the preparation of products **3** (Polyethylene Glycol 400) was purchased from Synth and used as received (analytical grade, PA). Other reagents were directly used as obtained commercially. Thin-layer chromatography (TLC) was performed using silica gel 60 aluminum plates with a fluorescent indicator (F_{254}) (Merck) to determine the Rf values of the compounds.

General procedure for the synthesis of 2-aryl-imidazo[1,2-*a*]pyrimidines 1. The synthesis of the substrates **1** was performed following a literature procedure with minor modifications.[61,62] A reaction vial equipped with a magnetic stirring bar was charged with appropriate 2-bromo-1-phenylethan-1-one (2 mmol), 2-aminopyrimidine (190 mg, 2.0 mmol) and acetone (5.0 mL). The reaction mixture was stirred at 60 °C for 15 h in the closed vial. The crude reaction mixture was concentrated under vacuum, and the 2-aryl-imidazo[1,2-*a*]pyrimidines **1** were purified by recrystallization from ethanol, affording the corresponding solids in yields ranging from 75% to 85%. Starting materials **1a**, **1b**, **1c**, and **1d** were characterized according to the procedure reported in literature.[61,62] Compound **1e** was fully characterized in this work, and its characterization data are provided below.

2-(4-nitrophenyl)imidazo[1,2-*a*]pyrimidine (1e). Obtained as an orange solid (390 mg, 81%), mp: 263-264 ºC, Rf: 0.33 (hexane/ethyl acetate, 3:2). ^{1}H NMR (400 MHz, DMSO-d_6) δ 8.08 (d, J = 6.8 Hz, 1H), 7.74 – 7.73 (m, 1H), 7.66 (s, 1H), 6.98 (d, J = 8.4 Hz, 2H), 6.83 (d, J = 8.3 Hz, 2H), 6.34 – 6.32 (m, 1H). ^{13}C{^{1}H} NMR (100 MHz, DMSO-d_6) δ 156.2, 145.6, 137.5, 136.6, 133.3, 132.8, 126.8, 112.9, 112.1, 111.1. MS (Rel. Int., %) m/z: 340.75 (19.38), 341.75, 342.80.HRMS (APCI-QTOF) *m*/*z*: [M + H]$^+$ Calcd for $C_{12}H_8N_4O_2$: 241.0726; Found: 241.0775.

General procedure for the synthesis of 3-(organoselanyl)imidazo[1,2-*a*]pyrimidines 3. Initially, 2-aryl-imidazo[1,2-*a*]pyrimidine **1** (0.250 mmol) was added to a test tube, followed by diorganyl diselenide **2**, (0.125 mmol, 0.5 equiv), molecular iodine (I_2) 20 mol% (12,7 mg, 20 mol%) and PEG-400 (2.0 mL). Finally, *tert*-butyl hydroperoxide (0.250 mmol, 24 µL) was added and the reaction was magnetically stirred for periods ranging from 0.5 to 4 h at room temperature. The reaction mixture was poured into a saturated aqueous solution of $Na_2S_2O_3$ (10 mL) and extracted with ethyl acetate (3x 10 mL). The organic phase was dried with anhydrous $MgSO_4$ and concentrated under vacuum. The reaction crude was purified by column chromatography on silica gel and a mixture of hexane and ethyl acetate (3:2) as the eluent.

2-Phenyl-3-(phenylselanyl)imidazo[1,2-*a*]pyrimidine (**3a**). Obtained as a yellowish solid (82 mg, 93%), mp: 93-96 °C, lit: 98-99 °C, Rf: 0.70 (hexane/ethyl acetate, 3:2).[50] ^{1}H NMR (400 MHz, $CDCl_3$) δ (ppm) 8.62-8.61 (m, 1H); 8.59 (d, J 6.8 Hz, 1H); 8.29-8.27 (m, 2H); 7.47-7.43 (m, 2H); 7.41-7.37 (m, 1H); 7.18-7.17 (m, 3H); 7.11-7.09 (m, 2H); 6.94-6.91 (m, 1H). ^{13}C{^{1}H} NMR (100 MHz, $CDCl_3$) δ (ppm) 152.7, 151.8, 150.6, 133.4, 132.9, 130.03, 130.0, 129.3, 129.1, 128.7, 128.6, 127.3, 109.8, 102.0. ^{77}Se{^{1}H} NMR (76 MHz, $CDCl_3$) δ (ppm) 215.5. MS (Rel. Int., %) m/z: 351 (43.73), 271 (75.90), 270 (100.0), 182 (29.52), 79 (76.25), 77 (25.63). HRMS (APCI-QTOF) *m*/*z*: [M + H]$^+$ Calcd for $C_{18}H_{13}N_3Se$: 352.0348; Found: 352.0351.

2-Phenyl-3-(4-tolylselanyl)imidazo[1,2-*a*]pyrimidine (**3b**). Obtained as an orange solid (68 mg, 75%), mp: 101-103 °C, Rf: 0.80 (hexane/ethyl acetate, 3:2). ^{1}H NMR (400 MHz, $CDCl_3$) δ (ppm) 8.59-8.56 (m, 2H); 8.31-8.29 (m, 2H); 7.47-7.43 (m, 2H); 7.40-7.36 (m, 1H); 7.02-6.96 (m, 4H); 6.88 (dd, J 6.7 and 4.3 Hz, 1H); 2.23 (s, 3H).

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$^{13}C\{^{1}H\}$ NMR (100 MHz, $CDCl_3$) δ (ppm) 152.8, 151.4, 150.8, 137.3, 133.32, 133.28, 130.7, 129.1 (3C), 128.9, 128.5, 126.1, 109.5, 102.2, 21.1. $^{77}Se\{^{1}H\}$ NMR (76 MHz, $CDCl_3$) δ (ppm) 209.1. MS (Rel. Int., %) m/z: 365 (3.19), 265 (25.71), 264 (100.0), 224 (17.79), 105 (7.20), 91 (8.67).

2-Phenyl-3-(4-methoxyphenylselanyl)imidazo[1,2-*a*]pyrimidine (**3c**). Obtained as a white solid (67 mg, 70%), mp: 126-128 °C, Rf: 0.80 (hexane/ethyl acetate, 3:2). ^{1}H NMR (400 MHz, $CDCl_3$) δ (ppm) 8.61 (dd, *J* 6.8 and 1.9 Hz, 1H); 8.57 (dd, *J* 4.1 and 1.9 Hz, 1H); 8.33-8.30 (m, 2H); 7.48-7.44 (m, 2H); 7.41-7.38 (m, 1H); 7.10 (d, *J* 8.8 Hz, 2H); 6.89 (dd, *J* 6.8 and 4.1 Hz, 1H); 6.71 (d, *J* 8.8 Hz, 2H); 3.69 (s, 3H). $^{13}C\{^{1}H\}$ NMR (100 MHz, $CDCl_3$) δ (ppm) 159.4, 152.4, 151.4, 150.6, 133.4, 133.2, 131.2, 129.1, 129.0, 128.5, 119.6, 115.7, 109.4, 103.0, 55.4. $^{77}Se\{^{1}H\}$ NMR (76 MHz, $CDCl_3$) δ (ppm) 203.5. MS (Rel. Int., %) m/z: 381 (39.43), 302 (22.91), 301 (100.0), 207 (50.59), 79 (76.84), 77 (19.74). HRMS (APCI-QTOF) *m*/*z*: $[M + H]^+$ Calcd for $C_{18}H_{13}N_3OSe$: 382.0454; Found: 382.0459.

2-Phenyl-3-(4-fluorophenylselanyl)imidazo[1,2-*a*]pyrimidine (**3d**). Obtained as an orange solid (85 mg, 92%), mp: 128-130 °C, Rf: 0.40 (hexane/ethyl acetate, 1:1). ^{1}H NMR (400 MHz, $CDCl_3$) δ (ppm) 8.62-8.58 (m, 2H); 8.29-8.27 (m, 2H); 7.48-7.45 (m, 2H); 7.43-7.39 (m, 1H); 7.12-7.09 (m, 2H); 6.94-6.87 (m, 3H). $^{13}C\{^{1}H\}$ NMR (100 MHz, $CDCl_3$) δ (ppm) 162.4 (d, *J* 245.9 Hz), 153.0, 151.7, 150.8, 133.2, 130.9 (d, *J* 7.8 Hz), 129.2, 129.1, 128.6, 124.4 (d, *J* 3.3 Hz), 117.2 (d, *J* 21.9 Hz), 109.6, 102.1. $^{77}Se\{^{1}H\}$ NMR (76 MHz, $CDCl_3$) δ (ppm) 211.0 (d, *J* 5.8 Hz). ^{19}F NMR (376 MHz, $CDCl_3$) δ (ppm) -114.37 - -114.44 (m). MS (Rel. Int., %) m/z: 368 (16.59), 265 (26.73), 264 (100.0), 129 (20.81), 105 (10.95), 91 (11.95). HRMS (APCI-QTOF) *m*/*z*: $[M + H]^+$ Calcd for $C_{18}H_{12}FN_3Se$: 370.0254; Found: 370.0251.

2-Phenyl-3-(4-chlorophenylselanyl)imidazo[1,2-*a*]pyrimidine (**3e**). Obtained as a white solid (82 mg, 85%), mp: 139-141 °C, Rf: 0.80 (hexane/ethyl acetate, 3:2). ^{1}H NMR (400 MHz, $CDCl_3$) δ (ppm) 8.63 (dd, *J* 4.1 and 1.9 Hz, 1H); 8.56 (dd, *J* 6.8 and 1.9 Hz, 1H); 8.26 (d, *J* 7.1 Hz, 2H); 7.48-7.44 (m, 2H); 7.42-7.39 (m, 1H); 7.15 (d, *J* 8.5 Hz, 2H); 7.03 (d, *J* 8.5 Hz, 2H); 6.94 (dd, *J* 6.8 and 4.1 Hz, 1H). $^{13}C\{^{1}H\}$ NMR (100 MHz, $CDCl_3$) δ (ppm) 153.4, 151.8, 151.0, 133.5, 133.2, 133.1, 130.2, 130.0, 129.3, 129.1, 128.6, 128.4, 109.7, 101.4. $^{77}Se\{^{1}H\}$ NMR (76 MHz, $CDCl_3$) δ (ppm) 215.4. MS (Rel. Int., %) m/z: 385 (11.69), 281 (39.71), 208 (22.33), 207 (100.0), 79 (22.48), 77 (9.31). HRMS (APCI-QTOF) *m*/*z*: $[M + H]^+$ Calcd for $C_{18}H_{12}ClN_3Se$: 385.9956; Found: 385.9945.

2-Phenyl-3-(3-methoxyphenylselanyl)imidazo[1,2-*a*]pyrimidine (**3f**). Obtained as a yellowish solid (88 mg, 93%), mp: 184-187 °C, Rf: 0.60 (hexane/ethyl acetate, 3:2). ^{1}H NMR (400 MHz, $CDCl_3$) δ (ppm) 8.61 (dd, *J* 4.1 and 2.0 Hz, 1H); 8.58 (dd, *J* 6.8 and 2.0 Hz, 1H); 8.30-8.28 (m, 2H); 7.47-7.43 (m, 2H); 7.41-7.37 (m, 1H); 7.08 (t, *J* 7.9 Hz, 1H); 6.91 (dd, *J* 6.8 and 4.1 Hz, 1H); 6.72-6.65 (m, 3H); 3.64 (s, 3H). $^{13}C\{^{1}H\}$ NMR (100 MHz, $CDCl_3$) δ (ppm) 160.7, 153.3, 151.6, 150.9, 133.4, 133.3, 131.2, 130.7, 129.2, 129.1, 128.5, 120.7, 114.2, 112.8, 109.5, 101.8, 55.4. $^{77}Se\{^{1}H\}$ NMR (76 MHz, $CDCl_3$) δ (ppm) 219.7. MS (Rel. Int., %) m/z: 381 (55.90), 301 (100.0), 300 (64.39), 182 (33.91), 143 (10.64), 91 (3.87). HRMS (APCI-QTOF) *m*/*z*: $[M + H]^+$ Calcd for $C_{18}H_{13}N_3OSe$: 382.0454; Found: 382.0450.

2-Phenyl-3-[(3-(trifluoromethyl)phenyl)selanyl]imidazo[1,2-*a*]pyrimidine (**3g**). Obtained as an orange solid (82 mg, 78%), mp: 95-97 °C, Rf : 0.66 (hexane/ethyl acetate, 1:1). ^{1}H NMR (400 MHz, $CDCl_3$) δ (ppm) 8.60 (dd, *J* 4.1 and 2.0 Hz, 1H); 8.57 (dd, *J* 6.8 and 2.0 Hz, 1H); 8.24-8.22 (m, 2H); 7.48 (s, 1H); 7.46-7.38 (m, 4H); 7.26-7.22 (m, 1H); 7.11 (d, *J* 7.9 Hz, 1H); 6.94 (dd, *J* 6.8 and 4.1, 1H). $^{13}C\{^{1}H\}$ NMR (100 MHz, $CDCl_3$) δ (ppm) 153.5, 151.9, 150.9, 133.1, 132.9, 132.2 (q, *J* 32.3 Hz), 131.6, 131.4, 130.3, 129.2, 128.9, 128.5, 125.1 (q, *J* 3.8 Hz), 124.0 (q, *J* 3.6 Hz), 123.5 (q, *J* 271.1 Hz), 109.8, 100.7. $^{77}Se\{^{1}H\}$ NMR (76 MHz, $CDCl_3$) δ (ppm) 224.6. ^{19}F NMR (376 MHz, $CDCl_3$) δ (ppm) -62.8. MS (Rel. Int., %) m/z: 419 (71.91), 339 (85.42), 338 (100.0), 207 (86.18), 79 (95.74), 77 (22.58). HRMS (APCI-QTOF) *m*/*z*: $[M + H]^+$ Calcd for $C_{19}H_{12}F_3N_3Se$: 420.0222; Found: 420.0222.

2-Phenyl-3-(2-tolylselanyl)imidazo[1,2-*a*]pyrimidine (**3h**) Obtained as a white solid (69 mg, 76%), mp: 134-136 °C, Rf : 0.80 (hexane/ethyl acetate, 3:2). ^{1}H NMR (400 MHz, $CDCl_3$) δ (ppm) 8.63 (dd, *J* 4.1 and 2.0 Hz, 1H); 8.51

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(dd, *J* 6.8 and 2.0 Hz, 1H); 8.25-8.22 (m, 2H); 7.46-7.42 (m, 1H); 7.41-7.37 (m, 1H); 7.19 (d, *J* 7.7 Hz, 2H); 7.09 (td, *J* 7.4 and 1.0 Hz, 1H); 6.92-6.86 (m, 2H); 6.55 (dd, *J* 7.9 and 1.0 Hz, 1H); 2.47 (s, 3H). $^{13}C\{^1H\}$ NMR (100 MHz, $CDCl_3$) *δ* (ppm) 153.9, 151.6, 151.2, 136.8, 133.4, 133.3, 131.1, 130.8, 129.2, 129.1, 128.6, 127.5, 127.2, 127.0, 109.6, 100.8, 21.4. $^{77}Se\{^1H\}$ NMR (76 MHz, $CDCl_3$) *δ* (ppm) 188.8. MS (Rel. Int., %) m/z: 365 (23.36), 363 (12.15), 196 (18.96), 195 (100.0), 105 (0.19), 91 (9.41).

2-Phenyl-3-(2-methoxyphenylselanyl)imidazo[1,2-*a*]pyrimidine (**3i**). Obtained as a white solid (68 mg, 72%), mp: 167-169 °C, Rf: 0.63 (hexane/ethyl acetate, 3:2). ^1H NMR (400 MHz, $CDCl_3$) *δ* (ppm) 8.62 (dd, *J* 4.1 and 2.0 Hz, 1H); 8.58 (dd, *J* 6.8 and 2.0 Hz, 1H); 8.27-8.25 (m, 2H); 7.45-7.41 (m, 2H); 7.39-7.35 (m, 1H); 7.19-7.14 (m, 1H); 6.92-6.86 (m, 2H); 6.68 (td, *J* 7.6 and 1.0 Hz, 1H); 6.46 (dd, *J* 7.7 and 1.5 Hz, 1H); 3.92 (s, 3H). $^{13}C\{^1H\}$ NMR (100 MHz, $CDCl_3$) *δ* (ppm) 156.9, 153.9, 151.5, 151.2, 133.7, 133.4, 129.1, 128.5, 128.1, 127.7, 122.3, 119.2, 111.0, 109.4, 100.3, 56.1. $^{77}Se\{^1H\}$ NMR (76 MHz, $CDCl_3$) *δ* (ppm) 179.9. MS (Rel. Int., %) m/z: 381 (93.12), 301 (100.0), 300 (31.29), 143 (20.86), 105 (4.31), 91 (13.10). HRMS (APCI-QTOF) *m*/*z*: $[M + H]^+$ Calcd for $C_{18}H_{13}N_3OSe$: 382.0454; Found: 382.0447.

3-(Mesitylselanyl)-2-phenylimidazo[1,2-*a*]pyrimidine (**3j**). Obtained as a yellowish solid (64 mg, 65%), mp: 134-137 °C, Rf: 0.66 (hexane/ethyl acetate, 3:2). ^1H NMR (400 MHz, $CDCl_3$) *δ* (ppm) 8.51 (dd, *J* 4.1 and 2.0 Hz, 1H); 8.23 (dd, *J* 6.8 and 2.0 Hz, 1H); 8.20-8.17 (m, 2H); 7.49-7.46 (m, 2H); 7.42-7.39 (m, 1H); 6.81-6.79 (m, 3H); 2.23 (s, 6H); 2.19 (s, 3H). $^{13}C\{^1H\}$ NMR (100 MHz, $CDCl_3$) *δ* (ppm) 151.6, 150.4, 150.1, 141.6, 138.7, 133.8, 132.9, 129.8, 129.3, 128.8, 128.4, 125.6, 109.1, 103.4, 23.9, 21.0. $^{77}Se\{^1H\}$ NMR (76 MHz, $CDCl_3$) *δ* (ppm) 142.0. MS (Rel. Int., %) m/z: 393 (27.22), 199 (12.62), 198 (100.0), 196 (84.41), 105 (6.57), 91 (17.61).

3-(Butylselanyl)-2-phenylimidazo[1,2-*a*]pyrimidine (**3k**). Obtained as an orange oil (42 mg, 51%), Rf: 0.83 (hexane/ethyl acetate, 3:2). ^1H NMR (400 MHz, $CDCl_3$) *δ* (ppm) 8.80 (dd, *J* 6.8 and 2.0 Hz, 1H); 8.58 (dd, *J* 4.0 and 2.0 Hz, 1H); 8.37 (d, *J* 7.5 Hz, 2H); 7.49-7.46 (m, 2H); 7.41-7.37 (m, 1H); 6.96 (dd, *J* 6.8 and 4.0 Hz, 1H), 2.68 (t, *J* 7.4 Hz, 2H), 1.46 (quint, *J* 7.4 Hz, 2H), 1.29 (sext, *J* 7.4 Hz, 2H), 0.76 (t, *J* 7.4 Hz, 3H). $^{13}C\{^1H\}$ NMR (100 MHz, $CDCl_3$) *δ* (ppm) 151.7, 150.9, 150.5, 133.7, 133.2, 129.0, 128.8, 128.4, 109.2, 103.0, 32.3, 29.7, 22.8, 13.5. $^{77}Se\{^1H\}$ NMR (76 MHz, $CDCl_3$) *δ* (ppm) 91.3. MS (Rel. Int., %) m/z: 331 (31.83), 275 (64.14), 274 (94.68), 196 (100.0), 79 (90.11), 77 (9.19). HRMS (APCI-QTOF) *m*/*z*: $[M + H]^+$ Calcd for $C_{16}H_{17}N_3Se$: 332.0661; Found: 332.0658.

3-(Phenylselanyl)-2-(4-tolyl)imidazo[1,2-*a*]pyrimidine (**3l**). Obtained as a yellow oil (65 mg, 71%), Rf: 0.60 (hexane/ethyl acetate, 3:2). ^1H NMR (400 MHz, $CDCl_3$) *δ* (ppm) 8.60 (dd, *J* 4.1 and 1.9 Hz, 1H); 8.57 (dd, *J* 6.8 and 1.9 Hz, 1H); 8.19 (d, *J* 8.2 Hz, 2H); 7.27-7.25 (m, 2H); 7.18-7.16 (m, 3H); 7.11-7.09 (m, 2H); 6.89 (dd, *J* 6.8 and 4.1 Hz, 1H); 2.39 (s, 3H). $^{13}C\{^1H\}$ NMR (100 MHz, $CDCl_3$) *δ* (ppm) 153.3, 151.4, 150.9, 139.2, 133.2, 130.4, 130.2, 130.0, 129.3, 129.0, 128.6, 128.2, 127.2, 109.4, 21.6. $^{77}Se\{^1H\}$ NMR (76 MHz, $CDCl_3$) *δ* (ppm) 214.7. MS (Rel. Int., %) m/z: 365 (51.59), 285 (100.0), 284 (91.69), 196 (30.36), 105 (0.56), 91 (9.57). HRMS (APCI-QTOF) *m*/*z*: $[M + H]^+$ Calcd for $C_{19}H_{15}N_3Se$: 366.0505; Found: 366.0500.

2-(4-Methoxyphenyl)-3-(phenylselanyl)imidazo[1,2-*a*]pyrimidine (**3m**). Obtained as a colorless solid (83 mg, 87%), mp: 130-132 °C, Rf: 0.90 (hexane/ethyl acetate, 3:2). ^1H NMR (400 MHz, $CDCl_3$) *δ* (ppm) 8.59-8.55 (m, 2H); 8.29-8.25 (m, 2H); 7.19-7.16 (m, 3H); 7.13-7.09 (m, 2H); 7.00-6.96 (m, 2H); 6.88 (dd, *J* 6.7 and 4.2 Hz, 1H); 3.84 (s, 3H). $^{13}C\{^1H\}$ NMR (100 MHz, $CDCl_3$) *δ* (ppm) 160.5, 153.1, 151.3, 150.9, 133.1, 130.4, 130.3, 130.0, 128.5, 127.2, 125.9, 114.0, 109.4, 100.8, 55.5. $^{77}Se\{^1H\}$ NMR (76 MHz, $CDCl_3$) *δ* (ppm) 213.9. MS (Rel. Int., %) m/z: 381 (9.85), 301 (41.46), 281 (36 .68), 207 (100.0), 77 (9.68). HRMS (APCI-QTOF) *m*/*z*: $[M + H]^+$ Calcd for $C_{19}H_{15}N_3OSe$: 382.0454; Found: 382.0454.

2-(4-Fluorophenyl)-3-(phenylselanyl)imidazo[1,2-*a*]pyrimidine (**3n**). Obtained as a white solid (76 mg, 83%), mp: 116-118 °C, Rf: 0.63 (hexane/ethyl acetate, 3:2). ^1H NMR (400 MHz, $CDCl_3$) *δ* (ppm) 8.63 (dd, *J* 4.1 and 2.0 Hz, 1H); 8.59 (dd, *J* 6.8 and 2.0 Hz, 1H); 8.32-8.27 (m, 2H); 7.21-7.17 (m, 3H); 7.16-7.08 (m, 4H); 6.93 (dd, *J* 6.8

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and 4.1 Hz, 1H). $^{13}C\{^{1}H\}$ NMR (100 MHz, $CDCl_3$) δ (ppm) 163.6 (d, *J* 247.5 Hz), 152.3, 151.7, 150.9, 133.4, 130.9 (d, *J* 8.2 Hz), 130.1, 130.0, 129.5 (d, *J* 3.2 Hz), 128.6, 127.4, 115.6 (d, *J* 21.4 Hz), 109.7, 101.6. $^{77}Se\{^{1}H\}$ NMR (76 MHz, $CDCl_3$) δ (ppm) 213.1. ^{19}F NMR (376 MHz, $CDCl_3$) δ (ppm) -112.28 - -112.35 (m). MS (Rel. Int., %) m/z: 369 (24.13), 289 (55.51), 288 (51.0), 270 (100.0), 77 (13.42). HRMS (APCI-QTOF) *m*/*z*: $[M + H]^+$ Calcd for $C_{18}H_{12}FN_3Se$: 370.0254; Found: 370.0247.

2-(4-Nitrophenyl)-3-(phenylselanyl)imidazo[1,2-*a*]pyrimidine (**3o**). Obtained as a yellow oil (54 mg, 55%), Rf: 0.86 (hexane/ethyl acetate, 3:2). ^{1}H NMR (400 MHz, $CDCl_3$) δ (ppm) 8.67 (dd, *J* 4.0 and 1.8 Hz, 1H); 8.64 (dd, *J* 6.8 and 1.8 Hz, 1H); 8.46 (d, *J* 8.3 Hz, 2H); 7.73 (d, *J* 8.3 Hz, 2H); 7.22-7.20 (m, 3H), 7.11-7.09 (m, 2H), 6.98 (dd, *J* 6.8 and 4.0 Hz, 1H). $^{13}C\{^{1}H\}$ NMR (100 MHz, $CDCl_3$) δ (ppm) 152.4, 151.0, 150.7, 137.8, 133.5, 132.4, 130.3, 129.4, 128.8, 127.7, 119.0, 112.5, 110.1, 103.3. $^{77}Se\{^{1}H\}$ NMR (76 MHz, $CDCl_3$) δ (ppm) 214.8. MS (Rel. Int., %) m/z: 396 (3.58), 301 (100.0), 300 (55.80), 221 (17.48), 105 (2.52), 91 (4.09).

Scale-up experiment for the synthesis of 3-(phenylselanyl)imidazo[1,2-*a*]pyrimidine 3a. Initially, 2-phenylimidazo[1,2-*a*]pyrimidine **1a** (975 mg, 5 mmol) was added to a test tube, followed by diphenyl diselenide **2a** (780 mg, 2.5 mmol), molecular iodine (I_2) (253 mg, 1.0 mmol) and PEG-400 (16.0 mL). Finally, *tert*-butyl hydroperoxide (5.0 mmol, 0.5 mL) was added and the reaction was magnetically stirred for 10 h at room temperature. The reaction mixture was poured into a saturated aqueous solution of $Na_2S_2O_3$ (10 mL) and extracted with ethyl acetate (3x 25 mL). The organic phase was dried with anhydrous $MgSO_4$ and concentrated under vacuum. The reaction crude was purified by column chromatography on silica gel using a mixture of hexane and ethyl acetate (3:2) as eluent.

General procedure for control experiments with radical scavengers. A test tube equipped with a magnetic stirring bar was charged with 2-phenyl-imidazo[1,2-*a*]pyrimidine **1a** (49 mg, 0.25 mmol), diphenyl diselenide **2a** (39 mg, 0.125 mmol), 1.0 equiv of TBHP (24 µL, 0.25 mmol), radical scavenger (TEMPO, BHT, or hydroquinone, 0.75 mmol), and PEG-400 (3.0 mL). Finally, molecular iodine (I_2) (13 mg, 0.05 mmol) was added, and the reaction was magnetically stirred for 0.5 h at room temperature. The reaction mixture was poured into a saturated aqueous solution of $Na_2S_2O_3$ (10 mL) and extracted with ethyl acetate (3x 10 mL). The organic phase was dried using anhydrous $MgSO_4$ and concentrated under vacuum. The reaction crude was purified by column chromatography on silica gel using a mixture of hexane and ethyl acetate (3:2) as eluent.

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Supplementary Material

Copies of ^{1}H, ^{13}C, ^{19}F, and ^{77}Se NMR spectra of compounds **3**.

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