

**Agrisost** | Vol. 25, No. 1, January-April 2019: 1-7

ISSN-e: 1025-0247

## Genus *Pogostemon* (Lamiaceae) in Cuba

Isidro E. Méndez Santos<sup>1</sup> and Rayner Morales Pérez<sup>2</sup>

<sup>1</sup> <https://orcid.org/0000-0002-0437-8057>, Center for Environmental Studies, Ignacio Agramonte Loynaz University of Camagüey, Cuba, <sup>2</sup> Julián Acuña Galé Botanical Garden.

Citation: Méndez Santos, I., & Morales Pérez, R. (2019). Genus *Pogostemon* (Lamiaceae) in Cuba. *Agrisost*, 25(1), 1-7. Recuperado a partir de <https://revistas.reduc.edu.cu/index.php/agrisost/article/view/e2931>

Received: December 26, 2018

Accepted: January 10, 2019

Published: April 04, 2019

Funding source: Belgium Development Cooperation through VLIR-UOS (Council of Flemish Universities)

Conflicts of interest: no conflict of interest has been declared.

Email: [isidro.mendez@reduc.edu.cu](mailto:isidro.mendez@reduc.edu.cu)

### Abstract

**Context:** The presence in Cuba of taxons of *Pogostemon* Desf. (Lamiaceae), a native genus from Africa, Asia, and Australia, whose previous recorded information was not accurate.

**Objectives:** To report on relocation of a species of this genus, define its nomenclature, contribute with data for identification, and provide arguments of its usefulness.

**Methods:** Study of herbarium specimens, field exploration, sample comparisons with descriptions, analytical keys, and samples incorporated to scientific collections.

**Results:** The presence of *Pogostemon cablin* (Blanco) Benth (Lamiaceae) was confirmed in the provinces of Sancti Spiritus, Camagüey, Holguín, and Guantánamo, Cuba. This is a promising species for the medical-pharmaceutical industry, and the areas of perfumes and cosmetics.

**Conclusions:** Out of the 34 infra-generic Lamiaceae representatives known to be of exotic origin in the Cuban archipelago, 25 have been unable to naturalize.

**Key words:** Cuban flora, medicinal plants, exotic plants, cultivated plants, patchouli.

### Introduction

As part of the studies currently done to implement a new taxonomic treatment of the Lamiaceae family in Cuba, evidence was found of the presence of genus *Pogostemon* Def. species in Cuba. However, the related data were not accurate enough in terms of nomenclature, taxonomy, and phytogeography.

Roig (1965) referred to *Pogostemon patchouli* Pellet, but this author (1974) cited *P. heyneanus* Benth. (for which *P. patchouli* Pellet. was considered a synonym). This criterion was also reflected in determinations of herbarium specimens (Acuña, 20-I-1947, series Roig 8853 in HAC and Acuña, 22-I-1947, 14553 HAC). Later, Esquivel, Hammer & Knüpffer (1992, and Greuter & Rankin (2017), reported the presence of *Pogostemon cablin* (Blanco) Benth. Hence, how many taxons have actually been spotted in Cuba? How are they related? What is their current nomenclature?

Besides, the persistence of this genus library in Cuba was doubted. There are no herbarium specimens collected in the last 70 years, whereas no botanist studying the Cuban flora has claimed its existence, either naturalized or cultivated. Despite multiple efforts made by the authors, it was impossible to spot

this genus in regions and institutions reportedly having evidence of previous existence in cultivation conditions.

This contribution is intended to report on the relocation of a species of this genus in the plants currently cultivated in Cuba, to elucidate its nomenclature, to describe it phenotypically, and to argument its usefulness.

### Materials and Methods

This result was achieved within the framework of Flora of the Republic of Cuba, a group of studies conducted as part of major research project "Installing a Center of Excellence in Mid-Eastern Cuba to Enhance Production and Research on Bioactive Plants", carried out by several Cuban Institutions (under the coordination of the university of Camagüey) and the University of Antwerp, thanks to a grant by the government of Belgium through the VLIR-UOS Program.

A study was made of various species from some of the main herbaria of the country. HAC, HAJB, HIPC, and ULV (according to Thiers, 2019). Specialized scientific collections were visited (botanical gardens, agricultural research centers, and natural medicine facilities), and some of their specialists were

interviewed. Similar studies were performed in private areas engaged in the production of ornamental or therapeutic species, with particular emphasis on areas previously referred to as having taxons of this genus.

The cultivated plants were photographed, and herborized and propagule samples were taken for vegetative reproduction. The propagation material was planted in land owned by the second author, and it was observed for over three years. The specimens were deposited at the Julian Acuña Gale Herbarium, at Ignacio Agramonte University of Camagüey (HIPC, according to Thiers, 2019).

The identity of the taxon was established, first, by contrasting herborized material and the photos to the existing specimens in HAC (according to Thiers, 2019). Then, they were compared to the descriptions and keys found in Yao, Deng & Ge (2015). The digital material at the herbaria was also consulted. P, K, and BM (according to Thiers, 2019).

The protolog was located at free access portals of Biodiversity Heritage Library Consortium (<https://www.biodiversitylibrary.org/>) and Botanicus Digital Library, Missouri Botanical Garden Library ([www.botanicus.org/](http://www.botanicus.org/)). The Global Plant JSTOR (Journal Storage, <http://plants.jstor.org>) was used to find the typological material. The species nomenclature fit the standards of the International Nomenclature Code of Algi, Plants and Fungi (Turland, Wiersema, Barrie, Greuter, Hawksworth, Herendeen, et al., 2018). The Font Quer Terminology (1975) was used for description. The search for possible documentary evidence of its presence in Cuba included the review of material deposited in herbaria: HAC, HAJB, HIPC, and ULV (according to Thiers, 2019), and bibliographic review.

## Results and discussion

Following seven years of search, by 2015, the co-author of this article located cultivated plants of genus *Pogostemon* on the property of Ricardo Denis Josmey Martin, in Los Pinos, on road to Fomento, Cabaiguan municipality, province of Sancti Spiritus. Later, in 2018, plantations of the same species were found in Quivijan, 18 km south-west of Baracoa, province of Guantanamo.

This particular species was identified as *Pogostemon cablin* (Blanco) Benth. The description below makes up for the lack of a detailed description of this genus and the species in the scientific literature of Cuba. The generic and specific reproductive characters (not recorded in the country) have been taken from Yao, Deng & Ge (2015).

*Pogostemon* Desf. Mém. Mus. Hist. Nat. 2:154. 1815.

Type: *Pogostemon plectranthoides* Desf.

Small bushes or annual or perennial grass. Stems: Round or hollow, strong or weak, erect or decumbent

and sometimes stems rooted on basal knots, with or without ramifications, and rarely glabrous. Leaves: opposed (normally petiolate), 3-12 verticillate (often subsessile), ovate limbs, tightly ovate, linear lanceolate or rarely falcate, single margin or simple crenated, doubly or remotely dented, simple or doubly serrate, incised, sometimes whole and revolute. Inflorescence: tirsoïd, often arranged in spikes, continuous or discontinuous, pubescent. Bractees and bracteoles: widely ovate, ovate-lanceolate, linear or filiform, and often ciliated. Calyx: ovoid, tubular, infundibuliform, campanulate, bearing 5 or 10 veins, usually glandular outside, 5-dented, subequal, triangular or tightly triangular teeth, rarely subulate teeth, usually ciliated. Corolla: white, pink, purple or rarely blue, usually exserta from the calyx, limb 2-labiate, whole upper lip, 3-lobulate, whole lower lip or 4-lobulate, sticking out from the calyx. Stamen: 4, erect, usually exserta, subequal or with a longer anterior pair, straight or bent, usually bearded filaments at the exserta position; anther 1-locules anthers, teaks with apical dehiscence. Style: insert, deeply bifid stigma, equal or subequal subulate lobules. Nucula: 4, ellipsoid to subglose, slightly flat, generally shiny.

Chromosomal number:  $2n = 12, 32, 34, 40, 60, 64, 72$  (Yao, Deng & Ge, 2015).

It comprises about 80 species distributed in Africa, Asia, and Australia (Yao, Deng & Ge, 2015). A species cultivated in Cuba.

This term means stamen Barbados (Ingrouille & Raza, 1998), which provides an idea of the importance this phenotypic trait to distinguish the genus in the Lamiaceae context.

*Pogostemon cablin* (Blanco) Benth. Prodr. 12: 156. 1848.  $\equiv$  *Mentha cablin* Blanco Fl. Filip. 473-474. 1837. Neotype (Gan Yao, Yun-Fei Deng & Xue-Jun Ge Phytotaxa 200 (1): 8, 2015): Philippines. Luzon, Antipolo, Rizal Province, XI-1914, E.D. Merrill Species Blancoanae 112 (US [n.v.]; isoneotypes BM #950346 [photo!], K #824876 [photo!], K #824877 [photo!], NY [n.v.], P #3012097 [photo!]).

$\equiv$  *Pogostemon patchouli* Pellet. Mem. Soc. Sci. Nat. Maroc 5: 277, pl. 7. 1845. Type: India, "In hortis cultitur ex India oriental" (ORM? [n.v.]).

– "*Pogostemon heyneanus*" auct.

Small perennial and aromatic bushes of up to 5 m high. Stems: erect, ramified teretes, tomentose. Leaves: opposed; 1-7 cm petioles, tomentose, orbiculare to broadly ovate, 4-11 x 2.5-9 cm, membranaceous, dark green and tomentose on the face, tomentose on the back; cuneate-attenuate basis, double or irregularly serrated margin; obtuse to acute apex; 4-5 pairs of lateral veins on either side of the main vein. Spikes: (never seen in Cuba) 3-6.5 x 1.3-1.8 cm long, terminal and axillar, bearing more than two lateral branches, continuous, densely tomentose; verticillasters with approximately 16 flowers; sessile

flowers. Bracts and bracteoles: ovate to narrow lanceolate (4–8 x 1–3 mm); whole or rarely serrated margin; pubescent face; densely glandular-tomentose back. Calyx: tubular, 6–8 mm long, 5 nervate, densely tomentose outside, slightly tomentose inside; 5 teeth, narrowly triangular, 1.2–2 mm long, scarcely tomentose inside. Corolla: white or purple, 7–9 mm long, exserta to calyx, 2-labiate, 3-lobate upper lip; whole lower lip; scarcely pubescent lips outside. Stamen: 4, erect, exserta, 5–7 mm filaments, inserted in the middle of the tube or higher, bearded on the upper side exserta; 1-locular anthers, dehiscent at the apex Style: 7.5–8 mm long; bifid stigma; equal lobes, 2.5–3 mm long. Nucula: 4, 0.8 x 0.6 mm, ellipsoid-oblong, reticulate-foveolate. Fig. 1.

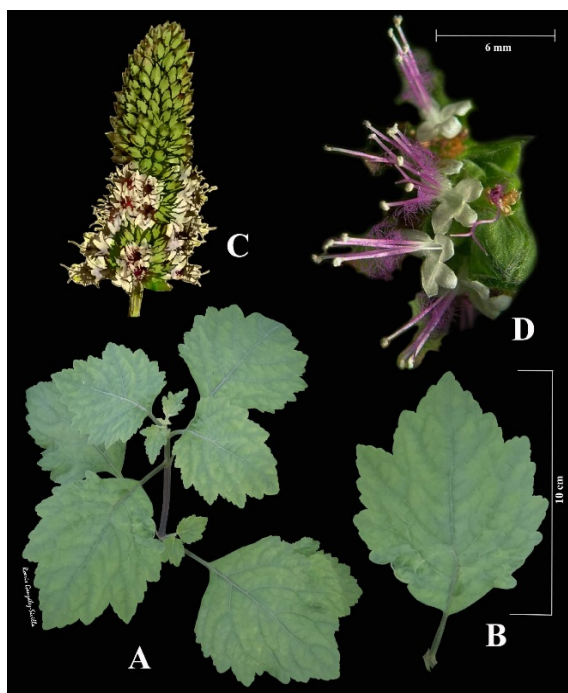


Fig. 1. *Pogostemon cablin* (Blanco) Benth. (Lamiaceae). A, sterile branch (photo: Rayner Morales Perez, from plants cultivated in Quivijan, Baracoa, Guantanamo). B, leaf (from the previously cited source) C, flowered branch (drawing from : Hooker, (1849, Pl. XI). C, flowers (photo taken from: <https://www.livemaster.com/item/26395897-essential-oils-patchouli-pogostemon-cablin-10ml>). Photographic composition: Roeris González Sivilla

*Pogostemon cablin* (Blanco) Benth. does not flower or bear fruits in Cuba. Reports from families with a long-lasting tradition of this species in Baracoa and Cabaiguan, who were interviewed as part of this research claim they have not seen plants in reproductive state, which corresponds to reports from other areas of the world, relatively far from their origin (Kumara, Balasubramanya & Anuradha, 2010).

Probably originated in tropical Asia (Kumara, Balasubramanya & Anuradha, 2010; Kumara, Balasubramanya & Anuradha, 2009), the plant is cultivated in different parts of the world today (Ramya, Palanimuthu & Rachna, 2013), including the

Americas, especially Brazil (Bunrathep, Brian, Songsak & Ruanrungsia, 2006).

No evidence of this species has been found in other regions of the West Indies (Acevedo-Rodríguez & Strong, 2012). In Cuba, both the historical collections of herbaria, as well as reports from the literature (Roig, 1965 y 1974; Esquivel, Hammer & Knüpffer, 1992), and results from this research have proven that its cultivation is limited to very specific regions of the country, and probably, occasionally. Currently, it has been spotted in mid Cuba: S.Spiritus and Camagüey, and eastern Cuba: ¿Holguín? and Guantanamo.

Spotted specimens: Havana: Experimental Agronomic Station, Santiago de las Vegas, cultivated plant, 22-1-1947, Acuña 14653 (HAC). Havana: Experimental Agronomic Station, Santiago de las Vegas, cultivated plant, 20-1-1947, Acuña 8853 (HAC). Sancti Spiritus: Cabaiguan municipality, Los Pinos, road to Fomento, Cabaiguan, 15-I-2015, Morales, 12114 (HIPC). Guantanamo: Quivijan community, 18 km west of Baracoa, 21-III-2018, Morales and Adan 2115 (HIPC). Camagüey: Lenin, road to Nuevitas, Camagüey 15-I-2019, Morales, 2116 (HIPC).

Uses: This is an economically remarkable species due to its aromatic properties, wide utilization in herbal medicine, and as raw material for the pharmaceutical, cosmetics, and perfume industries (Ramya, Palanimuthu & Rachna, 2013).

Common names: Patchouli (Roig, 1965, 1974; Esquivel, Hammer & Knüpffer, 1992).

Variability: This species has a variable chemical composition, for which two different genotypes have been described (He, Wan, Xiong, Li & Peng, 2014); therefore, it would be convenient to conduct research to find out which of the two species is present in Cuba.

The specimens studied historically, and the ones collected for the present study do not provide evidence to corroborate the presence of *Pogostemon heyneanus* Benth. Pl. Asia Rar. (Wallich). i. 31. 1830, cited by Roig (1974) for Cuba, clearly different from the taxon whose relocation has been reported in this paper, because of their ovate and acute foliar limbs in the apex (vs. orbicular to broadly ovate sheets, obtuse to acute in the apex).

With the confirmation of *Pogostemon*, there are 47 Lamiaceae genus observed in Cuba, among which, this one is part of a group of 27 only made of exotic species in the country. It is also within a subset of 15 that classified as occasionally cultivated, due to intermittent evidence found in the national archipelago.

Within Lamiaceae, the gender studied in this research classifies as Lamioideae, which is distinguished by the gynobasic style, usually tricoplate pollen, 2-

cellular, and spatulate embryonic sac (Harley, Atkin, Budantsev, Cantino, Conn, Grayer et al., 2004). *Leonurus* and *Leonotis*, also from the above mentioned subfamily, are the closest to *Pogostemon* in Cuba, which may be contrasted with the utilization of the analytical key below:

- 1... Conspicuously aromatic plants; morphologically uniform foliar sheets, orbicular to broadly ovate..... *Pogostemon Desf.*
- 1\* Non aromatic plant; morphologically different foliar sheets, according to their position in the plant, more or less aovate, oval-lanceolate; linear-lanceolate or palmatisect.....2
- 2 Aovate to broadly aovate inferior foliar sheets; oval-lanceolate upper sheets; linear-lanceolate flower sheets.....*Leonotis*
- 2\* Broadly ovate lower foliar sheets, palmatisect; narrower in the upper parts, less divided lobules; closely aovate flower sheets.....*Leonurus*

With *Pogostemon cablin* (Blanco) Benth. the number of Lamiaceae species known in Cuba total 137. It constitutes a group of 34 that classify as exotic, depending on their origin, and other subset of 25, which have only been recorded in cultivation (have not been naturalized).

The presence of *Pogostemon cablin* (Blanco) Benth. in the province of Holguin was not confirmed by the authors of this investigation. In spite of that, the previous section refers (but cannot corroborate) to the existence of a property in Cabaiguan (where the species is currently cultivated), from a family who donated the cuttings, and also cultivated the plant for a while in Moa.

The fact that the first reports on *Pogostemon Desf.* in Cuba, come from plants that were cultivated in the Agronomical Experimental Station in San Antonio de las Vegas, some of which, according to Roig (1974), had been generated from propagation material from Baracoa, and that the propagules now located in Cabaiguan came from that region, demonstrates the role played by the easternmost part of the country in the preservation of phytogenetic resources of this genus.

The essential oil from patchouli is extracted from the dry leaves of *Pogostemon cablin* (Blanco) Benth. (and from other species of the genus, according to Dharmadasa, Rathnayake, Abeysinghe, Rashani, Samarasinghe & Attanayake, 2014). It is widely used in the manufacture of perfumes and cosmetics (Sukardi, Soeparman, Argo & Irawan, 2017; Qing, Li, Jia, Wen, Zhi, Ren et al., 2014; Ramya, Palanimuthu & Rachna, 2013; Sharma & Sarma, 2015).

Their antioxidant, bactericidal, antifungal, and insecticidal properties have been recorded by Dechayont, Ruamdee, Poonnaimuang, Mokmued & Chunthorng-Orn, 2017; Sharma & Sarma, 2015; Karimi, 2014; Kongkathip, Sam-ang, Kongkathip, Pankaew, Tanasombat & Udomkusonsri, 2009).

The presence of this species has been recorded (Chen, Wu, Xu, Zhang, Song, Zhu et al., 2014; Li, Li, Ma, Yang, Chen, Liu, et al., 2013; Bunrathep, Brian, Songsak & Ruangrungsia, 2006).

The properties described for this plant make its cultivation appropriate for commercial use in countries like Indonesia, the Philippines, India, Java, China, Malaysia, and Brazil (Ramya, Palanimuthu & Rachna, 2013; Patil, Nayack, Barve, Tembe & Khan, 2012; Sandes, Pinheiro, Zucchi, Monteiro, Arrigoni-Blank & Blank, 2010; Bunrathep, Brian, Songsak & Ruangrungsia, 2006). To meet the demand of certified propagation material, hard to achieve in areas where flowering and fruiting are hindered due to climatic causes, multiplication can be made through cuttings of stems, leaves, tissue culture, especially nodal calluses, protoplast encapsulation, and stimulation of somatic embryogenesis (Kumara & Rani, 2016; Sharma & Sarma, 2015; Jin, Deng & He, 2014; Bin, Wei, Zhong, Hui, Cui, Yan, et al., 2013; Kumara, Balasubramanya & Anuradha, 2009 and 2010).

### Author contribution

- Isidro E. Méndez Santos. General redaction of the manuscript, identification and assembling of herbarium specimens, and field explorations.

- Rayner Morales Pérez. Field explorations, collections and herborization of specimens, photography, cultivation of studied plants, and general proofreading of the manuscript.

### Conflicts of interest

There are no conflicts of interest.

### Acknowledgments

The authors wish to thank the Belgium Development Cooperation through VLIR-UOS (Counsel of Flemish Universities) for granting the financial support for research, made possible thanks to TEAM Project, referenced CU2017TEA433A102.

### References

Acevedo-Rodríguez, P. & Strong M. (2012). *Catalogue of seed plants of the West Indies*. Smithsonian Contributions to Botany. N° 98. Washington, D.C. Retrieved on September 10, 2018, from: [https://www.researchgate.net/publication/263661734\\_Catalogue\\_of\\_Seed\\_Plants\\_of\\_the\\_West\\_Indies](https://www.researchgate.net/publication/263661734_Catalogue_of_Seed_Plants_of_the_West_Indies)

- Bin, J., Wei, D., Zhong, S., Hui, J., Cui, Y., Yan, J., et al. (2013). Immunomodulatory potential of patchouli alcohol isolated from *Pogostemon cablin* (Blanco) Benth (Lamiaceae) in mice. *Tropical Journal of Pharmaceutical Research*, 12 (4), 559-565. <http://dx.doi.org/10.4314/tjpr.v12i4.18>. Retrieved on November 10, 2018, from: <https://www.ajol.info/index.php/tjpr/article/view/93275>
- Biodiversity Heritage Library Consortium. (s.f.). *Biodiversity Heritage Library*. Retrieved on September 10, 2018, from: <https://www.biodiversitylibrary.org>
- Bunrathep, S., Brian, G., Songsakc, T. & Ruangrungsia, N. (2006). Chemical constituents from leaves and cell cultures of *Pogostemon cablin* and use of precursor feeding to improve patchouli alcohol level. *Science Asia* 32, 293-296. doi: <https://10.2306/scienceasia1513-1874.2006.32.293>. Retrieved on September 10, 2018, from: <http://www.scienceasia.org/2006.32.n3/293.php>
- Chen, Y., Wu, Y., Xu, Y., Zhang J., Song, X., Zhu, et al. (2014). Dynamic accumulation of sesquiterpenes in essential oil of *Pogostemon cablin*. *Revista Brasileira de Farmacognoscia* 24: 626-634. Retrieved on September 10, 2018, from: <https://www.sciencedirect.com/science/article/pii/S0102695X15000034>
- Dharmadasa, R., Rathnayake, R., Abeysinghe, D., Rashani, S., Samarasinghe, K. & Attanayake, A. (2014). Screening of local and introduced varieties of *Pogostemon heyneanus* Benth. (Lamiaceae), for superior quality physical, chemical and biological parameters. *World Journal of Agricultural Research* 2(6): 261-266. Doi: 10.12691/wjar-2-6-2. Retrieved on February 10, 2019, from: <http://pubs.sciepub.com/wjar/2/6/2/index.html>
- Dechayont, B., Ruamdee, P., Poonnaimuang, S., Mokmued, K., & Chunthong-Orn, J. (2017). Antioxidant and antimicrobial activities of *Pogostemon cablin* (Blanco) Benth. *Hindawi Journal of Botany*. Article ID 8310275. <https://doi.org/10.1155/2017/8310275>. Retrieved on September 10, 2018, from: <https://www.hindawi.com/journals/jb/2017/8310275>
- Esquivel, M. A., Hammer K. & Knüpffer H. (1992). Inventory of the Cultivated Plants. In K. Hammer, M. Esquivel & H. Knüpffer (eds.), "... y tienen faxones y fabas muy diversos de los nuestros...". *Origin, Evolution and Diversity of Cuban Plant Genetic Resources*. (Vol. 2, pp. 213-454). Gatersleben, Germany: Institut für Pflanzengenetik und Kulturpflanzenforschung.
- Font Quer, P. (1975). *Diccionario de Botánica* (5ta. ed.). Madrid: Editorial Labor, S. A.
- Greuter, W. & Rankin R. (2017). *Espermatófitos de Cuba* Inventario preliminar. Parte II: Inventario. Botanischer Garten und Botanisches Museum Berlin-Dahlem. Zentraleinrichtung der Freien Universität Berlin. Königin-Luise-Str. 6-8, D-14195 Berlin, Germany. doi: <http://dx.doi.org/10.3372/cubalist.2016.2>
- Harley, R., Atkin, S., Budantsev, A., Cantino, P., Conn, R., Grayer, R., et al. (2004). Lamiales (except Acanthaceae including Avicenniaceae). In *The families and genera of vascular plants. Flowering plants, Dicotyledons* [K. Kubitzki ed.]. Berlin: Springer.
- He, Y., Wan, F., Xiong, L., Li, D. & Peng, Ch. (2014). Identification of two chemotypes of *Pogostemon cablin* (Blanco) Benth. through DNA barcodes. *Z. Naturforsch.* 69c: 253 – 258, doi: <https://10.5560/ZNC.2013-0180>. Retrieved on September 10, 2018, from: <https://www.ncbi.nlm.nih.gov/pubmed/25069164>
- Hooker, W. (1849). *Journal of Botany and Kew Garden Miscellany*. (Vol. I). London: Reeve, Benham & Reeve.
- Ingrouille, M. & Raza, G. (1998). Infrageneric relationships within *Pogostemon* Desf. (Labiatae). *Botanical Journal of the Linnean Society*, 128, 159-183. Retrieved on September 10, 2018, from: <https://academic.oup.com/botlinnean/article/128/2/159/2557274>
- Jin, H., Deng, Z. & He, H. (2014). Effect of explant types and plant growth regulators on direct regeneration in medicinal plant *Pogostemon cablin*. *Plant Omic Journals*, 7(5), 322-327. Retrieved on September 10, 2018, from: <https://search.informit.com.au/documentSummary;dn=725857211503385;res=IELHSS>
- Journal Storage. (s.f.). *Jstor Global Plants*. Retrieved on November 12, 2018, from: <https://plants.jstor.org/search?plantName=%22Pogostemon+cablin%22&syn=1>
- Karimi, A. (2014). Characterization and antimicrobial activity of patchouli essential oil extracted from *Pogostemon cablin* [Blanco] Benth.

- [Lamiaceae]. *Advances in Environmental Biology*, 8(7), 2301-2309. Retrieved on September 10, 2018, from: [https://www.researchgate.net/publication/287306407\\_Characterization\\_and\\_antimicrobial\\_activity\\_of\\_Patchouli\\_essential\\_oil\\_extracted\\_from\\_Pogostemon\\_cablin\\_Blanco\\_Benth\\_lamiaceae](https://www.researchgate.net/publication/287306407_Characterization_and_antimicrobial_activity_of_Patchouli_essential_oil_extracted_from_Pogostemon_cablin_Blanco_Benth_lamiaceae)
- Kongkathip, N., Sam-ang, P., Kongkathip, B., Pankaew, Y., Tanasombat, M. & Udomkunsorn, P. (2009). Development of patchouli extraction with quality control and isolation of active compounds with antibacterial activity. *Kasetsart Journal (Natural Science)*, 43, 519 – 525. Retrieved on September 12, 2018, from: [https://www.researchgate.net/publication/283873802\\_Development\\_of\\_patchouli\\_extraction\\_with\\_quality\\_control\\_and\\_isolation\\_of\\_active\\_compounds\\_with\\_antibacterial\\_activity](https://www.researchgate.net/publication/283873802_Development_of_patchouli_extraction_with_quality_control_and_isolation_of_active_compounds_with_antibacterial_activity)
- Kumara, M., Balasubramanya, S. & Anuradha, M. (2009). Germplasm conservation of patchouli (*Pogostemon cablin* Benth.) by encapsulation of in vitro derived nodal segments. *International Journal of Biodiversity and Conservation*, 1(8), 224-230. Retrieved on September 12, 2018, from: [https://www.academia.edu/4613384/Germplasm\\_conservation\\_of\\_patchouli\\_Pogostemon\\_cablin\\_Benth\\_by\\_encapsulation\\_of\\_in\\_vitro\\_derived\\_nodal\\_segments](https://www.academia.edu/4613384/Germplasm_conservation_of_patchouli_Pogostemon_cablin_Benth_by_encapsulation_of_in_vitro_derived_nodal_segments)
- Kumara, M., Balasubramanya, S. & Anuradha, M. (2010). In vitro multiplication of *Pogostemon cablin* Benth. through direct regeneration. *African Journal of Biotechnology*, 9(14), 2069-2075, doi: <https://10.5897/AJB09.1580>. Retrieved on September 12, 2018, from: <http://www.academicjournals.org/AJB>
- Kumara, M. & Rani, U. (2016). Patchouli (*Pogostemon cablin* Benth.): Botany, agrotechnology and biotechnological aspects. *Industrial Crops and Products*, 87, 161–176. Retrieved on March 10, 2018, from: <https://www.sciencedirect.com/science/article/pii/S0926669016302485n>
- Li, F., Li, Ch., Ma, J., Yang, J., Chen, H., Liu, X. et al. (2013). Four new sesquiterpenes from the stems of *Pogostemon cablin*. *Fitoterapia*, 86, 183–187. Retrieved on September 10, 2018, from: <https://www.sciencedirect.com/science/article/pii/S0367326X13000671>
- Missouri Botanical Garden Library. (s.f.). *Botanicus Digital Library*. Retrieved on September 15, 2018, from: <http://www.botanicus.org/page/160380>
- Muséum National d'Histoire Naturelle. (s.f.). *P Virtual Herbarium*. Retrieved on September 10, 2018, from: <https://plants.jstor.org/stable/10.5555/al.ap.specimen.p03012097?searchUri=npplantName%3D%2522Pogostemon%2Bcablin%2522%26syn%3D1>
- Patil, S., Nayack, G., Barve, S., Tembe, R. & Khan, R. (2012). Impact of biofield treatment on growth and anatomical characteristics of *Pogostemon cablin* (Benth). *Biotechnology*, 11(3), 154.162, doi: 10.3923/biotech.2012.154.162. Retrieved on September 10, 2018, from: [https://www.researchgate.net/publication/280621941\\_Impact\\_of\\_Biofield\\_Treatment\\_on\\_Growth\\_and\\_Anatomical\\_Characteristics\\_of\\_Pogostemon\\_cablin\\_Benth](https://www.researchgate.net/publication/280621941_Impact_of_Biofield_Treatment_on_Growth_and_Anatomical_Characteristics_of_Pogostemon_cablin_Benth)
- Qing, Z., Li, X., Jia, M., Wen, Ch., Zhi S., Ren Z. et al. (2014). Isolation of (-)-patchouli alcohol from patchouli oil by fractional distillation and crystallization. *Tropical Journal of Pharmaceutical Research*, 13 (3), 359-363. <http://dx.doi.org/10.4314/tjpr.v13i3.7>. Retrieved on September 10, 2018, from: <https://www.ajol.info/index.php/tjpr/article/view/103730>
- Ramya, H., Palanimuthu, V. & Rachna, S. (2013). An introduction to patchouli (*Pogostemon cablin* Benth.) – A medicinal and aromatic plant: It's importance to mankind. *Agricultural Engineering International: CIGR Journal*, 15(2), 243–250. Retrieved on November 24, 2018, from: <http://www.cigrjournal.org/index.php/Ejournal/article/view/2289>
- Roig, J. (1965). *Diccionario botánico de nombres vulgares cubanos*. (2 vols.). La Habana: Editora del Consejo Nacional de Universidades.
- Roig, J. (1974). *Plantas medicinales, aromáticas o venenosas de Cuba*. (2da ed. ) La Habana: Ciencia y Técnica.
- Royal Botanic Gardens. (s.f.). *K Virtual Herbarium*. Retrieved on September 10, 2018, from: <https://plants.jstor.org/stable/10.5555/al.ap.specimen.k000824877?searchUri=plantName%3D%2522Pogostemon%2Bcablin%2522%26syn%3D1>
- Sandes, S., Pinheiro, J., Zucchi, M., Monteiro, M., Arrigoni-Blank, M. & Blank, A. (2010). Development and characterization of microsatellite primers in *Pogostemon cablin* (Lamiaceae). *Genetics and Molecular Research*, 12 (3), 2837-2840. Retrieved on

- September 10, 2018, from:  
<https://www.geneticsmr.org/abstract/development-and-characterization-of-microsatellite-primers-in-pogostemon-cablin-lamiaceae-1868.html>
- Sharma, P & Sarma, J. (2015). Pogostemon cablin (Blanco) Benth. (Lamiaceae): It's Ethnobotany & in vitro regeneration. *Pharmacognosy Journal*, 7(3): 152-156, doi: <https://10.5530/pj.2015.3.2>. Retrieved on September 10, 2018, from: <https://www.phcogj.com/article/44>
- Sukardi, Soeparman, S., Argo, B. & Irawan, S. (2017). Optimization of patchouli oil (Pogostemon cablin Benth.) with steam distillation assisted by pulsed electric field via response surface methodology. *Journal of Engineering Science and Technology*, 12 (8), 2106 – 2119. Retrieved on September 10, 2018, from: [https://www.researchgate.net/publication/319179756\\_Optimization\\_of\\_patchouli\\_oil\\_Pogostemon\\_cablin\\_benth\\_with\\_steam\\_distillation\\_assisted\\_by\\_pulsed\\_electric\\_field\\_via\\_response\\_surface\\_methodology](https://www.researchgate.net/publication/319179756_Optimization_of_patchouli_oil_Pogostemon_cablin_benth_with_steam_distillation_assisted_by_pulsed_electric_field_via_response_surface_methodology)
- The Natural History Museum. (s.f.). *BM Virtual Herbarium*. Retrieved on November 10, 2018, from: <https://plants.jstor.org/stable/10.5555/al.ap.specimen.bm000950346?searchUri=plantName%3D%2522Pogostemon%2Bcablin%2522%26syn%3D1>
- Thiers, B. (2019). *Index Herbariorum: A global directory of public herbaria and associated staff*. New York Botanical Garden's Virtual Herbarium. Retrieved on September 10, 2018, from: <http://sweetgum.nybg.org/science/ih>
- Turland, N., Wiersema, J., Barrie, F., Greuter, W., Hawksworth, D., Herendeen, A., et al. (eds.) (2018). *International Code of Nomenclature for algae, fungi, and plants (Shenzhen Code) adopted by the Nineteenth International Botanical Congress Shenzhen, China, July 2017*. Regnum Vegetabile 159. Koeltz Botanical Books. Glashütten, doi: <https://doi.org/10.12705/Code.2018>
- Yao, G., Deng, Y. & Ge, J. (2015). A taxonomic revision of Pogostemon (Lamiaceae) from China. *Phytotaxa*, 200 (1), 1-67. <http://dx.doi.org/10.11646/phytotaxa.200.1.1> Retrieved on February 10, 2019, from: <https://biotaxa.org/Phytotaxa/article/view/phytotaxa.200.1.1>