

ERYTHRINA L. (FABACEAE): UMA ABORDAGEM BIBLIOMÉTRICA

ERYTHRINA L. (FABACEAE): A BIBLIOMETRICAL APPROACHE

Resumo

As espécies de *Erythrina* possuem destaque na medicina popular, na recuperação ambiental, no paisagismo e outros tipos de usos. Estas informações levaram à investigação científica do gênero. Portanto, esse artigo realizou uma análise bibliométrica das espécies de *Erythrina* com distribuição no Brasil. A busca baseou-se no nome aceito e nos sinônimos das espécies do gênero *Erythrina*, com distribuição no Brasil, sendo amostrados os artigos que contêm este táxon no título, subtítulo, resumo ou nas palavras-chave. Os dados foram categorizados em classes de estudo. Observou-se que a maioria das publicações está relacionada às propriedades bioquímicas. Essa predominância vem da descoberta da produção de alcaloides pelas espécies de *Erythrina*. *E. velutina* é a espécie foco mais comum, ultrapassando a produção decorrente de *E. crista-galli*. A ascensão de *E. velutina* nas pesquisas mais recentes pode ser resultado da saturação da pesquisa com *E. crista-galli*. Em relação às demais classes de estudo, pouco se sabe sobre a biologia das espécies, reforçando a continuidade da investigação científica e preenchimento das lacunas de estudos com o gênero *Erythrina*.

Palavras-Chave: Papilionoideae, Cienciometria, Produção Científica.

Abstract

Erythrina L. stand out in folk medicine, environmental restoration, landscaping and other types of uses. These characteristics led to improvement the scientific research of the *Erythrina* genus. Therefore, this article aimed to perform a bibliometric analysis of *Erythrina* species distributed in Brazil. The search was based on the accepted name and synonyms of *Erythrina* species, with natural distribution in Brazil, being sampled the articles that contain this taxon in the title, subtitle, abstract or keywords. Data were categorized into study classes. Most publications were related to biochemical properties. This predominance comes from the discovery of alkaloid production by *Erythrina* species. *E. velutina* was the most common species, surpassing *E. crista-galli* scientific production. The rise of *E. velutina* in more recent research may be a result of the saturation of *E. crista-galli* research field. In relation to the other classes of study, little is known about the biology of the species, reinforcing the continuity of the scientific investigation and consequently, filling the gaps of studies with the *Erythrina* genus.

Keywords: Papilionoideae, Scientometry, Scientific Productivity.

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INTRODUCTION

Fabaceae Lindl. has approximately 751 genera and more than 19.000 species, being the richest botanical family in Brazil (BATISTA, 2015) and one of the most representative in the world (BRUNEAU et al., 2013). It has six subfamilies: Cercidoideae, Detarioideae, Duparquetioideae, Dialioideae, Caesalpinioideae e Faboideae (STEVENS, 2017). *Erythrina* L. is one of the main genera of the subfamily Faboideae, with approximately 120 species distributed in tropical and subtropical regions of the world (DA SILVA et al., 2013), and occurs in all Brazilian biomes (DA SILVA et al., 2013) with 11 species (Flora do Brazil 2020 under construction, 2018).

Erythrina's species stand out in the use as medicinal plants, in addition to notorious use in the environmental recovery and landscaping, besides the traditional use as materials for dyeing and making musical instruments (BACKES; IRGANG, 2002). Studies on *Erythrina* have been carried out and published almost a century ago (DEULOFEU; HUG; MAZZOCCO, 1939) and almost all production related to the genre is being published and available in online databases.

Due to the increasing number of published papers, the production of mechanisms to organize the publications in order to quantify, control, trace and disseminate all the knowledge already produced and indexed was stimulated (ZAPPI et al., 2016). In this context, the purpose of this bibliometric study was to analyze the literature on *Erythrina* with natural distribution in Brazil, considering the fluctuations in scientific production within the temporal gradient, areas of knowledge and according to the different species of the genus.

MATERIAL AND METHODS

The survey of papers was conducted in the electronic databases Web of Science, Scopus and Scielo. We registered all review and original papers containing the accepted name and synonyms of species (Table 1) (FLORA DO BRASIL 2020 EM CONSTRUÇÃO, 2018).

Table 1 - Native *Erythrina* species from Brazil, their synonyms and popular names.

Species	Synonyms	Popular names
<i>Erythrina amazonica</i> Krukoff	None	mulungu
<i>Erythrina cristagalli</i> L.		corticeira

Species	Synonyms	Popular names
	<i>Erythrina fasciculata</i> Benth. <i>Erythrina laurifolia</i> Jacq. <i>Erythrina pulcherrima</i> Tod.	
<i>Erythrina dominguezii</i> Hassl.	None	ceibo rosado
<i>Erythrina falcata</i> Benth.	<i>Erythrina crista-galli</i> var. <i>inermis</i> Speg. <i>Erythrina martii</i> Colla	bico-de-papagaio
<i>Erythrina fusca</i> Lour.	<i>Erythrina atosanguinea</i> Ridl. <i>Erythrina caffra</i> Blanco <i>Erythrina fusca</i> var. <i>inermis</i> Pulle <i>Erythrina glauca</i> Willd. <i>Erythrina moelebei</i> Vieill. ex Guillaumin & Beauvisage <i>Erythrina ovalifolia</i> Roxb.	suinã
<i>Erythrina poeppigiana</i> (Walp.) O.F.Cook	<i>Erythrina amasisa</i> Spruce <i>Erythrina darienensis</i> Standl. <i>Erythrina micropteryx</i> Poepp. ex Urb. <i>Erythrina pisamo</i> Pos.-Arang.	eritrina-do-alto
<i>Erythrina similis</i> Krukoff	None	mulungu
<i>Erythrina speciosa</i> Andrews	<i>Erythrina graefferi</i> Tineo <i>Erythrina poianthes</i> Brot. <i>Erythrina poianthes</i> var. <i>subinermis</i> Lindl. <i>Erythrina reticulata</i> C. Presl <i>Erythrina speciosa</i> var. <i>rosea</i> N.F. Mattos	corticeira-do-banhado
<i>Erythrina ulei</i> Harms	<i>Erythrina xinguensis</i> Ducke	mulungu
<i>Erythrina velutina</i> Willd.	<i>Erythrina aculeatissima</i> Desf. <i>Erythrina aurantiaca</i> Ridl. <i>Erythrina splendida</i> Diels	eritrina
<i>Erythrina verna</i> Vell.	<i>Erythrina flammea</i> Herzog <i>Erythrina mulungu</i> Mart. ex Benth.	suinã
<i>Erythrina mulungu</i> Mart.	<i>Erythrina dominguezii</i> Hassl.	mulungu

Therefore, we search for the taxa in the title, abstract and keywords. All papers were classified in study classes according to the main goal of the paper [Table 2; (ELIAS et al., 2015)].

Table 2 - Study classes for paper's classification of *Erythrina* genus.

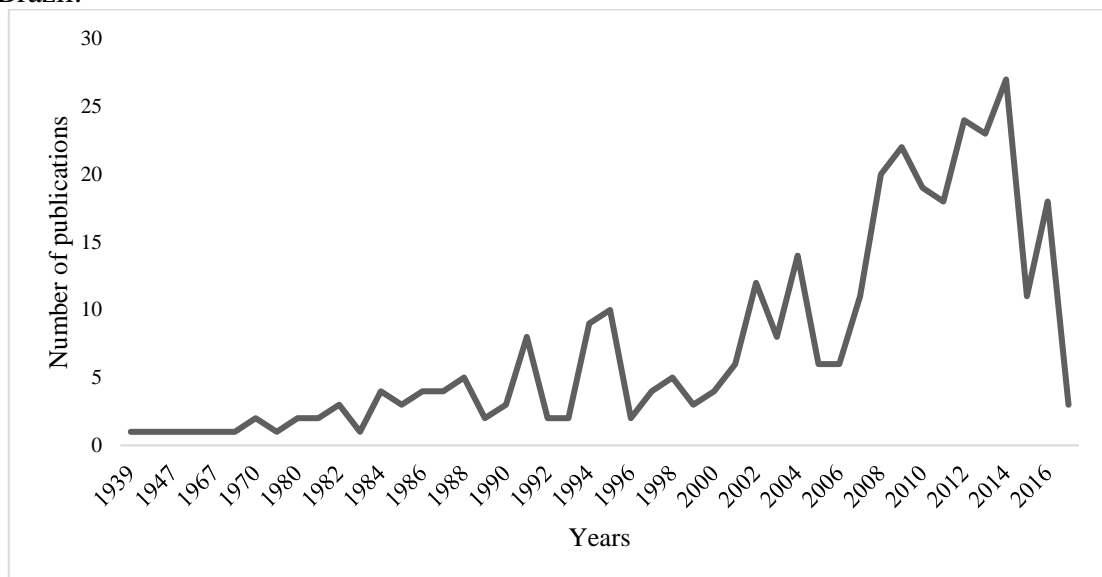
Classes	Study Classes	Description
C1	Biochemical and nutritional properties	Plant services used as feedstock for the isolation of one or more biochemical substances.
C2	Ecological	Floristics, phytosociology, phenology, conservation, population dynamics and interactions.
C3	Morphology, anatomy, histology, physiology and genetics	Morphology, anatomy, histology, plant physiology.
C4	Production and use	Production and transformation of forest products, use by communities or for commercialization.

In order to evaluate the relationship of the scientific production along the temporal gradient. These models were used for the *Erythrina* species (more than 25 papers) and for each study class. In order to determine the association between the study classes and the *Erythrina* species, we used χ^2 Independence Test (AGRESTI, 1996). This test generates Pearson residue values. These values indicate a study number above (positive residue) or below (negative residues) of the mean of the genus, indicating the trends for each species, compared to the mean values of the genus *Erythrina*. Statistical analysis was run in the R computing environment (R CORE TEAM, 2017).

RESULTS AND DISCUSSION

We registered 339 papers published in 192 scientific journals. Among the species sought (studied), *E. crista-galli*, *E. velutina* and *E. poeppigiana* stood out, representing 75% of the published literature (Table 3). The scientific production on *Erythrina* increased along the temporal gradient, however, until the 80's decade, publications were scarce. From 1938 to 1978 only nine papers were published, representing less than a third of the publications of the 1980s (29 papers). From 2000's, the increase was representative (Fig. 1).

Figure 1 - Overview of the scientific production on Native *Erythrina* species from Brazil.



Although *Erythrina* species are known for the great diversity and concentration of chemical compounds, there are few studies evaluating the potential of the genus (VIVOT et al., 2012). We did not register publications on *Erythrina amazonica*, *Erythrina similis* and *Erythrina ulei*, although their occurrences are registered for at least three Brazilian states (MARTINS; TOZZI, 2018).

Most of the publications are related to the biochemical and nutritional properties of the species (C1). The study class C1 (Table 3) concentrated about 65% of all scientific production. This predominance is derived from the discovery of large alkaloid production by *Erythrina* species (FOLKERS; UNNA, 1938; KUNTIYONG et al., 2017). In addition to these compounds, the genus is known for its bioavailability in flavonoids, metabolites that can act as antifungal, antibacterial, among others (YENESEW et al., 2005).

Besides that, the ecological class also stood out with 21.3% of the published papers. Many of them were focused on the association of *Erythrina* species in agroforestry systems (ZAHAWI et al., 2015), their use in ecological restoration (ZAHAWI; HOLL, 2009) or the association of these species with the soil (ZAHAWI; HOLL, 2009). *Erythrina* species are commonly associated with agroforestry systems, in association mainly with coffee (*Coffea arabica* L.) and cocoa (*Theobroma cacao* L.), being beneficial for biodiversity conservation without undermining crop yields (BEER

et al., 1990; MEYLAN et al., 2017; MUNROE et al., 2015; RUSSO, 1991). This management system can also be used to increase the provision of ecosystem services, such as regulation of pests and diseases; maintenance of soil fertility; provisioning of agroforestry products and carbon sequestration (CERDA et al., 2017). Our results indicated that scientific production, within each class, varied significantly between species (Table 3).

Table 3 - Number of published papers on *Erythrina* species and study classes, C1: Biochemical and nutritional properties; C2: Ecological; C3: Morphology, anatomy, histology, physiology and genetics; C4: Production and use.

Species	Total	C1	C2	C3	C4
<i>Erythrina amazonica</i> Krukoff	0	0	0	0	0
<i>Erythrina crista-galli</i> L.	122	111	6	3	2
<i>Erythrina dominguezii</i> Hassl.	2	0	2	0	0
<i>Erythrina falcata</i> Benth.	14	7	5	1	1
<i>Erythrina fusca</i> Lour.	22	11	11	0	0
<i>Erythrina poeppigiana</i> (Walp.) O.F.Cook	56	18	27	4	7
<i>Erythrina similis</i> Krukoff	0	0	0	0	0
<i>Erythrina speciosa</i> Andrews	17	10	1	6	0
<i>Erythrina ulei</i> Harms	0	0	0	0	0
<i>Erythrina velutina</i> Willd.	72	35	19	13	5
<i>Erythrina verna</i> Vell.	34	28	4	2	0
Total	339	220	75	29	15

* Species evaluated by the Pearson χ^2 test. Red / blue - categories with residue values \geq of ± 2 .

Erythrina crista-galli presented the highest number of published papers, corresponding to more than 90% of the papers registered. It is used in antibacterial and antioxidant action (TJAHJANDARIE et al., 2014; VIVOT et al., 2012). In addition, it has an important ecological role in pollination in cultivated and natural forests (COSTA; MORAIS, 2008; GALETTO et al., 2000), with a diversity of pollinators, highlighting *Apis mellifera* and *Xylocopa* sp. and four species of hummingbird: *Chlorostilbon aureoventris* (Shaw, 1812), *Hylocharis chrysurus* (Shaw, 1812), *Heliomaster furcifer* (Shaw, 1812) and *Leucochloris albicollis* (Vieillot, 1818) (COSTA; MORAIS, 2008).

On the other hand, *E. poeppigiana* presents the highest values of the Pearson residues in the class C2 and C4 (commercial uses), against the general overview of the

scientific production whose majority is in the area of biochemistry (C1). The different approach that the research gives to this species is due to its use in agroforestry systems associated with coffee and cocoa (ZAHAWI; HOLL, 2009).

The first paper to treat *E. velutina* was Barros et al. (1970) that studied the effect of ethanolic and aqueous extracts of this plant, along with 44 other native species. In the following decades, there was a predominance of studies classified in study class C1. Even so, *E. velutina* stands out due to the high scientific production in classes C2 and C3 (positive residues). This species is the most used in agroforestry systems (ZAHAWI; HOLL, 2009), which justifies the interest of the studies that aim to know the structure and ecology of the species. Considering the growing demand for economic development, associated with sustainable techniques, agroecosystems have been increasingly studied in terms of productivity and environmental impact (HASSAN; HADDAWY; ZHU, 2014), where the ecological interactions of the species composing the agroforestry.

On the island of Fernando de Noronha, *E. velutina* is visited by birds (SAZIMA et al., 2009), the species blooms for two days and its stigmas remain receptive to a small assembly of vertebrates, such as *Zenaida auriculata noronha* (Des Murs, 1847), *Vireo gracilirostris* (Sharpe, 1890), *Elaenia ridleyana* (Sharpe, 1888) and *Euprepis atlanticus* (currently under the accepted name of *Trachylepis atlantica*) (SCHMIDT, 1945) (SAZIMA et al., 2009). None of the animals cited by the authors are dependent on nectar as the main source of food, but *E. velutina* is the only species visited by these vertebrates (SAZIMA et al., 2009).

The oldest paper found in our study dates from 1939 and describes new alkaloids isolated from *E. glauca*, currently under the accepted name of *E. fusca* (DEULOFEU; HUG; MAZZOCCO, 1939).. This study was not found in our research because it was within the category of Discussion, our search limited papers in the category "Original Papers" and "Review".

Interest in the genus *Erythrina* started, mainly, from 1930, when alkaloids were discovered that induced similar effects to curare, and could be used in medicine (FARIA et al., 2007). Curare was used as an adjunct to general anesthesia in order to determine abdominal muscle relaxation and some degree of bowel contraction (LIMONGI, 1946).

The first studies on *Erythrina* were almost exclusively with *E. crista-galli*. Considering that until the 1980s, only nine articles were published, five of them corresponded to *E. crista-galli*, or 55.6% of the total publication. This predominance continued in the following decades, where of the 30 articles published in the 1980's, 21 were related to *E. crista-galli*. In the most recent studies *E. velutina* became the most common focus species, surpassing *E. crista-galli* production. This highlighted production on *E. velutina*, in more recent research, may be a result of the saturation on *E. crista-galli* research, where the lack of information about the composition and functionality of *E. velutina* compounds made it more attractive to the new studies. Another factor that may have influenced it is that, in addition to medicinal potential, *E. velutina* presents other study perspectives due to its application in agroecosystems. *Erythrina amazonica*, *E. similis* and *E. ulei* not appeared in our survey.

CONCLUSIONS

Erythrina crista-galli, *E. poeppigiana*, *E. velutina* and *E. verna* were the most representative species of our study, especially related to Biochemical and nutritional properties class. Regarding the other species, studies are scarce and restricts to some thematic, reinforcing the premise for the continuity of scientific research with *Erythrina* genus.

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