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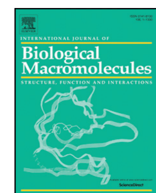
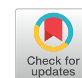


Review

Reviewing Mimosoideae lectins: A group of under explored legume lectins



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ABSTRACT

Lectins are proteins capable of specific and reversible binding to mono- and/or oligosaccharides, and within this group, Legume lectins are the most studied. However, most of these studies focus on the Papilionoideae subfamily, with Caesalpinioideae and Mimosoideae lectins being significantly less explored in the literature. The Mimosoideae subfamily consists of at least 79 genera and 3275 species, but, to date, only about 14 lectins have been purified, a fact which shows the lack of studies for this group. Based on their purification protocols, as well as physicochemical and structural properties, Mimosoideae lectins are very heterogeneous. Despite the few studies, a wide variety of biological activities have been tested, including, for example, inflammatory, anticancer, antibacterial, and antifungal. In this context, the present review aims to summarize the available data regarding the purification, physicochemical and structural properties, as well as biological activities, of lectins extracted from plants of the Mimosoideae subfamily in order to bring more insight to researchers interested in further exploring the potential of these molecules.

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1. Introduction

Lectins are a group of proteins of nonimmune origin widely distributed in nature. These proteins recognize and bind specific carbohydrates found on the surfaces of cells and play a role in interaction and communication between cells, as well as interaction with glycoproteins [1,2]. Of the lectins so far studied, those extracted from plants stand out those from the Leguminosae family. Legume lectins are an extensive group with homogeneous physicochemical and structural properties, but very different biological activities [3–5]. A vast majority of works reporting lectin purification make use of seeds as source. However, these proteins can be found in several tissues of the plant, such as leaves, roots, tubercles, among others [6,7].

Taxonomically, there is some confusion regarding the subfamily division of the Leguminosae family. Older taxonomy considers that Leguminosae comprises the subfamilies Papilionoideae, Caesalpinioideae, and Mimosoideae while a newer taxonomy classifies

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Mimosoideae as a clade within the Caesalpinoideae subfamily. For this review, Mimosoideae is considered a subfamily within Leguminosae Most of the research on lectins focuses on the Papilionoideae and Caesalpinoideae, mostly on the first, thus evidencing the need for further studies for lectins of Mimosoideae plants. The Mimosoideae subfamily is the second largest in number of taxa, comprising four tribes (Mimoseae, Mimozygantheae, Acacieae and Ingeae) with about 3275 species and 79 genera [8–10]. Mimosoideae is recognized for its bipinnate leaves with the presence of actinomorphic flowers and seeds with a U-shaped pleurogram [11,12]. The members of this subfamily are distributed in tropical, subtropical and temperate regions, but they are strongly present in the Americas, Africa, Asia and Australia [13]. Mimosoideae plants are used for forage and animal feed, firewood for domestic and industrial use, civil construction, as well as soil improvement and revegetation [14,15]. Scientific studies point out the importance of lectins as potential tools in pest control programs, as well as potential phytomedicines in the treatment and prevention of infections and diseases like cancer [16,17]. Some seeds of Mimosoideae plants lectins are depicted in Fig. 1, these seeds are sources of lectins that have been previously purified and characterized.

For the Mimosoideae lectins, researchers have reported on the purification, characterization and some biological activities of the genera *Parkia*, *Leucaena*, *Caliandra*, *Archidendron*, *Anadenanthera*, *Albizia* and *Acacia*. Some species with purified lectins are *Parkia javanica*, *Parkia platycephala*, *Parkia biglandulosa*, *Parkia roxburghii*, *Parkia panurensis*, *Leucaena leucocephala*, *Calliandra surinamensis*, *Archidendron syringe*, *Anadenanthera peregrina*, *Albizia lebbeck*, *Acacia constricta* and *Acacia farnesiana*. In the literature, reports can be found on some biological activities, such as antiviral, antibacterial [18], antifungal [19], inflammatory [20,21], immunostimulatory [20,22], nociceptive [21], and antiproliferative/cytotoxic [23], suggesting important applications for these lectins in biomedicine. Lectins in general including those from this group can be dramatically different in their properties, structure and applications.

Considering the number of taxa belonging to the subfamily Mimosoideae and the importance of their lectins, this review aims to present an overview of the available literature reporting on purification, structure, and biological activities.

2. Purification and physicochemical properties of Mimosoideae lectins

Hemagglutination activity in genera of the Mimosoideae subfamily was first detected in the genus *Acacia*. The first studies were controversial. In 1952, Cazal and Lalaurie [24] investigated 22 species and found no lectin activity. However, in 1971, Toms and Western [25] found that 5 species had positive activity out of 73 investigated species. Two of these species, *Acacia auriculiformis* and *Acacia podalyriaefolia*, were found to have a positive result in the 1952 work, but not in the 1971 work. In 1981, Hapner and Jermyn [26] detected activity in 20 Acacia spp. (*A. aneura*, *A. armata*, *A. baileyana*, *A. botrycephala*, *A. cowleana*, *A. cultriformis*, *A. decurrans*, *A. drummondii*, *A. elata*, *A. farnesiana*, *A. gilberti*, *A. homalophylla*, *A. longifolia*, *A. mearnsii*, *A. melanoxylan*, *A. penladenia*, *A. podalyriaefolia*, *A. pycnantha*, *A. sieberiana* and *A. saligna*). Hemagglutinating activities were detected from concentrated extracts of seeds, and all had the same hemagglutination profile against human red cells, mainly against type O. The activities were strongly inhibited by *N*-acetyl-D-galactosamine and weakly by D-galactose. The activity was not affected by treatment with EDTA and has not increased in the presence of manganese, calcium and/or magnesium, demonstrating that these lectins are not metalloproteins. Heating up the sample for 30 min at 55 °C was enough to abolish lectin activity.

It wasn't until 2004 that more Acacia lectins were purified. Guzmán-Partida and collaborators (2004) purified 3 isolectins (VL1, VL2 and VL3) from the *Acacia constricta* seed extract using two chromatographic steps, one affinity step using a fetuin-fractogel column, followed by a cation exchange step using HiTrap SP HP [27,28]. These isolectins showed an isoelectric point between 5.5 and 8.4 and an electrophoretic band of 34 kDa in SDS-PAGE in the presence of β-mercaptoethanol. In addition, molecular exclusion chromatography demonstrated that VL isolectins are a homotetramer of 133 kDa in solution, and the Dubois assay indicated that they had a sugar content of 7.5%. VLs were able to agglutinate ABO erythrocytes, but no monosaccharide or disaccharide was able to inhibit its activity, only glycoproteins, such as thyroglobulin, fetuin and asialofetuin, demonstrating that these isolectins have a higher affinity for complex carbohydrates, different from what was observed in the tests of carbohydrate inhibition of the extracts from other

Fig. 1. Seeds of some species from plants of the Mimosoideae subfamily. A) *Parkia nitida*, B) *Parkia panurensis*, C) *Parkia plathycephala*, D) *Parkia multijuga*, E) *Leucaena* sp., F) *Acacia farnesiana*.

Acacia species [26,27]. In 2008, Santi-Gadelha and colleagues purified a lectin from seeds of *Acacia farnesiana*, called AFAL. AFAL was purified from the saline extract of seeds submitted to ion exchange chromatography (Mono-Q), followed by chromatofocalization. Unlike VL, AFAL does not agglutinate ABO erythrocytes, only rabbit erythrocytes. The electrophoretic profile of AFAL consisted of two bands of 50 kDa and 25 kDa, corresponding to their dimeric and monomeric forms, respectively, and presented an isoelectric point of 4.4, lower than that of VL. AFAL also presented a tetrameric form in solution, but its formation was time dependent. Using molecular exclusion experiments, it was observed that AFAL oligomerizes in a time-dependent manner, taking about 90 min to start forming the tetramer in solution. In addition, after lectin oligomerization, it adopts an affinity for chitin since it can interact in chromatographic columns of chitin. However, no chitoligosaccharide could inhibit AFAL hemagglutination activity, not in the short term and not even the ovomucoid glycoprotein rich in GlcNAc residues. Despite these results, the specificity of this lectin remains inconclusive [27,28].

The first detection of a Mimosoideae lectin was initiated in the *Acacia* genus, but the first purified lectin belonged to the Mimosa genus. The seed lectin of *Mimosa invisa* was purified in two steps using gel filtration on Biogel P100 and a preparative polyacrylamide gel electrophoresis. The lectin was glycosylated with about 21% of sugar content, which allowed its purification through a ConA-Sepharose matrix. It formed a tetramer in solution with a relative mass of 100 kDa, being formed by two α-subunits of 35 kDa and two β-subunits of 15 kDa. The lectin had optimal activity between pH 7 and 8. It was also thermostable and apparently not dependent on divalent cations. In addition, its cell-binding activity was not inhibited by any mono- or oligosaccharide, but it was able to isolate polysaccharides from *Rhizobium* cells [29].

Lectins of the *Parkia* genus are the most studied of the Mimosoideae subfamily with more published studies. In general, the process of purifying these lectins involves saline extraction, followed by precipitation with ammonium sulfate (0–60%), one to three chromatographic steps, depending on the lectin, which involves anion exchange chromatography, followed by affinity in Sephadex G-100 and Agarose/Sepharose-mannose columns, with some exceptions (Table 1). To date, seven *Parkia* hololectins have been purified and characterized from seeds of *Parkia javanica* (PJL) [30], *P. speciosa* (PSL) [31], *P. platycephala* (PPL-1) [32], *P. discolor* (PDL) [33], *P. biglandulosa* (PbiL) [34], *P. pendula* (PpeL) [35], *P. roxburghii* (PRL) [34], *P. biglobosa* (PBL) [21] and *P. panurensis* (PpaL) [36]. All lectins showed specificity for mannosides, mainly α-methyl-D-mannoside and glycosides, and could agglutinate rabbit erythrocytes, but not human erythrocytes. The hemagglutinating activity of these lectins reached its maximum at pH between 6 and 8, which could be maintained up to 60 °C. PJL, PSL and PBL did not seem to depend on divalent metals for activation; however, PbiL, PRL and PpaL did appear to be metalloproteins, as their activity was affected by treatment with EDTA. According to their electrophoretic profile, these lectins have heterogeneous patterns. PJL and PSL have a double band around 45–47 kDa. PPL, PBL and PpaL have a single band of 47 kDa, and PDL has a single band of 58 kDa. PbiL and PRL have four bands of 49, 44, 41 and 38 kDa. This heterogeneity continues in relation to the oligomerization of these proteins. The data from gel filtration or PAGE indicate that PJL and PSL present only as monomers in solution. PPL, PBL and PpaL form dimers, and PbiL and PRL form tetramers. In addition, only PbiL and PRL were shown to be glycosylated using the anthrone method with sugar content of 1.06% and 0.6%, respectively. Macedo and coworkers detected lectin activity in the globulins fraction from *P. nitida* and *P. multijuga* seeds, but no isolation and characterization studies were carried out [37,38]. A chimerolectin was also found in *Parkia platycephala* seeds and named PPL-2. Soluble proteins were extracted in an acidic solution which was then neutralized and submitted to precipitation with ammonium sulfate (0–60%). The protein was purified by affinity chromatography on a Red-Sepharose CL-6B and showed specificity for chitin, as well as chitinase activity. The electrophoretic profile of the lectin indicated a single band around 28 kDa [39].

In addition to the genera already presented, bioprospecting studies on other genera can be found, further demonstrating that Mimosoideae lectins are a very heterogeneous group. In 2011, Charungchitrak and colleagues purified a lectin from *Archidendron jiringa* seeds by aqueous extraction, followed by precipitation with ammonium sulfate (0–90%) and a chromatographic step using ConA-Sepharose column [19]. This is a very glycosylated lectin with 15.84% sugar content; therefore, it was possible to isolate it using ConA. This lectin was able to agglutinate different types of erythrocytes, reaching optimum activity at pH 8 and maintained up to 45 °C, in addition to its dependence on divalent cations. Regarding its electrophoretic pattern, it presented a band of 35.7 kDa. Also, in 2011, the Inglum group purified Leucocephalin, a *Leucaena leucocephala* seed lectin. The lectin was purified by anion-exchange chromatography on DEAE-Sephacel and demonstrated specificity to mannose [40]. In 2017, Procopio's group isolated a lectin from *Calliandra surinamensis*, called CasuL [23]. The lectin was isolated from a saline extraction of the leaves, followed by precipitation by ammonium sulfate (0–60%) and an affinity chromatographic step in Sephadex G-75. CasuL presented a relative mass of 48 kDa composed of three subunits of 27, 13 and 10 kDa. CasuL was able to agglutinate red blood cells of rabbits. This activity could not be inhibited by monosaccharides, but only by glycoproteins, such as ovalbumin, fetuin and bovine serum albumin. Thus, CasuL has an affinity for complex carbohydrates. In addition, the activity of CasuL was excellent in the pH range between 5 and 7 and remained stable until 100 °C.

Reports of lectin activity of crude extracts from seeds of *Anadenanthera peregrina* and *Albizia lebbeck* can also be found in the literature, but these studies need further investigation [41,42].

As seen, despite being lectins extracted from species of the same subfamily, their structural characteristics and specificities are diverse, which reflects in the different purification strategies that have been

Table 1
Summary of the purification strategies on *Parkia* lectins.

Lectin	Tissue	Extraction	Fractionation[a]	Chromatography
PSL	Seeds	KPi-NaCl buffer	Yes (20–70%)	Sephadex G-100
PJL	Seeds	KPi-NaCl buffer	Yes (0–60%)	1°. DEAE-cellulose 2°. Sephadex G-100
PPL-1	Seeds	Acetate-NaCl buffer	Yes (0–40%)	1°. Sephadex G-100 2°. Mannose-agarose
PDL	Seeds	Tris-HCl-NaCl buffer	No	Sephadex G-100
PbiL	Seeds	PBS buffer	Yes (20–40%)	Asialofetuin-linked amino activated silica beads
PRL	Seeds	PBS buffer	Yes (20–40%)	Asialofetuin-linked amino activated silica beads
PBL	Seeds	Acetate-NaCl buffer	Yes (0–60%)	Sephadex G-100
PpaL	Seeds	Acetate-NaCl buffer	Yes (0–60%)	1°. Sepharose-mannose 2°. DEAE-cellulose

[a] Ammonium sulfate fractionation.

presented, thus not having a common pattern of steps in their purification. This makes the study of these lectins a challenge. This is different from what is seen for other known group of lectins such as those from Dalbergieae tribe and Diocleinae subtribe, both belonging to the Papilionoideae subfamily [43,44]. Regarding the sugar-binding assays, there is a complete lack of sugar-binding energy studies, with their specificity being determined by hemagglutination inhibition assays, which do not give accurate information on thermodynamic or kinetic properties. Several lectins, examples being ConA, peanut agglutinin and soybean agglutinin have their affinity with several ligands obtained by isothermal titration calorimetry [45,46] which give reliable thermodynamic information about the binding. This highlights the need for a more detailed study for these proteins regarding their carbohydrate-binding properties.

3. Structural analysis of Mimosoideae lectins

The differences among Mimosoideae lectins are evident when these proteins are analyzed from a structural point of view. Although we have a diversity of already purified lectins from this subfamily, the few structural studies to this date include only lectins of the *Acacia* and *Parkia* genera, and these are shown to be remarkably distinct from one another.

Parkia platycephala glucose/mannose lectin (PPL-1) was the first of its genera to have its amino acid sequence elucidated. The primary structure is formed by 447 amino acid residues, and heterogeneity was found in three positions, $(I/V)_{70}$, $(K/R)_{227}$, and $(D/N)_{296}$, indicating that the mature lectin appears on the plant as a mixture of isolectins [47] (SwissProt accession code: P83304). The three-dimensional analysis revealed that the monomeric structure of PPL-1 is formed by three β-prism domains (pk domains), and each one has a non-identical mannose binding site with the participation of the following residues: Gly136, Tyr137, Tyr138, and Asp140 (site 1); Tyr283, Tyr284, and Asp286 (site 2); and Asp432 and Asp435 (site 3) [42] (PDB code: 1ZGR, 1ZGS). Each of these domains has approximately 45% similarity to all other domains and is related to the β-prism domain of jacalin. The quaternary structure of PPL-1 is stabilized as a dimer through the contact of the N-terminal and C-terminal of two β-prism domains of each monomer.

This same structure is conserved in *Parkia biglobosa* lectin. PBL has had its primary and tertiary structure elucidated, revealing it to be homologous to PPL-1 (PDB code: 4MQ0) [21,22]. In more recent work, the partial amino acid sequence of the lectin of *Parkia panurensis* was published, and it showed 97% similarity with the lectins PPL-1 and PBL. PPaL also presents itself as a mixture of isolectins with sequence heterogeneity found in positions $(G/S)_{21}$, $(V/X)_{35}$, $(A/G)_{49}$, $(X/R)_{71}$, $(X/V)_{217}$, $(D/N)_{226}$ and $(P/Y)_{227}$ [36]. The three-dimensional structures of PPL1 and PBL are shown in Fig. 2A and B respectively.

Contrary to the similarity among PPL-1, PBL and PPaL lectins, the *N*-acetylglucosamine-binding lectin of *Parkia platycephala* (PPL-2) is formed by 271 amino acid residues showing 6 cysteine residues conserved in class III chitinases. The three-dimensional structure is shaped like a barrel with 8 α-helices and 8 β-sheets (α_8/β_8), being stabilized by three disulfide bonds (Cys_{20}–Cys_{67}, Cys_{50}–Cys_{57} and Cys_{158}–Cys_{187}) and five cis-peptide bonds (PDB code: 2GSJ). The CRD of the chimerolectin, the binding-site responsible for its chitinase activity, is formed by Asp_{125}, Glu_{127}, Tyr_{182}, Asp_{125}, Glu_{127} and Tyr_{182} residues and is highly conserved among this class of enzymes (i.e., hevamine) [48]. The structure of PPL-2 is depicted in Fig. 2C.

In the *Acacia* genus, structural studies include the lectins of *Acacia farnesiana* (AFAL) and *Acacia constricta* (Vinorama isolectins). AFAL had its amino acid sequence elucidated in 2008 using mass spectrometry (SwissProt Code: P84849). The lectin is formed by 227 amino acid residues and showed similarity with lectins from the Phaseoleae tribe, i.e., 66% with PHA hemagglutinin. The metal-binding site is coordinated by residues Glu_{112}, Asp_{114}, Asp_{122} and His_{127} (for Mn^{2+} ion) and Asp_{114},

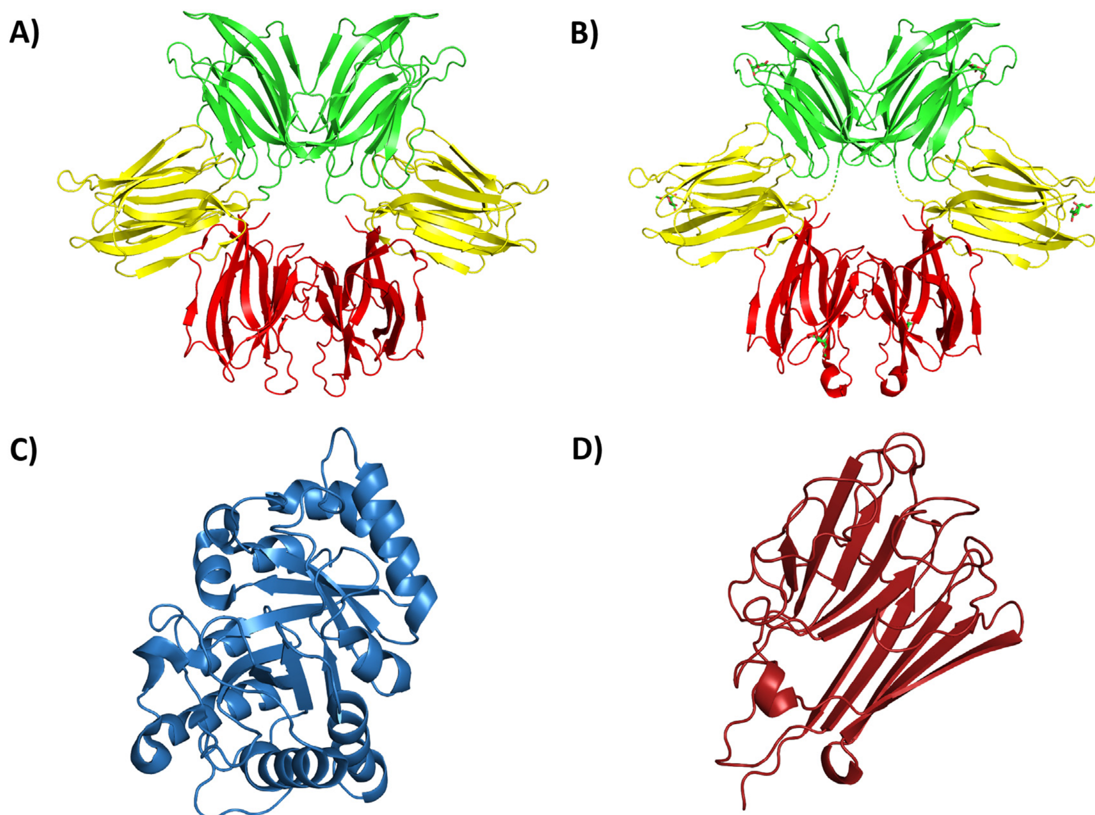

Fig. 2. Three-dimensional structure representations of Mimosoideae lectins. A) *Parkia platycephala* lectin 1, B) *Parkia biglobosa* lectin 1, C) *Parkia platycephala* lectin 2 and D) *Acacia farnesiana* modeled structure.

Tyr_{117}, Asn_{118}, and Asp_{122} coordinating the Ca^{2+} ion. The Phe_{06}, Asn_{07}, Glu_{08}, Val_{19}, and Glu_{185} residues make up the carbohydrate-binding site. All these residues are conserved and similar to PHA lectins [28,49].

The three-dimensional structure of AFAL was modeled in silico using the A chain of *Pisum sativum* lectin as template (42% of sequence identity, PDB code: 2BQP). The structure presented a folding common to legume lectins, i.e., β-sandwich with three β-sheet domains: a frontal one, a posterior one, and another positioned at the side [50]. The model of AFAL is depicted in Fig. 2D.

The *Acacia constricta* lectin has approximately 34 kDa, and its primary structure was partially sequenced with the presence of 4 isolectins (VL1–VL4). The N-terminal of Vinorama isolectins is 87.5% homologous to AFAL, also presenting sequence homology with PHA [27,50]. Structural data of lectins are quite important to correlate with its functions and give these molecules several applications [51,52].

4. Biological effects and activities of Mimosoideae lectins

Despite the relatively few works reporting on the biological activities of Mimosoideae lectins, tested activities indicate variability, including, for example, antiviral, antibacterial, antifungal, inflammatory, nociceptive, immunostimulatory, and antiproliferative.

Antibacterial/bacteriostatic effects are one of the most evaluated for this lectin group. The lectins from *Acacia farnesiana* (AfaL), *Archidendron jiringa* (AJL), *Calliandra surinamensis* (CasuL) and *Parkia platycephalla* 2 (PPL2) have been tested for their effects against bacteria [18,19,23,53]. In all cases, some degree of antibacterial or bacteriostatic activities were observed, albeit with significant differences in effect for Gram-positive and Gram-negative bacteria suggested to be caused by the difference in glycans on the cell surface. In addition, it was verified that AfaL induced membrane damage on the cells and that CasuL severely impaired biofilm formation. Santi-Gadelha and colleagues also verified that AfaL slightly interfered with egg hatching and motility of *Meloidodyne incognita* nematode, and Charungchitrak et al. verified that AJL strongly inhibits the growth of three plant fungi.

The lectin extracted from the seeds of *Parkia platycephala* (PPL) and *Parkia biglobosa* (PBL) showed antinociceptive and anti-inflammatory activity. PPL at a concentration of 1 mg/kg reduced by 74% (8.7 ± 2.2) the number of contortions (associated with nociception) induced by acetic acid (33.1 ± 4.2) in mice. For anti-inflammatory activity, PPL at this same concentration (1 mg/kg) reduced by 73% ($3.80 \pm 0.39 \times 10^3$ cells/mL vs. $1.00 \pm 0.12 \times 10^3$ cells/mL) leukocyte migration and by 89% ($2.66 \pm 0.3 \times 10^3$ cells/mL vs. PPL: $0.29 \pm 0.02 \times 10^3$ cells/mL) neutrophil migration induced by the indirect chemoattractive agent acetic acid. Meanwhile, PBL at 1 mg/kg concentration reduced by 58% the number of contortions (48.13 ± 4.1 vs. 20.00 ± 2.9) induced by acetic acid. When induced by the direct chemoattractant N-formylmethionyl-leucyl-phenylalanine (fMLF), PBL (1 mg/kg) reduced leukocyte migration by 71% and neutrophil migration by 94% [21,22]. It can be speculated that the reduction of the nociceptive response through the inhibition of contortion numbers may be associated with inhibition of the inflammatory process through blocking or drastic reduction in the release of the chemosensitive inflammatory mediators. The difference in values in relation to efficacy and potency between PPL and PBL can be related to the difference in the CRD conformation of these proteins.

Abrantes et al. [50] demonstrated that *Acacia farnesiana* lectin (AFAL) has anti-inflammatory activity when administered intravenously, reducing neutrophil migration to the peritoneal cavity, as well as reducing carrageenan-induced vascular permeability. The anti-inflammatory process of lectins is usually related to the ability of these proteins to recognize carbohydrates, although the mechanism is not yet well understood. It is suggested that AFAL presents a mechanism different from the other legume lectins because it has a carrageenan recognition site independent of the carbohydrate recognition site. The presence of two independent recognition sites in AFAL allows the improvement of the body's defense mechanism and simultaneously preserves its binding to carbohydrates.

A few works report the effect of these lectins on cancer. Procópio et al. [23] report the cytotoxicity of CasuL to K562 leukemia cell line and T47D breast cancer cell line with IC50 of $67.04 + 5.78$ and $58.75 + 2.5$ μg/mL, respectively. A work from Kaur and colleagues [34] reports the effect of two *Parkia* lectins against lymphoma and hybridoma murine cell lines with proliferation inhibition up to 68.21%. A third work in anticancer research was published by Inglum et al. (2011) [40], showing the antimutagenic potential of Leucophalin, a lectin from *Leucaena leucocephala*, against the mutagenic agent Trp-P-1.

These works suggest that the biological effects are mostly related to the capacity of the lectin to interact with glycans on the receptors located on the cell surface which is also showed for other lectins [54–58], although a specific mechanism was not studied.

In addition to the above said, Among the numerous interactions of carbohydrates and hydrophilic molecules conferred to lectins, there is also the importance of the recognition of hydrophobic molecules, which interact at specific sites that, in most cases, do not interfere with the carbohydrate recognition site, leading to an increase in the versatility of applications of these proteins [59]. The hydrophobic site of lectins was first described by Yang, Gall and Edelman [59,60], showing the interaction of ConA with a fluorescent probe TNS (2-p-toluidinonephthalene-6-sulfonate). Some legumes lectins show affinity for certain hydrophobic molecules, such as resveratrol [61], hydrophobic sugars [62], (indolacetic acid — IAA), alpha aminobutyric acid [63], and gamma-aminobutyric acid [51] among others. Other molecules such as adenines and porphyrins can also be mentioned as relevant in this context. Bean lectins (LBL) and *Dolichos biflorus*, for example, have several adenine-binding sites and, according to recent studies, these sites could suggest a physiological action for plant lectins [64]. Porphyrins, in turn, can act to increase the efficiency of lectins as possible biomarkers due to their clinical potential through photodynamic therapy, as well as a possible antimicrobial agent [59]. Specifically, for Mimosoideae lectins, there are no complete papers reporting interactions of lectins with hydrophobic ligands, leading to a greater need for studies in this area, considering that the specific hydrophobic binding sites in lectins can present themselves as an opportunity to expand activities conferred on them.

5. Conclusion

It is clear that lectins from the Mimosoideae subfamily have received substantially less attention than those from the Papilionoideae subfamily. Data in the literature show that these lectins are highly diverse with respect to their physicochemical properties, structural data and even biological activities. So far, however, the data is only preliminary, thus needing further investigation. To the best of our knowledge, this is the first review of its kind summarizing Mimosoideae lectins in a manner that should stimulate more research on this very heterogeneous subfamily.

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