PHARMACIA

Pharmacia 70(3): 699–706
DOI 10.3897/pharmacia.70.e101537

Research Article

Identification of potential molecular target of hypertension from *Allium schoenoprasum* by using network pharmacology and molecular docking strategies

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Received 6 February 2023 ♦ **Accepted** 9 May 2023 ♦ **Published** 31 August 2023

Citation: Trias Pradana A, Haro G, Marbun N, Rahmi S, Iksen I (2023) Identification of potential molecular target of hypertension from *Allium schoenoprasum* by using network pharmacology and molecular docking strategies. Pharmacia 70(3): 699–706. https://doi.org/10.3897/pharmacia.70.e101537

Abstract

Hypertension is one of the silent killers in human life which is characterized by uncontrolled blood pressure. Although many therapeutic drugs have demonstrated success in treating hypertension, these treatments have their own drawbacks, most notably in terms of cost and side effects. Hypertension treatment with natural products has lately been proposed. This study focused on the potential of *Allium schoenoprasum* against hypertension based on network pharmacology and molecular docking strategies. Interested compounds and targets were identified by searching accessible databases. Protein-protein interaction (PPI), Gene ontology (GO), and Kyoto encyclopedia of genes and genomes (KEGG) were conducted to determine the potential targets from *Allium schoenoprasum*. In this study, 10 potentially active compounds were obtained. PPI results showed SCR, STAT3, PIK3R1, CTNBB1, and ESR1 as the main targets of hypertension. GO and KEGG investigation confirmed the PPI targets are mainly involved in protein binding and catalytic in the membrane and cytoplasm. In the end, by using molecular docking, kaempferol, isorhamnetin, and quercetin showed the most potent compounds in *Allium schoenoprasum* against hypertension. In summary, *Allium schoenoprasum* exhibited antihypertensive activity via network pharmacology and molecular docking approaches.

Keywords

Hypertension, *Allium schoenoprasum* L., network pharmacology, molecular docking

Introduction

One of the diseases that is one of the most dangerous to human health and has a high incidence rate all over the world is hypertension. The number of people who have been diagnosed with hypertension continues to rise on an annual basis, and it is anticipated that the number of people who have been diagnosed with hypertension will reach almost 2 billion by the year 2025 (Mills et al. 2020). A relatively small percentage of patients with hypertension can have their condition properly managed once the disease has already manifested itself. Hypertension is harmful

because it increases the risk of developing cardiovascular disease, heart attack, stroke, kidney disease, intracerebral hemorrhage, end-stage organ injury, and a variety of secondary diseases (Wajngarten and Silva 2019). These diseases pose a significant risk to the lives of patients and have a significant impact on the patient's ability to survive and live (Buonacera et al. 2019). As for the side effects of hypertension, the research and development of drugs that can cure hypertension are of the utmost significance.

Improvements in lifestyle and medication both play a role in hypertension treatment. The use of antihypertensive medication, which may also be combined with changes to one's diet and way of life, has been shown to significantly lower blood pressure and heart rate, which in turn reduces the risk of cardiovascular disease and mortality (Al-Makki et al. 2022). These medications come with a number of drawbacks, the most notable of which is their adverse effects, high prices, and limited availability in certain regions of developing nations (Kumbhare et al. 2014). The search for novel pharmaceuticals, particularly those derived from natural products, is the significant importance for the development of treatments that are more effective and more tolerated by patients (Jung et al. 2018).

The medicinal plant *Allium schoenoprasum*, which was used in this study, is a member of the Amaryllidaceae family and may be found growing in large quantities throughout Asia, Europe, and North America (Haro et al. 2017). The culinary uses of this plant are its primary market (Sinaga et al. 2018). Anticancer, antioxidant, antibacterial, antilithogenic, antiviral, and vasodilator actions were among the many pharmacological effects seen in *Allium schoenoprasum* (Haro et al. 2017; Sinaga et al. 2018; Islamie et al. 2022). Several reports showed that organosulfur compounds from the *Allium* species such as diallyl disulfide downregulated intercellular adhesion molecule-1 and matrix metalloproteinase-9 and blocked the inactivation of endothelial nitric oxide synthase (eNOS), both of which have been shown to alleviate hypertension (Song et al. 2021). In addition to organosulfur, it has been shown that *Allium schoenoprasum* contains several flavonoids that possess antihypertensive properties. Gallic acid, for instance, reduces systolic blood pressure and suppresses oxidative stress in rats with hypertension (Jin et al. 2017). According to Yu et al (2022), p-Coumaric acid, Ferulic acid, and Sinapic acid all work to lower ACE levels, which is how they exert their antihypertensive effects. Several studies concluded that people suffering from hypertension whose diets contained quercetin and kaempferol experienced a reduction in their blood pressure (Dabeek and Marra 2019). According to Chang et al. (2020) research, another form of flavonoid called isorhamnetin has the potential to inhibit protein expression of TNF- α and IL-6 in an in vivo study.

With so many different pharmacological mechanisms at play, it can be challenging to develop and improve upon solutions that make use of natural resources because these solutions tend to have several targets and pathways (Sinaga et al. 2019). The use of network pharmacology and molecular docking has been proposed as a solution to the problem and a means of increasing the likelihood that new medications will be discovered (Iksen et al. 2022; Iksen et al. 2023). Drugs, protein targets, illnesses, genes, and other factors can all be studied in detail by using pharmacological networks. This conforms to the fundamental principle of traditional medical treatment, whereas targets acquired using network pharmacology can be validated via molecular docking (Iksen et al. 2023). This study was carried out to evaluate the potential targets and mechanisms of *Allium schoenoprasum* against hypertension by using network pharmacology and molecular docking techniques, which might become a promising novel treatment.

Materials and methods

Compounds screening

The information on all possible active compounds of *Allium schoenoprasum* was obtained by inserting the keyword *Allium schoenoprasum* from the online database of KNApSAcK Family Databases (http://www.knapsack-family.com/KNApSAcK/) and our previous report (Iksen and Buana 2022). All the possible compounds were then screened according to the Lipinski rule violation = 0 and bioavailability score > 0.3.

Targets screening

Possible targets from the active compounds were obtained from the Swiss Target Prediction database (http://www.swisstargetprediction.ch/) by inserting the SMILE code from each compound into the system. The hypertension-related targets were obtained from the GeneCards database (https://www.genecards.org/). Venny 2.1.0 was used to identify the overlapping targets obtained from the compounds and hypertension-related targets which were then defined as the potential therapeutic targets for *Allium schoenoprasum* to combat hypertension (https://bioinfogp.cnb.csic.es/tools/venny/).

Construction of protein-protein interaction network

Firstly, to visualize how is the interaction network between each target protein, we used the STRING database (https://string-db.org/) by inputting the targets we obtained from the Venny diagram before and downloaded the possible PPI network by choosing Homo sapiens as the model with the highest confidence score of 0.9. Then we continue to analyze the PPI network by using Cytoscape 3.9.1 (https://cytoscape.org/). In this program, from all of the PPI networks, we need to analyze which target protein is the most important by seeing several parameters provided by STRING and Cytoscape. Next, by using an additional CytoHubba plug-in, we can visualize the top 5 most important targets by using the color gradients obtained from previous results we obtained from STRING and Cytoscape.

Identification of Gene Ontology and Kyoto Encyclopedia of Genes and Genomes

Analysis of gene ontology was conducted the in the aspect of biological process, molecular function, and cellular components. Kyoto Encyclopedia of Genes and Genomes (https://www.genome.jp/kegg/) pathway enrichment analysis was conducted to obtain the possible pathway related to the treatment of *Allium schoenoprasum* in hypertension disease. All the data were analyzed by using RStudio with a ggplot2 plug-in as the bubble plot (Islamie et al. 2022).

Molecular docking investigation

The possible interaction between active compounds from *Allium schoenoprasum* and the top 5 targets was conducted by using PyRx 0.8 Virtual Screening (https://pyrx.sourceforge.io/). Each protein target was obtained from the Protein Data Bank (https://www.rcsb.org/pages/policies) with the PDB ID 3F3V, 6NJS, 2IUG, 1JDH, 7UJO respectively for Proto-oncogene c-Src (SRC), Signal transducer and activator of transcription 3 (STAT3), Phosphoinositide-3-Kinase Regulatory Subunit 1 (PIK3R1), Catenin beta-1 (CTNBB1), and Estrogen receptor 1 (ESR1). All proteins were prepared by using PyMol 2.5 (https://pymol.org/2/) in the format of PDB by removing the water molecules and specific ligands (Iksen et al. 2022). The binding energy (kcal/mol) was obtained and recorded.

Results

Active compound and target screening

The potential active compounds from *Allium schoenoprasum* were obtained from our previous report (Iksen and Buana 2022) and the KNApSAcK family database led us to identify 13 compounds in *Allium schoenoprasum* that show promise in terms of basic pharmacokinetics (Table 1). No compounds had a bioavailability score lower than 0.3 and none of them violated Lipinski's rule. From 13 compounds, we conducted the potential target prediction by using Swiss Target prediction and it was found that only 10 compounds (Fig. 1A) had targets namely Diallyl disulfide, 2-Methyl-2-pentenal, Tiglaldehyde, Gallic acid, p-Coumaric acid, Ferulic acid, Sinapic acid, Kaempferol, Isorhamnetin, and Quercetin. Interestingly, all of those 10 compounds had a total of 201 potential targets. Next, from the GeneCards database, we obtained around 7174 potential hypertension-related targets. As shown in Fig. 1B, 168 overlapping targets were filtered out as the potential target of *Allium schoenoprasum* for the treatment of hypertension.

Table 1. The main compounds information from *Allium schoenoprasum* and Lipinski's rule.

Molecule	MW	Rotatable bonds	H-bond acceptors	H-bond donors	Molar refractivity	TPSA	Log P	Lipinski violations	Bioavailability score
Diallyl disulfide	146.27	5	0	0	45.19	50.6	2.49	0	0.55
2-Methyl-2-pentenal	98.14	2	1	0	30.68	17.07	1.71	0	0.55
Methyl propyl disulfide	122.25	3	0	0	36.52	50.6	2.19	0	0.55
Methyl pentyl disulfide	150.31	5	0	0	46.14	50.6	2.66	0	0.55
1-Pentanesulfenothioic acid	136.28	4	0	0	41.67	64.1	2.37	0	0.55
Tiglaldehyde	84.12	1	1	0	25.87	17.07	1.47	0	0.55
Gallic acid	170.12	1	5	4	39.47	97.99	0.21	0	0.56
p-Coumaric acid	164.16	2	3	2	45.13	57.53	0.95	0	0.85
Ferulic acid	194.18	3	4	2	51.63	66.76	1.62	0	0.85
Sinapic acid	224.21	4	5	2	58.12	75.99	1.63	0	0.56
Kaempferol	286.24	1	6	4	76.01	111.13	1.7	0	0.55
Isorhamnetin	316.26	2	7	4	82.5	120.36	2.35	0	0.55
Quercetin	302.24	1	7	5	78.03	131.36	1.63	0	0.55

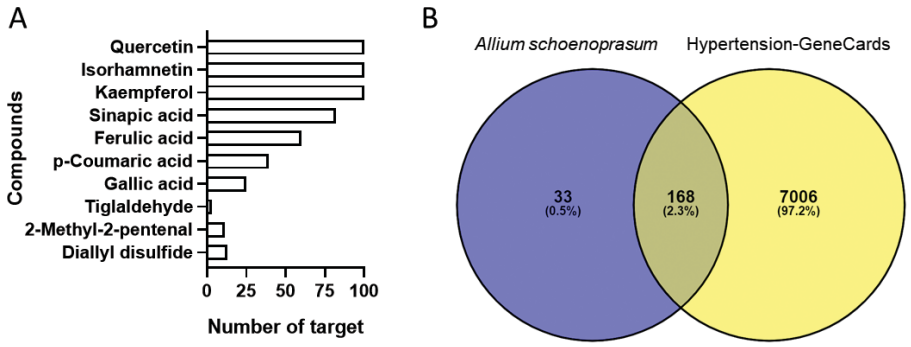

Figure 1. The number of potential targets for each compound from *Allium schoenoprasum* against hypertension. **A.** Each compound consists of at least 3 potential targets against hypertension obtained from the Swiss target prediction database; **B.** Venny diagram showing 168 intercepting targets between main compounds from *Allium schoenoprasum* against hypertension. The yellow color represents hypertensive-related targets, and the blue represents targets from *Allium schoenoprasum*.

Compound-target interaction network

To visualize the interaction network between the potential targets from *Allium schoenoprasum* and the majority compound, we construct the compound-target network (Fig. 2). The PPI network reveals the interaction among the targets with more interacting lines between proteins representing highly connected proteins in the network which was constructed using the Cytoscape 3.9.1 software. The orange diamond and purple ellipse represent active compounds from *Allium schoenoprasum* and hypertension targets.

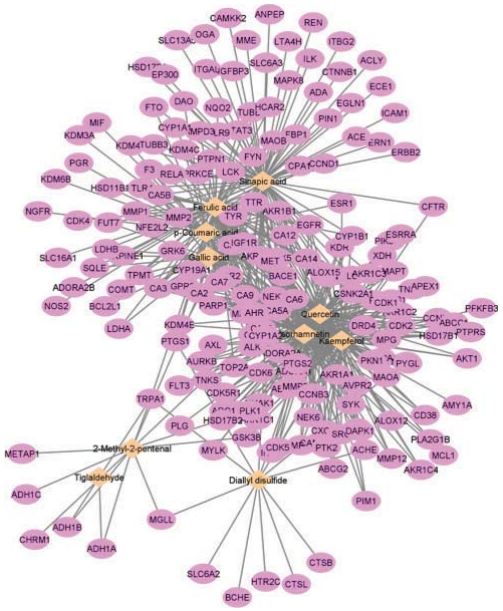

Figure 2. The compound-targets interaction network. The purple oval represents the targets, while the cream diamond represents the main compounds in *Allium schoenoprasum*.

Protein-protein interaction network

Interactions between proteins are a common mechanism by which proteins exert control of physiological processes. We used STRING 11.5 to construct a protein-protein interaction network (Fig. 3A) and search for 168 target proteins involved in the treatment of hypertension in order to better understand its function and mechanism at the protein level. Following the completion of the topology analysis on the protein-protein interaction network, it was discovered that the network has a total of 331 edges and 168 nodes. In addition to this, the average node degree is 3.94, the average local clustering coefficient is 0.441, and the PPI enrichment p-value is $< 1.0e^{-16}$. Fig. 3B showed the main protein cluster and the findings from each node in the PPI network underwent additional analysis by utilizing the CytoHubba plug-in according to the number of degrees, which subsequently led to the identification of 5 top targets derived from *Allium schoenoprasum*. The interaction between the top 5 targets was shown in Fig. 3C, with the SRC having the highest degree of involvement, followed by STAT3, PIK3R1, CTNNB1, and ESR1 respectively.

GO and KEGG enrichment analysis

Gene ontology and Kyoto Encyclopedia of Genes and Genomes pathway enrichment analyses were carried out with the assistance of RStudio in order to further assess and acquire a better understanding of the molecular mechanism that the compounds-targets have on hypertension. These possible target genes were subjected to three different kinds of gene ontology functional annotation assessments. These analyses comprised the biological process (Fig. 4A), the molecular function (Fig. 4B), and the cellular component (Fig. 4C). The analysis results as shown in Fig. 4, the images show only the top 10 related functions. The gene ontology of biological processes was mainly involved in the metabolic process and cellular responses in several behaviors of cells. Gene ontology of molecular function showed that protein binding and catalytic activity on a protein are the main activities related to the targets. The gene ontology of the cellular component showed that the targets were mainly distributed in the cytoplasm region. Similar to gene ontology, the pathway enrichment analysis using the KEGG method only shows the top 10 pathways involved in the mechanism of *Allium schoenoprasum* against hypertension. The KEGG pathways are shown in Fig. 4D, which mainly focused on the pathways in cancer, metabolic pathways, nitrogen metabolism, HIF-1 signaling pathway, PI3K-Akt signaling pathway, proteoglycans in cancer, AGE-RAGE signaling pathway in diabetic complications, endocrine resistance, microRNAs in cancer, and measles.

Molecular docking

The protein-protein interaction analysis showed that the targets SRC, STAT3, PIK3R1, CTNNB1, and ESR1 were the most important target hub in the network. We conducted further analysis by using PDB ID 3F3V, 6NJS, 2IUG, 1JDH, and 7UJO respectively for SRC, STAT3, PIK3R1, CTNNB1, and ESR1 obtained from the protein data bank and performed the molecular docking analysis to confirm the possibility of interaction between the compounds and target protein. The outcome of the docking affinity is reported in Table 2, and it is generally agreed upon that the lower the binding energy, the greater the likelihood that it will bond. In general, kaempferol, isorhamnetin, and quercetin showed the best binding energy to all 5 targets. However, some compounds showed binding energy higher than -5 kcal/mol which means they might not interact well with the targets and form less stable complexes with the targets (Syahputra et al. 2022), for example, diallyl disulfide, 2-Methyl-2-pentenal, and tiglaldehyde.

Discussion

Hypertension is a condition that occurs when a person's systolic blood pressure increases by more than 140 mmHg and the diastolic blood pressure increases by more than 90 mmHg. This condition is one of the silent killers (Mills

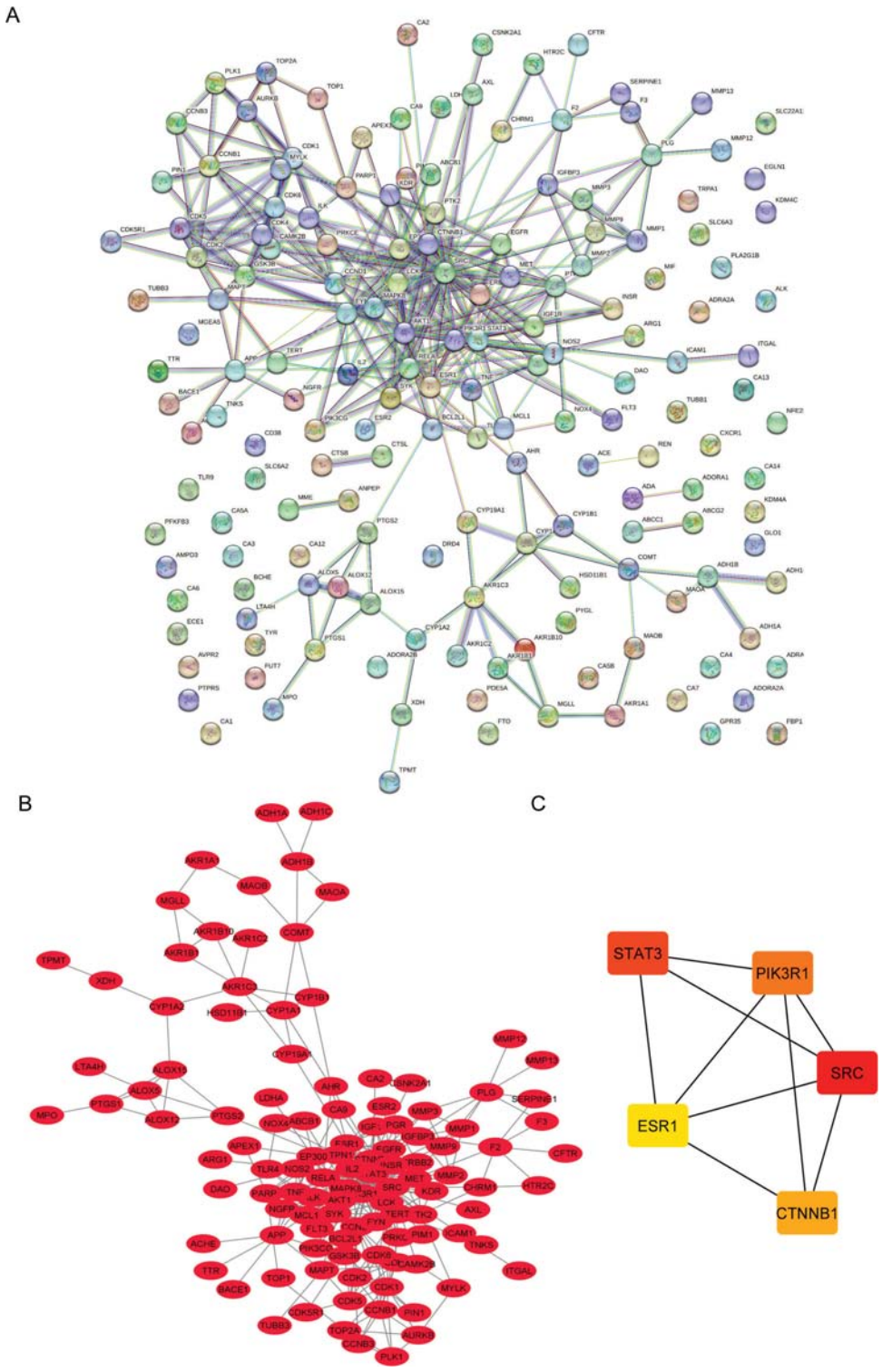

Figure 3. Protein-protein interaction network. **A.** The main protein-protein interaction was obtained from 168 potential targets; **B.** The main cluster of protein-protein interaction; **C.** Top 5 targets from the protein-protein interaction network.

et al. 2020). The major medical condition known as hypertension dramatically raises the likelihood of developing a variety of diseases, including those affecting the kidneys, the brain, and the heart (Wu et al. 2015). At the moment, the gold standard treatment for hypertension is a dietary modification that involves cutting back on salt consumption and alcohol intake. Additional pharmacological therapies, such as angiotensin-converting enzyme inhibitors, angiotensin receptor blockers, calcium channel blockers, diuretics, alpha-blockers, and beta-blockers, can be used

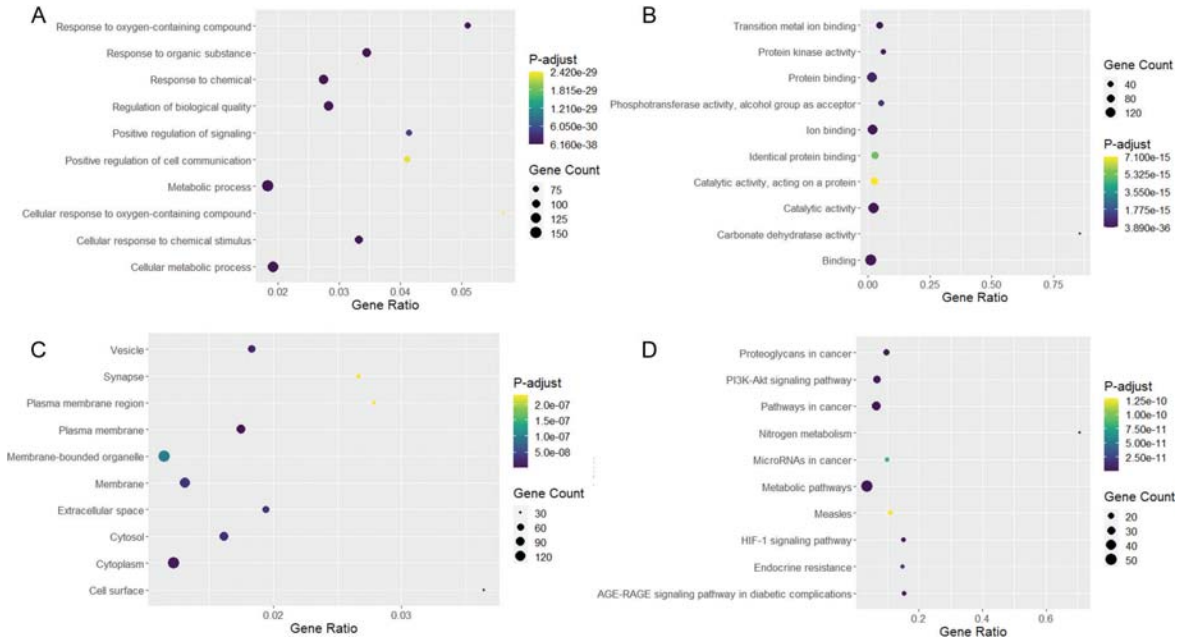

Figure 4. Gene Ontology and Kyoto Encyclopedia of Genes and Genomes enrichment analysis. **A.** Biological process; **B.** Molecular function; **C.** Cellular component; **D.** KEGG pathway.

Table 2. Binding energy (kcal/mol) of active compounds in *Allium schoenoprasum* and main targets.

Compounds	Binding energy (kcal/mol)				
	SRC	STAT3	PIK3R1	CTNNB1	ESR1
Diallyl disulfide	-3.9	-3.2	-3.3	-3.4	-3.8
2-Methyl-2-pentenal	-4.1	-4.1	-4.3	-3.8	-4.5
Tiglaldehyde	-3.8	-3.8	-3.9	-3.6	-4
Gallic acid	-5.6	-5.2	-5.1	-5.4	-6.4
p-Coumaric acid	-6.2	-5.5	-5.3	-5.6	-6.1
Ferulic acid	-6.4	-5.8	-5.1	-5.5	-6.2
Sinapic acid	-6.3	-6	-4.8	-5.3	-6.2
Kaempferol	-9.2	-7.2	-5.8	-7.5	-7.7
Isorhamnetin	-9.5	-7.3	-5.8	-6.5	-7.6
Quercetin	-9.4	-7.5	-5.9	-7.8	-7.5
Dasatinib (SRC inhibitor)	-8.4	-	-	-	-
Napabucasin (STAT3 inhibitor)	-	-6.6	-	-	-
LY294002 (PI3K inhibitor)	-	-	-6.4	-	-
MSAB (Beta catenin inhibitor)	-	-	-	-6.5	-
Elacestrant (ESR inhibitor)	-	-	-	-	-6.1

singly or in combination to treat hypertension (Carey et al. 2022). However, despite the availability of several antihypertensive treatment options, there are still some issues to be concerned about. These issues include the potential adverse effects of the medications as well as their prohibitively expensive costs, both of which cause patients to be unable to purchase them, negatively impacting both their chances of surviving and the quality of their lives. As a result, the research and development of drugs that can cure hypertension are of the utmost significance.

It is indisputable that traditional medicine can be applied to prevent or cure a diverse range of complex illnesses, and it also provides a feasible source for the identification of further candidate drugs for managing hypertension (Kamyab et al. 2021). In the treatment of hypertension in particular, the rising fields of network pharmacology and molecular docking offer a cutting-edge method as well as an excellent instrument for figuring out the biological foundation of conventional medication which can be very beneficial for the discovery of new antihypertensive drugs (Zhai et al. 2021). Traditional medicine is known for having multiple components, multiple targets, and multiple pathways (Islamie et al. 2022). As a result, it would take a significant amount of time and resources to investigate the effects and mechanisms of traditional medicine and its pharmacological activities. This presents a significant barrier to the widespread acceptance and use of traditional medicine in clinical settings.

Using data mining, we first identified 13 compounds from *Allium schoenoprasum* that might be useful in treating hypertension in this investigation. We also integrated hypertension-related targets from the GeneCards database into the screening process, narrowing the pool of candidate targets down to only 10, from a total of 168. The investigation of protein-protein interactions provides an in-depth understanding of the network of interactions between drugs and their targets. According to the findings of network pharmacology and PPI analysis, there are five primary targets in *Allium schoenoprasum* that are effective against hypertension. These targets include SRC, STAT3, PIK3R1, CTNNB1, and ESR1. Inhibition of SRC has been shown in previous research to result in a reduction in blood pressure as well as improvements in cardiac and vascular function (Callera et al. 2016). In line with the findings of the previous study, blocking the SRC signaling pathway may improve the function of the vascular smooth muscle, hence reducing the risk of

hypercontraction (Camargo et al. 2022). In the meantime, STAT3 is an essential component that plays a role in preventing excessive hypertension from damaging the heart. In hypertension hearts, a lack of STAT3 may decrease cardiac function due to faulty myofibrillar structure and remodeling, which may eventually result in heart failure (Zouein et al. 2013). In addition, it has been demonstrated that the gene PIK3R1, which encoded the p85 form of PI3K signaling, is closely associated with hypertension. PI3K signaling, which is one of the primary signaling regulators inside the cells, can govern apoptosis and inflammation, as well as influence the creation of nitric oxide and glucose metabolism, which can result in hypertension that is out of control (Iksen et al. 2021; Zhang et al. 2022). Meanwhile, various hypertension agents, including angiotensinogen, angiotensin-1-converting enzyme, renin, angiotensin I, and angiotensin II, are transcribed via the beta-catenin transcription factor, which is encoded by the human CTNNB1 gene (Zhou et al. 2015; Xiao et al. 2019). By facilitating nitric oxide bioavailability via the suppression of oxidative stress, ESR1 has a role in the vasodilation of blood vessels, which contributes to the reduction of blood pressure (Favre et al 2021).

A comprehensive Gene ontology and Kyoto encyclopedia of genes and genomes pathway enrichment analysis revealed that these targets are mostly involved in protein binding in the membrane and cytoplasm. The findings from the KEGG pathway enrichment study provide further credence to this interpretation. To confirm the results obtained from the network pharmacology, we conducted molecular docking against the top 5 targets from hypertension. Molecular docking analysis results corroborated the preceding findings, showing that the target proteins and the active ingredients in *Allium schoenoprasum* interact closely, providing proof of the binding between the active ingredients and the target protein. The results of the molecular docking study showed that the active components of *Allium schoenoprasum* had a strong ability to bind with these essential targets. This finding suggests that the active components of *Allium schoenoprasum* function regulate numerous targets at the same time, rather than a single target agent. However, our works have some limitations, especially in data mining. Additional study is required to determine the precise antihypertensive mechanisms that are at work when *Allium schoenoprasum* is administered. In the future, we intend to carry out additional research utilizing an in vivo model while making use of extract from *Allium schoenoprasum*.

Conclusions

Network pharmacology and molecular docking were used to investigate the hypertension-treating mechanism of *Allium schoenoprasum*. According to the protein-protein interaction network study, *Allium schoenoprasum*'s active components may target SCR, STAT3, PIK3R1, CTNNB1, and ESR1 to treat hypertension. Gene ontology functional enrichment analysis and KEGG pathway enrichment analysis showed that the target largely bound and catalyzed proteins in the cell's membrane and cytoplasm. Kaempferol, isorhamnetin, and quercetin are the most potential antihypertensive components from *Allium schoenoprasum*, according to molecular docking.

Acknowledgments

The authors wish to express their thanks for the full support from the Faculty of Pharmacy University of Surabaya, Faculty of Pharmacy Universitas Sumatera Utara, and Sekolah Tinggi Ilmu Kesehatan Senior Medan. We also expressed our gratitude to Prof. Ginda Haro, Ph.D. for the guidance and resources for data mining.

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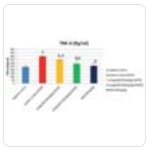

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Yousif Hashim Mohammed, Ali Faris Hassan

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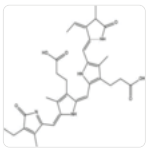

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Potential combined effect of *Spirulina platensis* and *Momordica charantia* fruits on attenuation of isoproterenol-induced myocardial infarction in rats: identification and prediction its mechanism

Gayuk Kalih Prasesti, Kusnandar Anggadiredja, Neng Fisheri Kurniati

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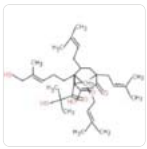

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Ivelin Iliev, Svetlana Georgieva, Yoana Sotirova, Velichka Andonova

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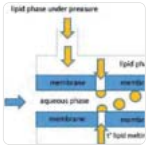

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Technological strategies for the preparation of lipid nanoparticles: an updated review

Stefan Stefanov, Viliana Gugleva, Velichka Andonova

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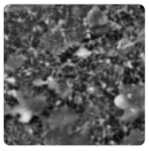

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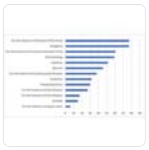

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Elizaveta Kovtun, Alina Volkova

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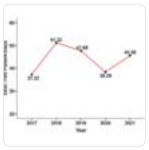

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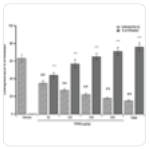

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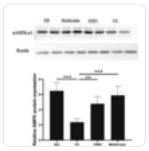

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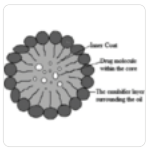

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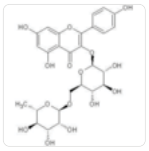

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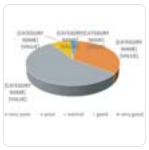

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Assessment of patients' awareness on drugs use and adherence to drug therapy as an element of Medication Review service

Galina Petrova, Anna Todorova, Tihomir Georgiev, Elina Petkova-Gueorguieva, Anna Mihaylova, Lily Peikova, Stefan Balkanski, Stanislav Gueorguiev

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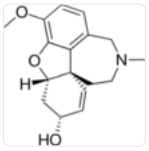

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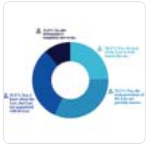

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The application of digital tools in Ukrainian pharmacies within holistic marketing

Nataliia Sakhnatska, Nataliia Aliekperova, Kostyantyn Kosyachenko, Alexander Kostenko

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Astragalus glycyphyllos L.: Phytochemical constituents, pharmacology, and biotechnology

Ivan Stambolov, Aleksandar Shkondrov, Ilina Krasteva

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Valentina Petkova, Anna Peneva, Kalina Andreevska, Emil Hristov, Daniela Grekova, Anna Todorova, Antoaneta Tsvetkova, Milen Dimitrov

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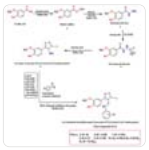

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Synthesis, characterization, and antimicrobial evaluation of new Schiff bases derived from vanillic acid conjugated to heterocyclic 4*H*-1,2,4-triazole-3-thiol

Noor Ali Hussein Sabzi, May Mohammed Jawad Al-Mudhafar

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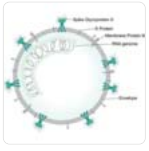

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The effect of a small polyphenolic and terpenoids phytochemical constituent on curing and preventing of Covid-19 infections

Saif Aldeen Jaber

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665-672

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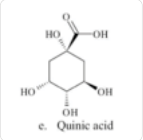


Review Article

An updated review of *Typhonium flagelliforme*: phytochemical compound, pharmacological activities and the use of vitexin and isovitexin as flavonoid compound in cosmetics development

Hetty Lendora Maha, Irda Fidrianny, Satrialdi, Tri Suciati

10.3897/pharmacia.70.e106092

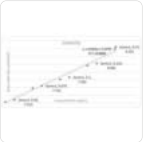
21-08-2023

Unique: 1974 | Total: 2851

Reprint: € 5,00

673-680

HTML XML PDF



Research Article

Development and validation of analytical procedure for analysis of Amoxiciline, Metronidazole and Omeprazole, used as anti- *Helicobacter pylori* agents alone and in mixture

Vania Maslarska, Lily Peikova, Maya Georgieva, Stefka Ivanova, Miglena Smerikarova, Stefan Balkanski, Stanislav Bozhanov

10.3897/pharmacia.70.e109211

23-08-2023

Unique: 1066 | Total: 1445

Reprint: € 5,00

681-688

HTML XML PDF

Review Article

INNs granted with specific storage requirements in Bulgarian pharmacies. Part 1: Medicines acting on cardiovascular and nervous system

Evgeni Grigorov, Maya Radeva-Ilieva, Kaloyan D. Georgiev

10.3897/pharmacia.70.e109692

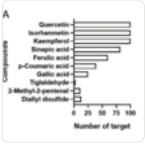
25-08-2023

Unique: 844 | Total: 1091

Reprint: € 6,00

689-697

HTML XML PDF



Research Article

Identification of potential molecular target of hypertension from *Allium schoenoprasum* by using network pharmacology and molecular docking strategies

Aditya Trias Pradana, Ginda Haro, Novarianti Marbun, Sofia Rahmi, Iksen Iksen

10.3897/pharmacia.70.e101537

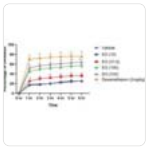
31-08-2023

Unique: 1015 | Total: 1368

Reprint: € 5,00

699-706

HTML XML PDF



Research Article

Potential anti-inflammatory activity of the *Tamarix aphylla* essential oil

Esam Qnais, Abdelrahim Alqudah, Mohammed Wedyan, Rabaa Y. Athamneh, Yousra Bseiso, Rawan Abudalo, Muna Oqal, Omar Gammoh

10.3897/pharmacia.70.e107237

31-08-2023

Unique: 991 | Total: 1326

Reprint: € 6,00

707-715

HTML XML PDF

Review Article

Update review: Etnopharmacological, bioactivity and phytochemical of *Allium cepa* L.

Sylvia Rizky Prima, Elfahmi, Elin Julianti, Irda Fidrianny

10.3897/pharmacia.70.e99666

31-08-2023

Unique: 1104 | Total: 1515

Reprint: € 5,00

717-724

HTML XML PDF

Research Article

Perceptions of resident physicians towards antibiotic prescribing during the COVID-19 pandemic: a qualitative study

Wejdan Shroukh, Nada Yasein, Farihan Barghouti, Manar Yousef, Ghayda Alnajdawi

10.3897/pharmacia.70.e110012

05-09-2023

Unique: 757 | Total: 955

Reprint: € 5,00

725-732

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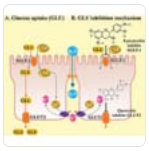


Research Article

In vitro antioxidant and *in vivo* hypoglycemic activity of biophenols and polyunsaturated fatty acids from *Vitis vinifera* L. muscat and quebranta seeds from the Valley of Ica-Peru

Angel T. Alvarado, Ana María Muñoz, Nesquen Tasayco-Yataco, Fabricio Gamarra-Castillo, Roberto O. Ybañez-Julca, María R. Bendezú, Haydee Chávez, Jorge A. García, Felipe Surco-Laos, Elizabeth J. Melgar-Merino, Pompeyo A. Cuba-Garcia, Patricia Castillo-Romero, Nelly Vega-Ramos, Berta Loja-Herrera, Mario Pineda-Pérez, Mario Bolarte-Arteaga

10.3897/pharmacia.70.e109129

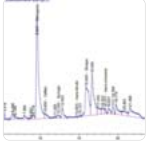
08-09-2023

Unique: 1353 | Total: 2597

Reprint: € 6,00

733-744

HTML XML PDF



Research Article

HPLC-DAD analysis of flavonoids and hydroxycinnamic acids in *Aster novi-belgii* L.

Diana Demydiak, Liudmyla Slobodianiuk, Oleg Gerush, Liliia Budniak, Valeriia Sydor , Olha Skrynchuk , Olha Demydiak, Nadiia Panasenko , Vadym Ratynskyi

10.3897/pharmacia.70.e94344

08-09-2023

Unique: 1011 | Total: 1523

Reprint: € 5,00

745-750

HTML XML PDF

Review Article

The benefits of sports for the physical and mental health of adolescents

Maria Stamova Vakrilova Becheva, Angelina Georgieva Kirkova-Bogdanova, Krasimira Milcheva Kazalakova, Stefka Achkova Ivanova

10.3897/pharmacia.70.e111888

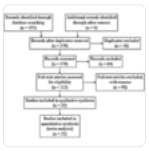
14-09-2023

Unique: 4933 | Total: 7390

Reprint: € 5,00

751-756

HTML XML PDF



Review Article

Efficacy of topical acne agents in the treatment of Acne Vulgaris: Insights from a meta-analysis

Adeola Tawakalitu Kola-Mustapha

10.3897/pharmacia.70.e109952

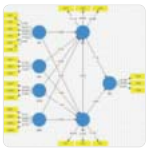
14-09-2023

Unique: 1062 | Total: 1363

Reprint: € 5,00

757-763

HTML XML PDF



Research Article

The complex mechanism of developing trust in pharmacy

Indriyati Hadi Sulistyaningrum, Prasojo Pribadi, Arifin Santoso, Erki Arfianto, Rayi Citra Ayu Pangestuti, Nahdliyah Umma, Meiliana Purnama Ningrum

10.3897/pharmacia.70.e109396

14-09-2023

Unique: 968 | Total: 1232

Reprint: € 5,00

765-770

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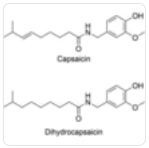


Research Article

Capsaicinoids content in some Bulgarian varieties of *Capsicum annuum* L. obtained by RP-HPLC

Trifon Angelov, Anna Gavrilova, Nikolay Panayotov, Galina Dyakova, Alexandar Pashev, Genadi Gavrilov, Maya Yotova

10.3897/pharmacia.70.e109767

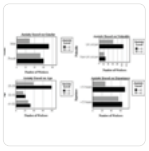
15-09-2023

Unique: 874 | Total: 1164

Reprint: € 5,00

771-777

HTML XML PDF



Research Article

Assessment of anxiety levels for Heathrow Airport workers after Covid-19 pandemic situation

Saif Aldeen Jaber

10.3897/pharmacia.70.e111260

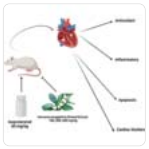
18-09-2023

Unique: 817 | Total: 1111

Reprint: € 5,00

779-783

HTML XML PDF



Research Article

Phytochemical profiling and cardioprotective activity of *Vernonia amygdalina* ethanol extract (VAEE) against ISO-induced cardiotoxicity in rats

Arya Tjipta Prananda, Aminah Dalimunthe, Urip Harahap, Rony Abdi Syahputra, Sony Eka Nugraha, Putri Cahaya Situmorang, Yee Teck Fah, Adrian, Jekson Martiar Siahaan, Adrian Joshua Velaro, Besa Bilakaya, Muhammad Andika Yudha Harahap

10.3897/pharmacia.70.e111329

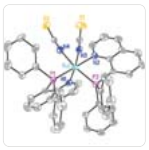
18-09-2023

Unique: 1032 | Total: 1365

Reprint: € 14,00

758-796

HTML XML PDF



Research Article

Antiproliferative activity of ruthenium complex II against human cancer cell *in vitro*

Mohamed Saadh

10.3897/pharmacia.70.e111410

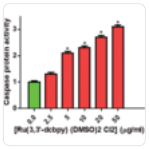
18-09-2023

Unique: 769 | Total: 982

Reprint: € 5,00

797-801

HTML XML PDF



Research Article

Anticancer and antiproliferative activity of ruthenium complex (II) bearing 3,3'-dicarboxy-2,2'-bipyridine ligand

Mohamed Saadh

10.3897/pharmacia.70.e111508

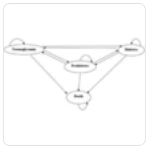
18-09-2023

Unique: 701 | Total: 870

Reprint: € 5,00

803-807

HTML XML PDF



Research Article

Cost-effectiveness of treatment intervention in prediabetic patients in Bulgaria

Stanislava Yordanova, Konstantin Mitov, Maria Kamusheva

10.3897/pharmacia.70.e110104

19-09-2023

Unique: 842 | Total: 1153

Reprint: € 5,00

809-816

HTML XML PDF

Research Article

Prevalence of potentially inappropriate medications among elderly patients with diabetes – study based on STOPP/START criteria

Petya Milushewa, Kristina Kosanova, Petar Nikolov

10.3897/pharmacia.70.e110386

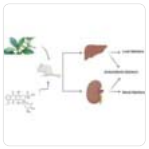
19-09-2023

Unique: 983 | Total: 1349

Reprint: € 5,00

817-823

HTML XML PDF



Research Article

Vernonia amygdalina protects against doxorubicin-induced hepatic and renal damage in rats: mechanistic insights

Arya Tjipta Prananda, Aminah Dalimunthe, Urip Harahap, Rony Abdi Syahputra, Sony Eka Nugraha, Putri Cahaya Situmorang, Yee Teck Fah, Adrian Joshua Velaro, Besa Bilakaya, Muhammad Andika Yudha Harahap

10.3897/pharmacia.70.e112425

19-09-2023

Reprint: € 6,00

825-835

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Pharmacia

COUNTRY

Bulgaria

Universities and research institutions in Bulgaria

Media Ranking in Bulgaria

SUBJECT AREA AND CATEGORY

Health Professions
Pharmacy

Medicine
Pharmacology (medical)

Pharmacology, Toxicology and Pharmaceutics
Pharmaceutical Science

PUBLISHER

Pensoft Publishers

H-INDEX

18

PUBLICATION TYPE

Journals

ISSN

04280296

COVERAGE

1945, 1954-1955, 1987-1991, 1997-2023

INFORMATION

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SCOPE

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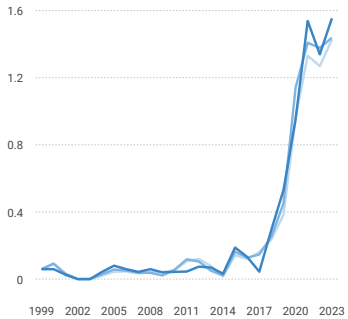

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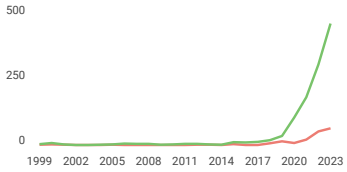

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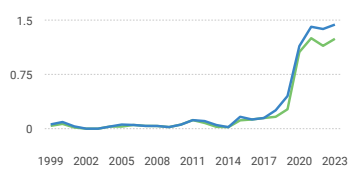

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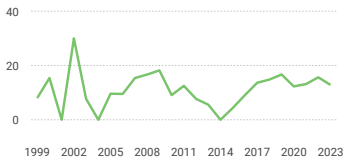

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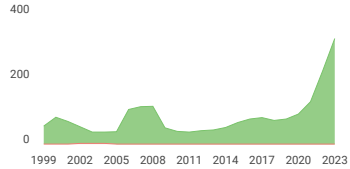

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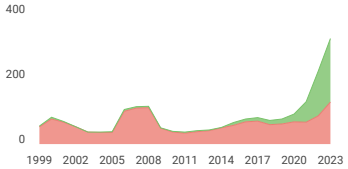

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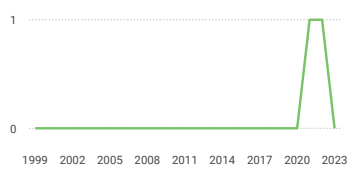

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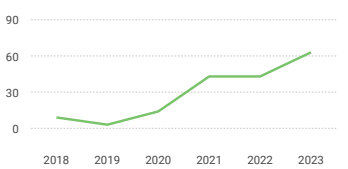

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W **widysusanti** 4 months ago

Is this journal still indexed by scopus until now june 2024?

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Melanie Ortiz 4 months ago

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The Scopus' update list can also be consulted here:
https://www.elsevier.com/solutions/scopus/how-scopus-works/content
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D **Delveen Ibrahim** 1 year ago

Dear SCImago team,
I can see on the site of this journal showing it is impact factor 1.1 , but when I search in Web of science website it doesn't show those information, how can I confirm?

reply

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N **Naelaz Zukhruf** 2 years ago

Hello...Could you tell me about this journal, Is still indexed in Scopus 2021.
If I search in Scopus, this journal Scopus coverage from 1997-present. I Have already read your explanation that the SJR indicators for 2020 will be available in June 2021. And now March 2023 so how about this indicator?

Hopefully I will find the answer soon
Thank you

reply

SCImago Team

Melanie Ortiz 2 years ago

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N **Naela** 2 years ago

Hello...
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If I search in Scopus, this journal Scopus coverage from 1997-present. I Have already read your explanation that the SJR indicators for 2020 will be available in June 2021. And now March 2023 so how about this indicator

Hopefully I will find the answer soon
Thank you

reply

SCImago Team

Melanie Ortiz 2 years ago

Dear Naela,
Thank you for contacting us. Our data come from Scopus, they annually send us an update of the data. This update is sent to us around April / May every year. The SJR for 2021 was released on 11 May 2022. Therefore, the indicators for 2022 will be available in May/June 2023.
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The Scopus' update list can also be consulted here:
https://www.elsevier.com/solutions/scopus/how-scopus-works/content
Best Regards, SCImago Team

A **Angel T. Alvarado** 2 years ago

Sirs
Scimago
Good afternoon
I verified until March 2022 that Pharmacia was in Q2; Today I am surprised that it is in quartile 3.
Please, could you tell me the exact date of the evaluation of the magazine and its fall to Q3.
Thanks for your attention.
Angel Alvarado

reply

SCImago Team

Melanie Ortiz 2 years ago

Dear Angel,
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N **Nur Alam Abdullah** 3 years ago

Dear editorial team of the pharmacia, I would like to ask how long it will take us as authors to get confirmation of the rejection or acceptance of our manuscript.
tx regards.

reply

SCImago Team

Melanie Ortiz 3 years ago

Dear Nur,
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We are sorry to tell you that SCImago Journal & Country Rank is not a journal. SJR is a portal with scientometric indicators of journals indexed in Elsevier/Scopus.
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L **Linda Laksmiani** 3 years ago

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If I search in Scopus, this journal Scopus coverage from 1997-present. I Have already read your explanation that the SJR indicators for 2020 will be available in June 2021. And now August 2021 so how about this indicator?

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Thank you

reply

SCImago Team

Melanie Ortiz 3 years ago

Dear Linda,
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D **Dr.Alex** 4 years ago

Dears,

Kindly can you tell me is this journal still ranked in sjr during 2020-2021?

Regards

reply

SCImago Team

Melanie Ortiz 4 years ago

Dear Dr.Alex,
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June 2021.
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M **Ms.pharmadi** 4 years ago

Dear

Kindly could you tell me does this journal still indexed in web of science and scopus in 2021

Many thanks!

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Melanie Ortiz 4 years ago

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T **Tamara** 4 years ago

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Melanie Ortiz 4 years ago

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H **Haider F. Shamikh Al-Saedi** 4 years ago

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reply

SCImago Team

Melanie Ortiz 4 years ago

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Best Regards, SCImago Team

T **taras** 6 years ago

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I would like to know if you are printing an article and what requirements to the article, and what price article?
Thank you.
Good day for you.

reply

SCImago Team

Elena Corera 6 years ago

Dear Taras, in the link below you will find the information corresponding to the author's instructions of this journal. Best regards, SCImago Team
http://ores.su/en/authors/

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Open Access

Years currently covered by Scopus: 1945, from 1954 to 1955, from 1987 to 1991, from 1997 to 2024

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ISSN: 0428-0296

Subject area: Health Professions: Pharmacy | Pharmacology, Toxicology and Pharmaceutics: Pharmaceutical Science | Medicine: Pharmacology (medical)

Source type: Journal

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