A Review of Different Medicinal Plants with Potential Anti-inflammatory Activities

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Abstract

Numerous nonsteroidal anti-inflammatory drugs have been shown to alleviate pain and inflammation by inhibiting the cyclooxygenase enzyme isoform, thereby reducing the synthesis of prostaglandins from arachidonic acid. Unfortunately, the use of these drugs is associated with a range of adverse effects. However, there exists a group of medicinal plants that exhibit anti-inflammatory therapeutic properties with minimal or no adverse effects. These plants have proven successful in treating inflammatory disorders in conventional medicine. It's noteworthy that researchers have extensively studied and documented the biological and therapeutic effects of some common medicinal plants. Regrettably, there is a notable absence of a comprehensive review paper cataloging medicinal plants with anti-inflammatory properties across various African nations. Recognizing the significance of ethnobotanical knowledge, it is crucial to document and understand the applications of anti-inflammatory medicinal plants from selected countries representing different regions of the African continent. This approach aims to illustrate the diverse array of medicinal plants utilized for traditional or therapeutic purposes globally, and the present study enumerates the anti-inflammatory properties of several such plants from varied geographic regions

Keywords: Inflammation, Anti-inflammatory conditions, local plants, plant potentials.

Introduction

In various diseases, inflammation and oxidative stress have long been considered the primary pathological processes. Numerous studies have provided scientific evidence revealing the interconnected mechanisms governing inflammation induced by oxidative stress and vice versa. Inflammatory cells release reactive oxygen species (ROS), causing heightened oxidative damage at the inflammation site. Moreover, ROS and oxidative stress products amplify pro-inflammatory reactions. Researchers have increasingly turned to traditional knowledge of medicinal plants and their active components for developing new medications. Medicinal plants, due to their low toxicity, have been prioritized for testing and developing treatments for various ailments. Natural sources of antioxidants and anti-inflammatory compounds, such as polyphenol extracts, have gained attention (Liu *et al.,* 2022).

Over the years, medicinal plants have played a crucial role in the traditional treatment of numerous human diseases, including leprosy, gonorrhea, dyspepsia, wounds, malaria, fever, and diarrhea (Hussain et al., 2021). The therapeutic effects of these plants are attributed to various phytochemicals, such as alkaloids, tannins, terpenoids, flavonoid glycosides, and saponins, which exhibit diverse physiological effects on humans (Junejo et al., 2020). Utilizing plant-derived anti-inflammatory medications has been advocated as a logical and effective approach, as these compounds are known to suppress specific inflammatory mediators (Lahare et al., 2021).

In response to harmful substances, living mammalian tissues often undergo local inflammation, a process that eliminates allergens or microorganisms and accelerates tissue restoration (Zhao et al., 2021). Inflammation manifests as redness, swelling, heat, pain, and functional impairment. Although inflammation is a protective response, it is associated with various disease conditions at the cellular level, including arthritis, prostatitis, anaphylaxis, diabetes, chronic kidney disease, digestive disorders, Alzheimer's disease, bacterial infections, and novel coronavirus infections, leading to serious health issues (Bandyopadhyay et al., 2021). Furthermore, it has been reported that inflammatory bowel disease (IBD), a chronic inflammatory disorder, affects over 3 million people in the United States, with 1.6 million residing in the region (Kumar, 2021).

Methods:

The research encompassed an extensive exploration of databases, including PubMed, Google Scholar, Scopus, and ScienceDirect. The search focused on identifying relevant studies incorporating terms related to inflammation, inflammatory conditions, therapeutic plants, and the potential of plants. The search duration was not restricted to ensure comprehensive coverage of pertinent materials. Information on isolated chemical compounds, pharmacological activity, utilized plant parts, experimental models, and other relevant details was systematically gathered and compiled.

Table 1: The medicinal plants which are considered to possess anti-inflammatory activity based on in vitro studies:

S. no	Scientific name	Family	Local name	Part/solvent used	Types of assays	Anti-inflammatory Activity %	IC50	Active compounds	Ref
1	*Agelaea borneensis*	Connara ceae	Akar rusa-rusa	Bark/methan ol-l	LOX inhibition	71%–100% at 100 µg/m	NA	**NA**	Chung *et al.*, 2009
2	*Timonius flavescent*	Rubiaceae	Batut	Leaves/meth a-nol	LOX inhibition	71%–100% at 100 µg/m	8.9 µg/ m	NA	Chung *et al.*, 2009
3	*Anacardi um occidentale*	Anacardi aceae	Pokok gajus	Leaves/meth a-nol	NO inhibition	16.10% at 250 µg/ml	NA	NA	Abas *et al.*, 2006
4	*Thymus vulgaris*	Lamiaceae	Taim	Whole plant/methan ol	LOX inhibition	62% at 100 µg/ml	NA	NA	Abu Bakar *etal* 2018
5	*Averrhoa bilimbi*	Oxalidace ae	Belimbin g buluh	Fruits/water	NO inhibition	22.30% at 250 µg/ml	NA	NA	Abas *et al.*, 2006

6	*Solanum torvum*	Solanacea e	Terung belanda	Leaves and fruits/methan ol	NO inhibition	25.20% at 250 µg/ml	NA	NA	Abas *et al* 2006
7	*Barringto nia racemosa*	Lecythid aceae	Put at kampung	Leaves/ethan ol	Gries s assay (NO inhibition)	29.80% at 100 µg/ml	NA	NA	Ana., *et al.*,200 7
8	*Solanum nigrum*	Solanacea e	Terung meranti	Leaves/meth anol	NO inhibition	27.60% at 250 µg/ml	NA	NA	Abas *et al.*, 2006

Table .1 Continue

s. no	**Scientifi cname**	**Family name**	**Local name**	**Part/solve ntused**	**Types of assays**	**Anti-infla m m atory activi ty %**	**IC50**	**Active compounds**	**References**
9	*Ficus deltoide i*	Moracea	Mas cotek	Leaves / methan ol	LOX inhibition	10.35% at 100 µg/ ml	NA	NA	Abdullah *et al.*, 2009
10	*Eurycom alinifolia*	Simarouba ceae	Tongkat ali	Root/ hydro alcoholi cs	Human redblood cell	70.97% at 1000 µg/m	NA	NA	Varghese *et al.*, 2013
11	*Garcinia subelliptic a*	Guttiferae	Pokok penanti	Seeds/ chlorofor m	Chemic al mediato r	NA	18.2 µM	Garsubellin	Weng., *et al.*, 2003
12	*Gynura pseudochin a*	Asteracea e	Pokok daun dewa	Leaves/ ethyl acetate	IL-6/luciferas eassay	NA	11.63 µg/m	NA	Siriwata nametan on, *et al.*,2010
13	*Cythostem aexcelsia*	Annonaci n	Liana	Leaves and stems/meth anol	LOX inhibition	41%–70% at 100 µg/ml	NA	NA	Chung*etal.*, 2009

14	*Jatroph acurcas*	Euphorbia ceae	Jarak pagar	Leaves/aqu eous methanol	NO inhibition	NA	93.5 µg/m	NA	Ehsan *etal*., 2011
15	*Kaempferi agalanga*	Zingiberac eae	Cekur	petroleu m ether, chlorofor m	COX-2 inhibitor y screenin gassay	57.82% at 200 µg/ ml	0.83 µM	NA	Umar *et al.*, 2012
16	*Musa acuminat e*	Musaceae	Pisang abu nipah	Flowering stalk/meth anol	(NO inhibition	71.06% at 100 µg/ ml	42.24 µg/ml	NA	Lee *et al.*, 2011
17	*Ocimu m canum*	Lamiaceae	Kemangi putih	Whole plant/meth anol	LOX inhibition	32% at 100 µg/ml	NA	NA	Abu Bakar *etal* 2018

Table. 1 continue

s.no	**Scientific name**	**Family**	**Local name**	**Part/solv ent used**	**Types of assays**	**Anti- inflam matory activity %**	**IC50**	**A.co mpou nds**	**Ref**
18	*Piper sarmentosu m*	Piperacea e	Kaduk	Leaves/metha n ol	Griess assay	62.82% at 100 µg/ml	60.24 µg/ml	NA	Lee *et al.*, 2011
19	*Curcu ma longa*	Zingiber aceae	Kunyit	Rhizomes/ he xane-ethyl	COX-2 inhibitor y activity	58.90% at 125 µg/ml	NA	NA	Ram Sewake *t al.*, 2000.

20	*Boswellia serrata*	Bursera ceae	Kemeny an	Leaves/methan ol	Human red blood cel	80.00% at 2000 µg/ml	NA	NA	Afsar *et al.*, 2012
21	*Pithecellobium confertum*	Fabaceae	Medang	Seeds/methano l	NO inhibitio n	23.50% at 250 µg/m	NA	NA	Abas *et al.*, 2006
22	*Crinum asiaticum*	Amaryll idaceae	Pokok bakung	Leaves/ethanol	NO inhibitio n	NA	58.5 µg/ml	NA	Kim, *et al.*, 2008
23	*Chisocheton polyandrou s*	Meliacea e	Lisi-lisi	Leaves/hexane	Soybean	NA	1.11 µM	Hydroxyd ammara	Chan., *et al.*, 2012
24	*Litsea garciae*	Lauracea e	Engkala/	Fruits/methano l	LOX assay	9.42% at 2 mg/ml	NA	NA	Kutoi *et al.*, 2012
25	*Carica papaya*	Caricacea e	Betik	Leaves/methan ol	(NO inhibitio n	72.63% at 100 µg/ml	60.18 µg/ml	NA	Lee *et al.*, 2011

Table. 1 continue

S.n o	Scientific name	Family	Local name	Part/solven t used	Typesof assays	Anti-infla mm atory activit y %	IC 50	Activ e comp o Unds	Ref
26	*Leucas linifolia*	Lamiaceae	Ketumba k	Whole plant/metha nol	LOX inhibition	34% at 100 µg/m	N A	NA	Abu Bakar *et al* 2018
27	*Cosmos caudatus*	Asteraceae	Ulam raj	Leaves/meth anol	NO inhibition	15.40 % at 250 µg/ml	N A	NA	Abas.*e t al.*, 2006
28	*Melicope ptelefolia*	Rutaceae	Tenggek burung	Leaves/meth anol	NO inhibition	95% at 250 µg/ml	N A	p-O-geranylco umaric	Shaari *et al.*, 2011

29	*Ficus deltoidei*	Moraceae	Mas cotek	Leaves/meth anol	LOX inhibition	10.35 % at 100 μg/ml	N A	NA	Abdullah *et al.*, 2009
30	*Citrullus lanatus*	Cucurbita ceae	Tembika	chloroform, and 90% ethanol	COX-2 inhibit ory activity	60–70% at 100 μM	69 μ M	Cucurbitac in E	Abdel Wahab *et al.*, 2011
31	*Buchan ania insignis*	Anacardi a ceae	Tais/man gga hut an	Bark/metha nol	LOX inhibition	41%–70% at 100 μg/m	N A	NA	Chung*et al.*, 2009
32	*Buchanania insignis*	Anacardi a ceae	Tais/	Bark/metha nol	LOX inhibition	41%–70% at 100 μg/ml	N A	NA	Chung*et al.*, 2009
33	*Desmos chinensis*	Annonac eae	Kenanga hutan	Bark/metha nol	LOX inhibition	41%–70% at 100 μg/ml	N A	NA	Chung*et al.*, 2009

Table. 1 Continue

S no	Scientific name	Family	Local name	Part/sol ven t us ed	Types of assays	Anti-inflam m atory activity %	IC50	Active compo Unds	Ref
34	*Canarium patentinerv ium*	Burseracea e	Kedondo ng	Leaves	5-LOX inhibition	NA	1.76 μM	Scopoletin	Mogana *et al.*, 2013
35	*Eurycoma longifolia*	Simaroub aceae	Tongkat ali	Root/hyd roa lcoholic	Human redblood cell	70.97 % at 1000 μg/ml	NA	NA	Varghese *et al.*, 2013
36	*Cythostema excelsia*	Annonacea e	Lianas	Leaves	LOX inhibition	41%–70% at 100 μg/ml	NA	NA	Chung*et al.*, 2009

37	*Boesenb ergia rotunda*	Zingiberac eae	Temu kunci	Rhizome s/hexane	Griess assay	NA	36.6 8 µM	Boesenber gin	Isa *etal.*, 2012
38	*Gynura pseudochina*	Asteraceae	Pokok daun dewa	Leaves/et hyl acetate	IL- 6/luciferas eassay	NA	11.6 3 µg/ ml	NA	Siriwa tanam etanon*et al.*, 2010
39	*Piper sarmentosu m*	Piperaceae	Kaduk	Leaves/m ethanol	Griess assay	62.82 % at 100 µg/ml	60.2 4 µg/ ml	NA	Lee *etal.*, 2011
40	*Labiatae pumila var. alata*	Myrsinacea e	Kacip Fatimah	Roots/me thanol	Colorimetri cnitric oxide	75.68 % at 100 µg/ml	NA	NA	Karim i.*et al.*,2013

Table 2: The medicinal plants which are considered to possess anti- inflammatory activity based on *in vivo* studies.

S no	Scientific name	Family	Local name	Part/solve nt used	Dose of the extract	Experime ntal animals	Results	Ref
1	*Polygonum minus*	Polygonaceae	Kesum	Aerial parts/water	100 mg/kg and 300 mg/kg	Wistar albino rats	+e extracts significantly reduced the paw edema volume in the rats after 4 h	Geor ge *et al.*, 2014
2	*Annona muricata*	Annonaceae	Durian belanda	Leaves/aqu eous ethanol	10–300 mg/kg	Sprague-Dawley rats	A significant decrease of the concentration of the proinflammato rycytokines TNF-αand IL- 1 β was observed	Foon g.*et al.*, 2014

3	*Achyranthes aspera*	Amaranthacea e	Ara songsang	Root/ethyl alcohol	50, 100, and 200 mg/kg	Wistar rats	All the doses caused significant reduction in paw edema compared to control	Vijay a Kuma r*et al*.,20 0 9
4	*Ficus deltoidea*	Moraceae	Mas cotek	Whole plant/water	30, 100, and 300 mg/kg	Sprague-Dawley rats	The rats' paw edema volume reduced significantly in a dosedependen t manner	Zaka ria *et al*., 2012
5	*Sandoricu m koetjape*	Meliaceae	Sentul	Stems/meth anol	5 mg/ea.	BALB/c mice	significant inhibition (94%) in TPA-induced edema was observed in the isolated compound 3- oxo-12-oleanen29-oic acid	Rasa dah *et al*., 2004
6	*Garcinia subelliptica*	Guttiferae	Pokok penanti	Seeds/chlor oform	3, 10, 30, 50, and 100 µM	Sprague-Dawley rats	A potent inhibitory effecton fMLP/CB-induced superoxid gobser	Wen g *et al.*, 2003

Table. 2 continue

S no	Scientific name	Family	Local name	Part/so lven t used	Dose of the extract	Experi mental animals	Results	Ref
7	*Ardisia crispa*	Myrsina ceae	Mata pelandok	Root/et hanol	100, and 300 mg/kg of body weigh	Sprague - Dawley rats	A significant inhibition(93.34%) was observedin carrageenaninduced edema in rats at a dose of 300 mg/k	Roslida *et al.*,20 08
8	*Justicia gendarussa*	Acantha ceae	Daun rusa	Root/ metha nol	50 mg/kg of the extract	Wistar rats	80% and 93% edema inhibition at the third and fifth hours	Kumar *et al.*,2012
9	*Solanum nigrum*	Solanac eae	Terung meranti	Leaves /water	10, 50, and 100% ofconcentr ation	BALB/c mice and Sprague - Dawley rats	Extracts produce apparently two- phase anti- inflammatory activity: the first phasebetween 1 and 2 h	Zakaria *et al.*, 2009
10	*Atylosia scarabaeoi des*	Fabaceae	kacang kerara	Leaves /etha nol	150, 300, and 450 mg/kg	Swiss albino mice	The extract displayed significant inhibition of inflammation. Highest inhibition of paw edema(38.38%) at a dose of 450 mg/kg after 4 h of administration Cucurbitacin E inhibits	Sufian*et al.*, 2017
11	*Kaempferia galanga*	Zingibe raceae	Ceku	Rhizo mes/c hlorofo rm	2 g/kg of the extract	Male Sprague - Dawley rats	Highest edema inhibition(42.9%)	Umar. *et al.*, 2012

Table 2 continue

S. no	Scientific name	Family	Local name	Part/solve n t used	Dose of theextra ct	Experimen tal animals	Results	Ref
12	*Stachytarph eta jamaicensis*	Verbenace a e	Selasih dandi	Leaves/eth ane	50, 100, and 150 mg/k g	BALB/c albino strain mice	A significant dose-dependent anti-inflammatory activity was observed 30 min after the administrati on of the extract atall doses	Sulaiman *et al.*, 2009
13	*Citrullus lanatus*	Cucurbita ceae	Tembikai	Fruit pulp/petrol eum ether, chloroform ,and 90% ethanol	30 and60 mg/k g of body weight	BALB/c mice	Cucurbitacin E inhibits inflammati on significantly from the fourth hour and is able to revert paw edema through the COX-2 inhibition	Abdel Wahab*et al.*, 2011
14	*Manilkara zapota*	Sapotaceae	Ciku	Leaves/eth ylacetate	300 mg/k g of body weight	Albino Wistar rats	Inhibitionof paw edema (92.41%	Gangul y *et al.*, 2013
15	*Vitex negundo*	Lamiaceae	Legundi	Leaves/eth ane	2 mg/ea r	Mice	+e extract showed an inhibitory activity of 54.1%	Yunos*et al.*,2005

Table. 2 Continue

S.no	Scientific name	Family	Local name	Part/solven tused	Dose of the extract	Experimental animals	Results	Ref
16	*Corchorus capsularis*	Malva ceae	Kancing baju	Leaves/chlo roform	20, 100, and 200 mg/kg	BALB/c mice and Sprague- Dawley ra	The extract caused significant reduction in the thickness of edematous paw forthe first 6 h	Zakaria *et al.*,2007
17	*Mitragyna speciosa*	Rubia ceae	Biak- biak and ketom	Leaves/met hanol	50, 100, and 200 mg/kg	Sprague- Dawley rats	Both doses of 100and 200 mg/kg showed a significant inhibition of the paw edema (63%)	Mosaddeq *et al.*,200 9
18	*Zingiber zerumbet*	Zingib era ceae	Lempo yang	Rhizomes/ methanol	5, 10, 50, and 100 mg/k g	ICR mice	The isolated compound (zerumbone) significantly showed dose- dependent inhibition of paw edema induced by carrageenan at all doses (5, 10, 50, and 100 mg/kg) inmice with percentage of inhibition of 33.3, 66.7, 83.3, and 83.3%, respectively	Sulaiman *et al.*,2010
19	*Crinum asiaticum*	Amar ylli dacea e	Pokok bakung	Leaves/met hanol	50 mg/kg ofthe extract	Mice	Inhibition of pawedema (94.8%)	Samud *et al.*,199 9
20	*Moringa oleifera*	Moring aceae	Kelur	Leaves/water	10, 30, and 100 mg/kg	BALB/c mice and Sprague- Dawley rat	Highest edema inhibition (66.7%) atthe second hour at 100 mg/kg of dose	Sulaiman *et al.*,2008

Table. 2 Continue

S.no	Scientific name	Family	Local nam e	Part/ solve nt used	Dose of the extract	Experi mental animals	Results	Ref
21	*Curcuma aeruginosa*	Zingibera ceae	Temuhita m	Rhizomes/c hlorofo rm, methanol, andwater	100, 200, 400, and 800 mg/kg	Swiss mice and Wistar rats	No significant suppression was observed after oral administration of all doses on carrageenan-induced paw edema	Reanmong ko *et al*.,2006
22	*Muntingia calabura*	Muntingi aceae	Kerukup siam	Leaves/wate r	27 mg/kg, 135 mg/kg	Spragu e- Dawle y rats	+e extract was found to exhibit a concentration-independent anti-inflammatory activity	Zakaria *et al*.,20 07
23	*Dicranopt eris linearis*	Gleicheni aceae	Resam	Leaves/chlor oform	10, 100, and 200 mg/kg	BALB/c mice and Spragu e- Dawley rats	+e extract produced significant anti-inflammatory activity that did not depend on the doses of the extract	Zakaria *et al*.,20 06
24	*Orthosiph on stamineus*	Lamiaceae	Misai kucing	Leaves/m ethanol: water	125, 250, 500, and 1000 mg/kg	Charles River miceand Sprague - Dawley rats	Increase in edema inhibition (26.79%)	Yam *et al*.,2008
25	*Curcuma longa*	Zingibera ceae	Kunyit	Rhizomes/w ater	200 mg/kg of body weight	Wistar albino rats	+e production of anti-inflammatory/proi nflammatory cytokines is decreasing	Rama dan *etal*.,2011

Table. 2 continue

S. no	Scientific name	Family	Local name	Part/solv entused	Dose of the extra ct	Experi mental animal s	Results	Ref
26	*Physalis minima*	Solanace ae	Pokok letup-letup	Whole plant/metha noland chloroform fraction	200 and 400 mg/kg	NMRI mice and Wista r rats	inhibition of paw edema at66% and 68% at 400 mg/kg, respectively	Khan *et al.*, 2009
27	*Dicranopt eris linearis*	Gleiche niaceae	Resam	Leaves/chlor ofo rm	10, 100, and 200 mg/kg	BAL B/c mice and Sprag ue-Dawl ey rats	+e extract produced significant anti-inflammatory activity that did not depend on thedoses of the extract	Zakaria *et al.*,2006
28	*Curcuma aeruginosa*	Zingibe raceae	Temu hitam	Rhizomes/c hloroform, methanol, and water	100, 200, 400, and 800 mg/kg	Swiss mice and Wista r rats	No significant suppression was observed after oral administrationof all doses on carrageenan- induced paw edema	Reanmongko *etal.*,2006
29	*Phyllanth us acidus*	Phyllant haceae	Cermai	Leaves/meth anol, ethyl acetate, and petroleum ether	250 and 500 mg/kg	Wist ar rats and albin o mice	All the extracts showed reduction in carrageenanin duced paw edema with highest inhibition (90.91%) in the methanol extract	Chakraborty *etal.*, 2012

Discussion:

According to the World Health Organization (WHO), medicinal plants are defined as those containing chemicals suitable for therapeutic use or pharmaceutical production. In developing countries, people continue to rely on these plants for treating various diseases, and the market for medicinal plant products is expanding, indicating their economic importance. Despite a vast number of plant species, only 15% of the world's 300,000 plant species have been studied for their pharmacological activity. Notably, 25% of modern medicines have origins in natural resources like medicinal plants. Recently, global attention towards researching health benefits of medicinal plants has increased, including in Malaysia, known for its diverse medicinal plant species. For example, Peninsular Malaysia and Sabah boast 1300 and 7411 documented medical plant species, respectively (Abu Bakar et al., 2018). Inflammation, a response to cell damage from pathogens or irritants, involves the activation of leukocytes and release of proinflammatory cytokines. This process includes the production of nitric oxide (NO), prostaglandin E2 (PGE2), and other mediators. Proinflammatory mediators, like nitric oxide and prostaglandins, contribute to various inflammatory conditions, and uncontrolled inflammation is associated with several chronic diseases. Acute inflammation is characterized by increased blood flow and swelling, while chronic inflammation may lead to genetic instability, neoplasia, cancer, and infectious illnesses. Nonsteroidal anti-inflammatory drugs (NSAIDs) effectively reduce COX-1 and COX-2 activity, but their use is linked to adverse effects such as gastrointestinal erosions, renal failure, and hepatic failure. COX-2 inhibitors, like Vioxx, have been associated with significant cardiovascular events. To address these issues, research has focused on anti-inflammatory medicines derived from natural sources, particularly medicinal plants abundant in phytochemicals. Enzyme inhibitory assays, such as COX and LOX, are commonly used to assess their anti-inflammatory efficacy. Tables 1 and 2 present in vitro and in vivo investigations of Malaysian medicinal plants with anti-inflammatory properties.

Conclusion:

The primary aim of this research was to examine academic studies focusing on the anti-inflammatory attributes of specific medicinal plants utilized across diverse countries. In this review, a wide array of plants from different geographical regions, including north, south, east, central, and west African countries, were identified. While various medications for treating and managing inflammatory conditions exist in both developed and developing nations, many of these drugs are associated with undesirable side effects. Consequently, numerous investigations have been undertaken in different countries to evaluate the anti-inflammatory properties of medicinal plants, aiming to validate their utilization in traditional medicine. The exploration of plants with anti-inflammatory properties represents an emerging field in contemporary biomedicine. Given that traditional healers worldwide may possess valuable knowledge about unstudied plants, further research on those with anti-inflammatory potential is imperative.

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