Bioorganic Chemistry 50 (2013) 1–10

Contents lists available at ScienceDirect

Bioorganic Chemistry

journal homepage: www.elsevier.com/locate/bioorg

Reviews

Lignans of sesame: Purification methods, biological activities and biosynthesis – A review

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ARTICLE INFO

Article history:
Received 15 April 2013
Available online 19 July 2013

Keywords:
Sesamum indicum
Lignans
Sesamin
Biosynthesis
Enterolignans
HPLC

ABSTRACT

Lignans are a group of compounds consisting of dimers of phenyl propane units. They are found in diverse forms distributed in a variety of plants. Sesame lignans in particular are obtained from *Sesamum indicum*, a highly prized oilseed crop cultivated widely in many countries in the east. The plant is the main source of clinically important antioxidant lignans such as sesamin, sesamolin, sesaminol and sesamol. These lignans exhibit antihypertensive, anticancerous and hypocholesterolemic activities as well especially in humans due to which they have become compounds of tremendous research interest in recent times. Sesamin is synthesized from shikimic acid through phenylpropanoid pathway and metabolised into enterolignans which play a pivotal role in protection against several hormone related diseases. In this paper we present an overview of current status of research on sesame lignans with respect to the analytical methods employed, the biological activities and biosynthesis of sesame lignans.

Contents

1. Introduction

The term lignan was coined by Haworth in 1936 to describe a group of phenylpropanoid dimers in which C6–C3 units are linked by the central carbon of their propyl side chains [1,2]. Under IUPAC nomenclature, the lignans are 8,8″-coupled dimers of coniferyl or cinnamyl alcohols. The lignans are currently known for their role in conferring health benefits such as lowering the cholesterol and blood glucose levels in humans [3] Based on the way in which oxygen is incorporated into the skeleton and the cyclization pattern, the lignans are classified into the eight subgroups, namely, furofuran, furan, dibenzylbutane, dibenzylbutyrolactone, aryltetralin, arylnaphthalene, dibenzocyclooctadiene and dibenzylbutyrolactol[1,4]. These compounds are found in diverse species in the plant kingdom including members of pteridophytes, gymnosperms and angiosperms [5,6]. In angiosperms, lignans have been isolated from members belonging to Asterales, Scropholariales, Lamiales, Solanales, Apiales, Sapindales, Aristolochiales, Piperales, Laurales, Malvales, Malpighiales and Magnoliales orders in the division

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http://dx.doi.org/10.1016/j.bioorg.2013.06.009

Table 1
List of plant species that are sources of sesamin.

S. No.	Plant	Method of analysis	Solvent for extraction	Source	Quantity (mg/100 g)	Reference
1	*Anacyclus pyrethrum*	NA	Ethanol	Roots	NA	[7]
2	*Zanthoxylum. armatum*	NA	NA	Bark	NA	[8]
3	*Vitex negundo*	Silica gel column chromatography	80% Ethanol	Dried seeds	0.024	[9]
4	*Aristolochia cymbifera*	NA	NA	Leaves	NA	[10]
5	*Piper longum*	NA	Dichloromethane	Fruit	NA	[11]
6	*Knema glauca*	Sephadex column chromatography	*n*-Hexane	Dried and milled fruits	2.83	[12]
7	*Magnolia denudata*	NA	NA	Fruit	NA	[13]
8	*M. kobus*	Sephadex column chromatography	95% Ethanol	Dried barks	4.16	[14]
9	*Piper retrofractum*	Chromatographic separation	*n*-hexane	Stem hexane extract	366.66	[15]
10	*Camellia oleifera*	HPLCs	Methanol, Ethanol, Acetone, Ethyl acetic, and Acetonitrile	Seed oil	33.88	[16]
11	*Chrysanthemum cinerariaefolium*	Gas chromatography – mass spectrometery	Diethyl ether, Hot methanol and boiling water	Dried flower	10.00	[17]
12	*Eucalyptus globulus*	Preparative TLC and GC–MS	Acetone and petroleum (1:1)	Freshly capsules	0.278	[18]
13	*Machilus thunbergii*	NA	NA	Bark	NA	[19]
14	*Piper sarmentosum*	NA	NA	Fruit	NA	[20]
15	*Acanthopanax senticosus*	Silica gel column chromatography	Water and chloroform	Chloroform extract of dried stem	75.00	[21]
16	*Artemisia absinthium*	Silica gel column chromatography	Methanol	Dried roots	7.2	[22]
17	*Paulownia tomentosa*	NA	NA	Leaves	NA	[23]
18	*Ginkgo biloba*	Vacuum liquid chromatography	Acetone	Dried leaves	NA	[24]
19	*Acanthopanax sessiliflorus*	Silica gel column chromatography	Hot methanol	Dried fruits	0.25	[25]
20	*Chamaecyparis obtusa*	Silica gel column chromatography and HPLC	Hot methanol	Young shoots and leaves	11.38	[26]
21	*Semen Cuscutae*	Gas chromatography	Chloroform	Dried stem	112–200	[27]
22	*Zanthoxylum integrifoliolum*	Column chromatography and TLC	Methanol	Dried fruits	1.57	[28]
23	*Magnolia coco*	NA	NA	Leaves	NA	[29]
24	*Caryodaphnopsis baviensis*	Flash column chromatography	95% Methanol	Fruits	220	[30]
25	*Virola surinamensis*	Flash column chromatography and TLC	Hexane and chloroform	Seeds and pericarps	70.00	[31]
				Tegments and kernels of seeds	6.00	
26	*Pericarpium zanthoxyli*	TLC	*n*-Hexane	Fruits	NA	[32]
27	*V. venosa*	Flash column chromatography and TLC	Dichloromethane	Pericarp crude extract	8516.48	[33]
28	*Nectandra amazonum*	Chromatography	Ethanol	Fruit calyces	14.63	[34]
29	*Virola flexuosa*	Silica gel column chromatography	Chloroform	Seeds	737.5	[35]
	V. multinervia				5.00	
30	*Piper guineense*	TLC	Light petroleum and chloroform	Fruit	2.66	[36]

NA = Data not available.

Magnoliophyta [1]. A list of plants that serve as sources of sesamin, an important furofuran lignan are presented in Table 1. Sesame of scrophulariales is a source of several dibenzyl butyrolactone lignans such as sesamin. Though sesamin has been isolated from *Piper* sp., *Virola* sp., *Magnolia sp*. and *Camellia* sp. in respectable amounts the oilseed crop *Sesamum indicum* still continues to be the major source of sesamin. The following is an overview on the current status of research on lignans of sesame in terms of distribution, biological significance, biosynthesis and analytical methods adopted.

2. Lignans in sesame

There are sixteen types of lignans isolated from sesame (Fig. 1). Most of them are fat soluble aglycons and therefore elute into the oil on extraction. The remaining are glycosylated and have been isolated from the oil free meal. The major aglycon lignans are sesamin and sesamolin [37,38]. Sesamol, sesaminol, sesamolinol, pinoresinol, matairesinol, lariciresinol and episesamin form minor aglycons of sesame oil [39–42]. The lignan glycosides include mono- di- and triglucosides of sesaminol, sesamolinol and pinoresinol [40,43–45,36,47–49]. Sesaminol triglucoside, sesaminol diglucoside and sesaminol monoglucoside are the most abundant lignan glycosides in sesame [50]. Sesame also contain biologically active tocopherol homologues [α-tocopherol (αT), δ-tocopherol, (δT) and γ-tocopherol (γT)], tocotrienols and naphthoquinones (like chlorosesamone, hydroxysesamone and 2,3 epoxysesamone [51,52]. *Sesamum alatum,* a species with winged seeds, is said to be devoid of both sesamin and sesamolin but has a novel furofuran lignan, 2-episesalatin [53]. Three additional lignans namely saminol, episesaminone-9-O-*β*-D-sophoroside, and semamolactol have been detected in the perisperm of *Sesamum indicum* [54]. Episesaminone, a furanoketone was characterized in part via hemisynthesis from sesamolin. Recently these authors have isolated two new lignans namely, sesamolinol-4́-*O*-β-D glucoside and disaminyl ether (samin dimer) from sesame seeds [55].

3. Analytical methods used for the isolation, identification and quantification of lignan

There were several bioseparation techniques used for analysis and quantitation of lignans in sesame (Table 2). Some of the studies that have contributed significantly to an understanding on the