

9

NA-205

SRI LANKAN MEDICINAL PLANT

MONOGRAPHS AND ANALYSIS

VOL - 5



CASSIA ANGUSTIFOLIA



LAKSHMI ARAMBEWELA & RUVINA SILVA

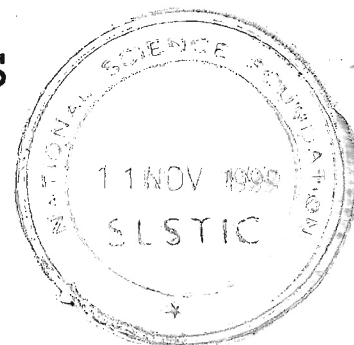
NA 205

NA 205

SRI LANKAN MEDICINAL PLANT

MONOGRAPHS AND ANALYSIS

1999 VOL. 5



CASSIA ANGUSTIFOLIA

LAKSHMI ARAMBEWELA & RUVINA SILVA

INDUSTRIAL TECHNOLOGY INSTITUTE

(CEYLON INSTITUTE OF SCIENTIFIC AND INDUSTRIAL RESEARCH)

363, BAUDDHALOKA MAWATHA,

COLOMBO 7,

SRI LANKA.

SPONSOR

NATIONAL SCIENCE FOUNDATION

© Industrial Technology Institute (CISIR) & National Science Foundation
First published in 1999

National Library of Sri Lanka-Cataloguing-in-Publication Data

Arambewela, Lakshmi

Cassia angustifolia/ Lakshmi Arambewela. Ruvina Silva –

Colombo : National Science Foundation, 1999

Vol 5 -20p;30cm. –(Sri Lankan Medicinal Plant Monograph & Analysis)

ISBN 955-590-023-X

Price : Rs. 150.00

i. 615.321 DDC 21

ii. Title

iii. Series

iv. Silva, Ruvina jt.au.

1. Medicinal plants

2. Botany, Medical

ISSN 1391-4499

ISBN 955-590-023-X

Published by National Science Foundation

The information provided in this monograph is taken from available scientific literature.
The authors accept no liability for any damages arising from any claims contained in this text.

PREFACE

The medicinal plants of Sri Lanka have been investigated in the Natural Products Development Group for nearly two decades. This monograph which is the fourth in this series is the result of the literature surveys, researches and experiences of the Natural Products Development Group of Industrial Technology Institute (Ceylon Institute of Scientific & Industrial Research). This is intended for varied reading public the herbal drug manufactures who need to identify and standardise their herbal raw materials, the Ayurvedic physicians who need some scientific information on medicinal plants, the research workers requiring a quick background on a plant, the industrialist or entrepreneur pondering on commercial ventures and the inquiring lay readers. We hope this monograph fulfils some requirements of each of these.

The authors wish to thank all the members of Natural Products Development Group for their contribution to this, the Information Service group for providing information and Dept. of Chemistry, University of Sri Jayawardenepura for the TLC scanning facility and Dept. of Botany, University of Colombo for photographs of slides. They also gratefully acknowledge the sponsor **National Science Foundation for research grant RG/98/IS/01.**

Natural Products Development Group
Industrial Technology Institute
(Ceylon Institute of Scientific & Industrial Research)
P.O.Box 787,
Colombo 7
Sri Lanka.

CASSIA ANGUSTIFOLIA

<u>Synonyms</u>	-	<i>Cassia lanceolata</i> <i>Cassia elongata</i> <i>Cassia medicinalis</i> <i>Senna officinalis</i> <i>Seena angustifolia</i> ¹
<u>Sinhalese name</u>	-	Senehe
<u>Other names</u>	-	English - Indian senna, Tinnevelly senna, Tamil - Kattunilavari, Nilavagai, Nilavirai, Hindi - Hindisana, Sanskrit - Bhumiari, Bhumichari, Bhumivalli, Bhupadma, Hemapatri, Hemapatrika, Jalatika, Kalyani, Mahaushadhi, Malaharini, Markandika, Mridurechani, Pitapushpi, Rochani, Stholotpala, Svarnamukhi, Svarnapatri, Svarna patrika, Savrnini, Bengali - Sanna-makki, Son-pat, Telugu - Nela-tangedu, Marati - Shona-makki, Kannada - Nelavarike, Malay - Nilavaka, Gujarati - Nat-ki-sana ^{1,2} .
<u>Family</u>	-	Caesalpiniaceae
<u>Parts used</u>	-	Leaves and pods
<u>Pharmacopoeia</u>	-	Ayurveda Pharmacopoeia ³ Sinhalese Materia Medica ⁴ Indian Materia Medica ⁵
<u>Official drugs</u>	-	Powder, concentrated decoctions, boluses, senna pods extract ³ .

Uses in Traditional
Medicine

- The leaves of senna are used in the form of a decoction as a purgative well adapted for children, elderly people and under nourished females in Sri Lanka¹.

Powdered senna leaves mixed with vinegar and made into a plaster are applied locally in certain skin diseases in India⁵.

Senna has been used in the traditional and folklore medicines of East and West as laxatives, stomachic medicines and antidotes^{6,7}.

Middle East physicians had esteemed the fruits more than the leaves and extolled the merits of senna as a purgative and as a cordial when mixed with suitable drugs. Later physicians preferred senna leaves. Senna is most commonly employed in conjunction with an aromatic and alkaline salt to prevent griping⁵.

Other Uses

- Senna leaves combined with henna are used as a black hair dye ⁵.

Distribution

- Sri Lanka, Tropical Africa, Tamilnadu in India^{2,18}.

Morphology

- A small shrub with stems 0.6-1 m high, erect smooth pale green somewhat zigzag with long spreading branches, terete or angular; leaves alternate, spreading, stalked, abruptly pinnate, petiole without a gland, with small, persistent, linear-lanceolate, acute, rigid, spreading stipules, leaflet opposite in 5-8 pairs, 2.5-5 cm long, narrowly lanceolate, or obovate-lanceolate, slightly rounded at base, somewhat tapering to a macronate apex, entire glabrous or very slightly pubescent beneath, bright green above, glaucous on the under surface; flowers irregular, bisexual, bright yellow, arranged in few-flowered, rather lax erect, stalked, axillary racemes, at first about the length of the leaves, afterwards much exceeding them, bracts large, thin, ovate, acute, orange-coloured, falling before the flower expand; calyx very deeply divided into five almost distinct, nearly equal, imbricate, oblong, obtuse, membranous, veined sepals five, imbricate bud, nearly equal, widely spreading, rounded with an acute claw, veined; stamens ten, distinct, hypogynous, unequal, the three uppermost abortive, very small with short barren anthers, the seven lower fertile with short filaments, anthers of the fertile stamens large, linear-oblong, varying in size, the two lowest much longer than the rest and curved upwards, all two-celled, dehiscing by two round pores at the apex of the cells; ovary superior, unilocular, stalked, oblong, falcately curved upwards, minutely downy, strongly compressed with several marginal ovules, style shorter, than the ovary, curved, slender, stigma terminal; fruit pod oblong, 5 cm or long, 1.05-1.8 cm broad, almost straight, smooth or slightly puberulous, without any crests, or other appendage, two-valved, seeds about eight, obovate, wedge-shaped in outline, compressed, hilum large at the pointed end, scantily albuminous⁹.

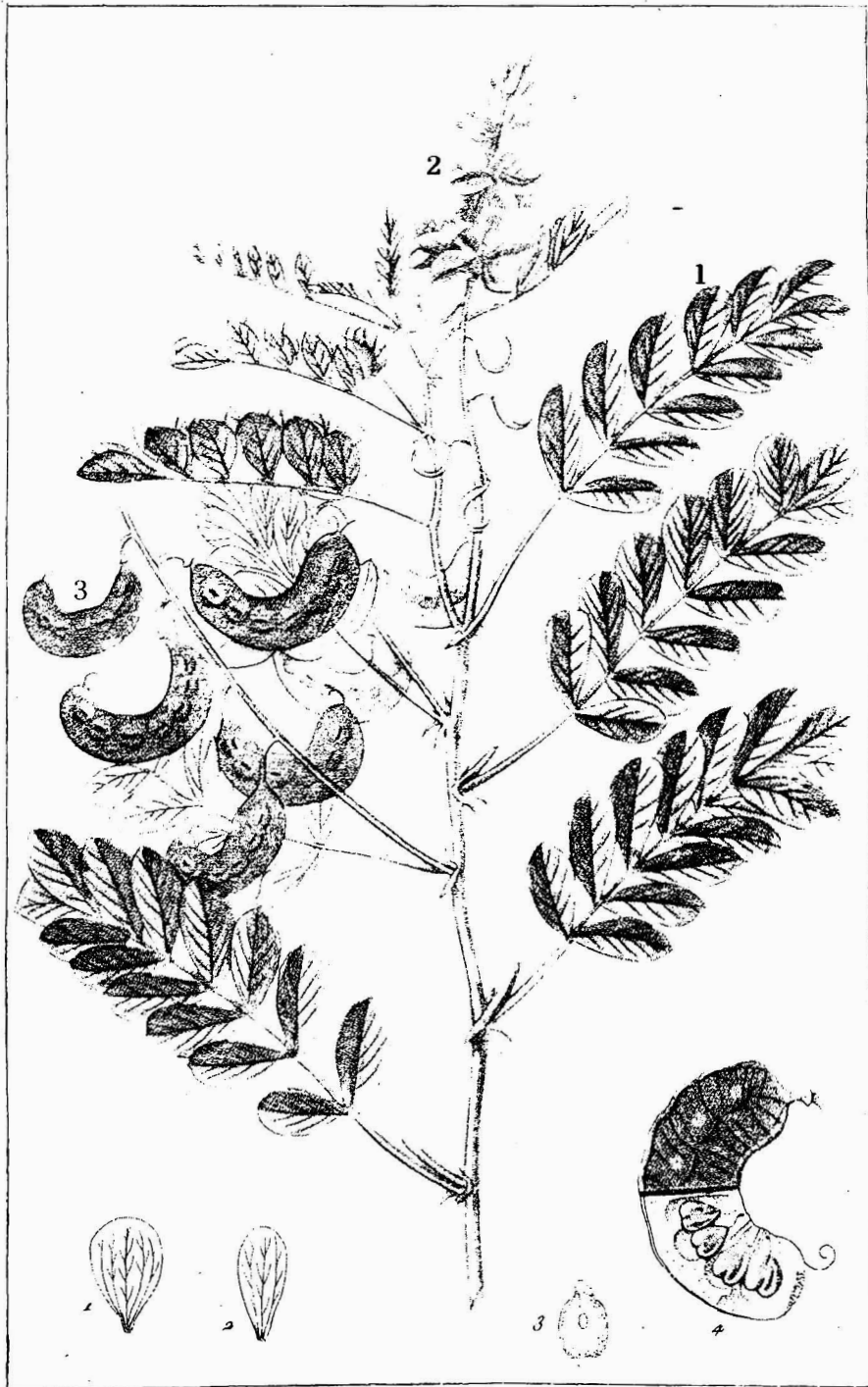


Fig 1 : 1. Leaf 2. Flower 4. Fruit

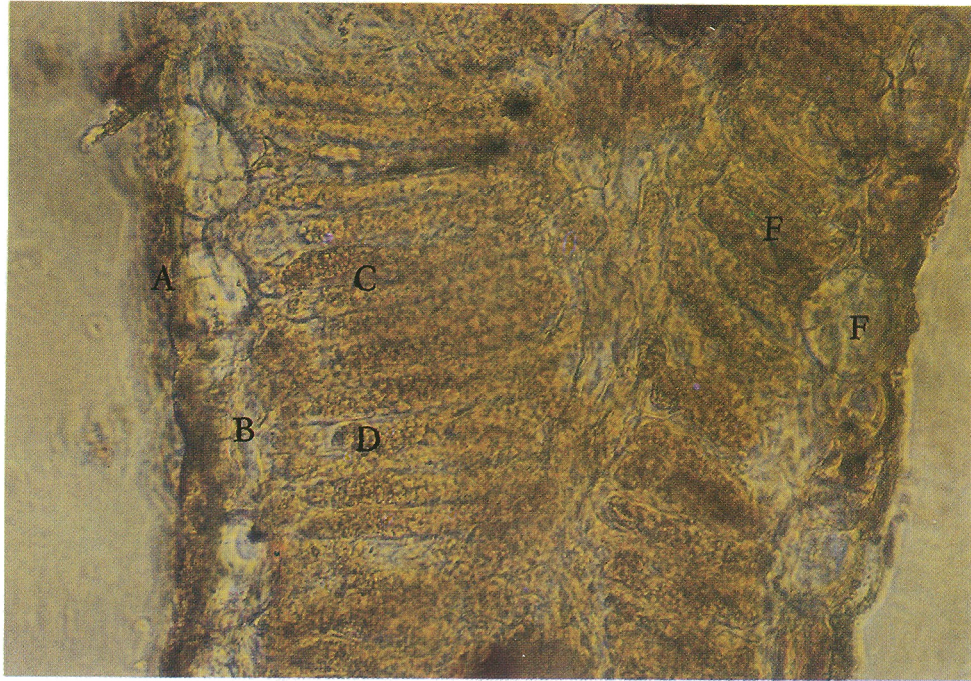


Fig 2 : Cross section of *Cassia angustifolia* leaf

- | | | |
|----------------|----------------------------|------------------------------|
| A. Cuticle | B. Upper epidermis | C. Palisade parenchyma cells |
| D. Chloroplast | E. Spongy parenchyma cells | F. Lower epidermis |

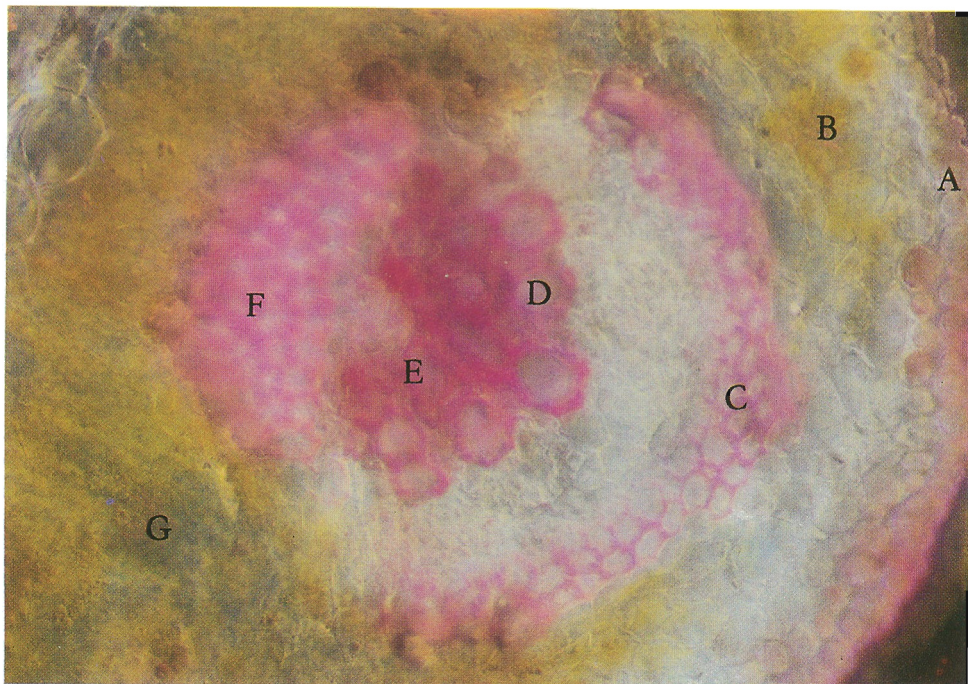


Fig 3 : Cross section of *Cassia angustifolia* leaf through main vein

- | | | |
|--------------------|----------------------------|-----------------|
| A. Upper epidermis | B. Spongy parenchyma cells | C. Fiber sheath |
| D. Vessels | E. Xylem | F. Phloem |
| G. Chloroplast | | |

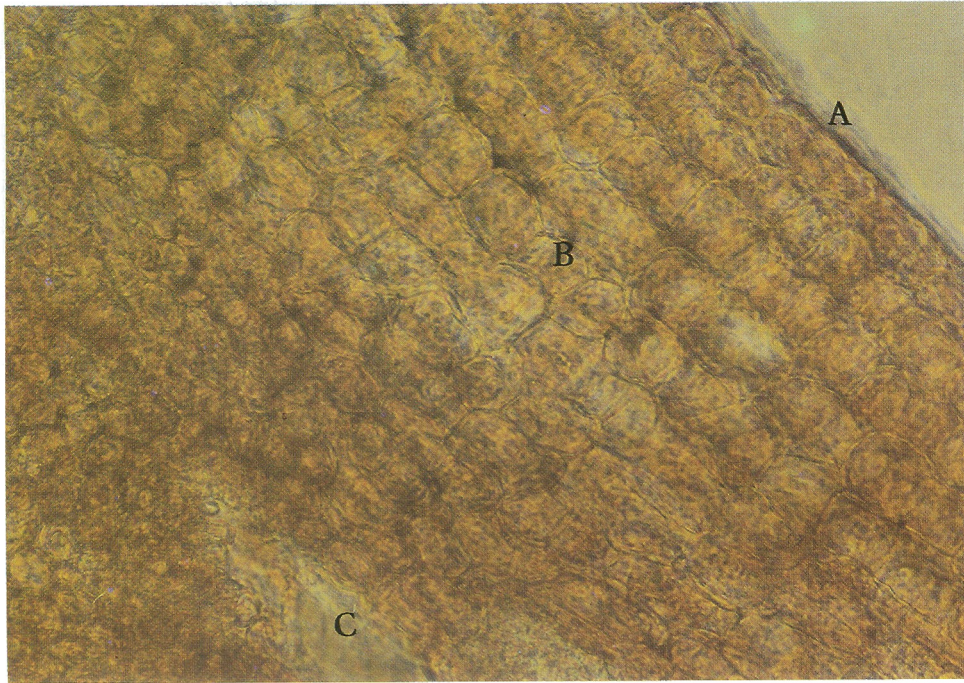


Fig 4 : Cross section of *Cassia angustifolia* pod
 A. Cuticle B. Parenchyma cell C. Lumen for seed

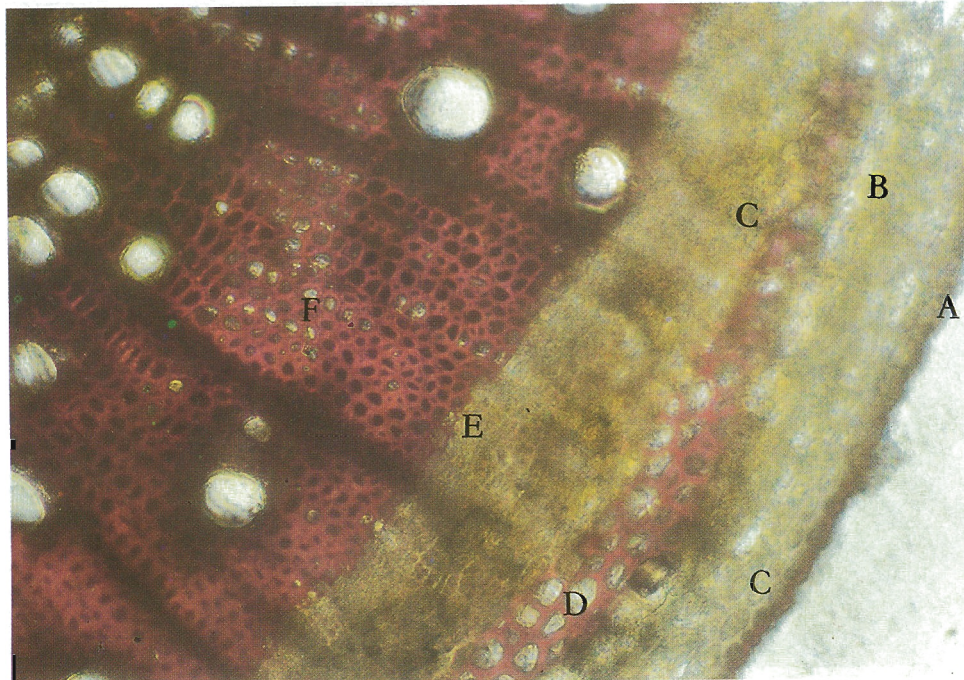


Fig 5 : Cross section of *Cassia angustifolia* stem
 A. Epidermis B. Chlorenchyma C. Cholenchyma
 D. Layer of fibre E. Phloem F. Xylem

AGRONOMY

In *Cassia angustifolia* the number of branches, length of leaves number of leaves per plant, leaf yield at 90 days, and sennoside content of pods at 25 days showed significant positive correlation with leaf yield in *C. angustifolia*. The pod yield significantly correlated with plant height, number of branches, length of racemes, number of pods set per spike at 100 days, length of pods, yields of pods at 25 days and sennoside content pods at 25 days¹¹.

In *Cassia angustifolia*, spacing and nitrogen levels were found to have significant influence on plant height, which showed an increasing trend with reduction in spacing and increasing levels of nitrogen¹⁰.

Cassia angustifolia plants under closer spacing yielded lesser amount of sennoside due to less yield of leaves and pods per plant, sennoside yield per plot showed significant differences due to levels of spaces, nitrogen and phosphorus and interaction between spacing and nitrogen¹².

The sennoside content increased with the increasing amounts of N-fertiliser content. The highest content of sennosides in leaves was observed around 95-100 days of maturity. The optimum amount of N needed to obtain highest sennoside content in senna plant was 120kg/ha. Lower amount of fertilizer application resulted in a lower yield of sennoside. When N fertiliser was applied to *C. angustifolia* plant, the period of maturity shifted from 90-95 days to 100-102 days¹³.

The sennoside content in leaves increased gradually when rice straw mulch was applied, when the beds were not covered with mulching material, but completely weeded, it did not show the highest percentage of sennoside content as expected. This shows that microclimatic changes in soil due to straw mulching can favour sennoside production. The need for weed control and moisture retention can thus be stressed for high sennoside yield¹³.

The pods possess more sennoside than other parts of the *C. angustifolia* plant (through out the life time). Therefore pods can be used as a good source of sennoside. Pods appeared after about 90 days of planting, and they were yellowish green in colour when they are juvenile. Gradually the pods become large in size and dark in colour. The pods harvested earlier (25 days from set) developed pleasing colour popularly called “golden green” colour on drying, and such pods are preferred and fetch nearly twice the price in the market. The pods contained their maximum sennoside content when the plants were about 120 days old. After about 130 days, the sennoside content in pods reduced fast and colour changed from green to black (blackish green). The best time to harvest pods is when the plants are 120-125 days old^{13,14}.

The formation of free anthraquinone and glycosides starts in 72 hours to one week old seedling and increased to its optimum level in 90 days old plants¹⁵.

The promise of *Cassia angustifolia* Vahl, *Tinnevelly senna*, as an alternative crop for stressful agroecosystems has been evaluated. Effects of drought, foliar nitrogen application, and crop type on sennoside yields were studied with simultaneous measurements of net photosynthesis. Short-term drought increased sennoside A + B concn. (% dw). After drought-induced morphological changes had occurred, long term drought did not influence sennoside A + B concentration but severe loss of leaf biomass caused 78% reduction of the sennoside yield per plant. Foliar nitrogen application increased the total sennoside A + B content per plant by 140% when the plants were not water stressed, but in severely droughted plants, no effect of foliar nitrogen application was detected. Although foliar nitrogen application increased sennoside A + B per plant, the sennoside concentration (% dw) decreased. The latter effect was still persistent three months after the nitrogen treatments were discontinued. In a comparison among three crop types of Tinnevelly senna, ratoon plants had the highest sennoside A + B concentration in leaves followed by seedlings and cuttings. However, seedlings produced the highest sennoside A + B yields per plant due to the higher leaf biomass. Except in long-term drought, sennoside levels were higher in leaves with lower net photosynthesis, and were increased by treatments that induced physiological stress. Lower net photosynthesis occurred in short term and long term drought, and with deprivation of foliar nitrogen supplements. In contrast, sennoside yields per plant are readily increased by treatments that increase the total leaf biomass. Short term drought, nitrogen stress, and ratooning are promising component technologies for field and on-farm investigations with the goal of increasing sennoside yields¹⁶.

ANALYTICAL SPECIFICATION

Powder Analysis : Leaves

Macroscopic characters

Colour - Dark brown
Odour - Slightly aromatic
Taste - Slightly bitter

Microscopic character

The powder of *Cassia angustifolia* aerial parts shows-
Wilt irregular shape parenchyma cells and their parts.
Large numbers of droplet like granules that have come out from the cells.

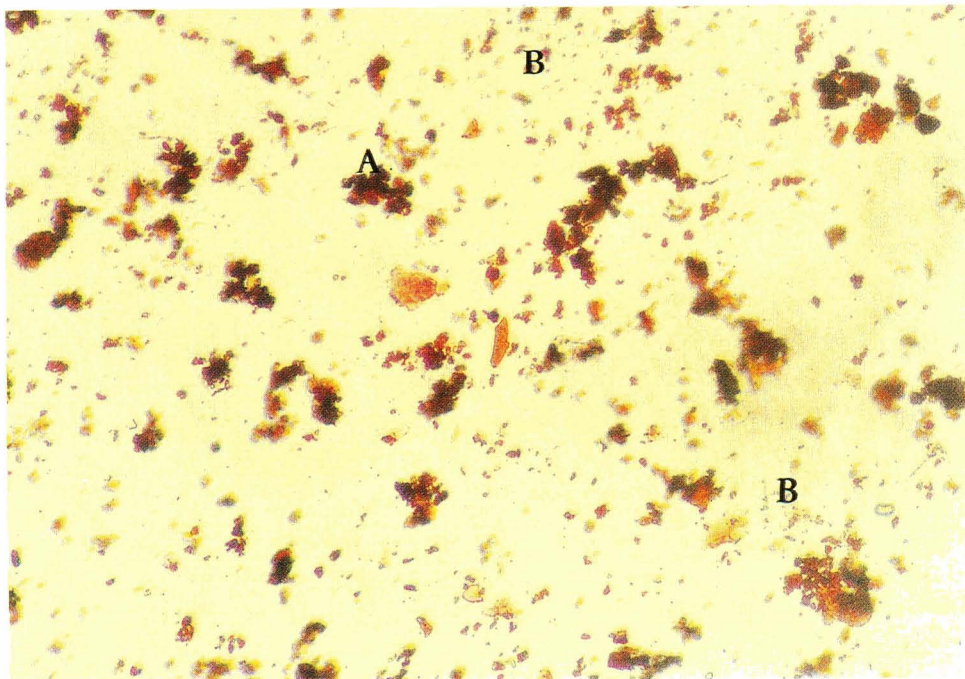


Fig 6 : Powder of *Cassia angustifolia* leaves under the microscope
A. Part of parenchyma cells B. Cell content

Powder Analysis : pods

Macroscopic characters

Colour - Dark brown
Odour - Slightly aromatic
Taste - Slightly bitter

Microscopic character

The powder of *Cassia angustifolia* pods shows-

Thin walled parenchyma cells.

Fragments of thick walls of tracheids / vessels and parts of tracheids / vessel, with irregular shape parenchyma cells and their parts.

Large numbers of droplet like granules that have come out from the cells.



Fig 7 : Powder of *Cassia angustifolia* pods under the microscope

A. Part of parenchyma cells

B. Cell content

C. Fragment of a tracheid / vessel

Table 1 : Physico – Chemical Analysis

Test	Limits
Ethanollic extract of leaves	7.3-11.3%
Ash content of aerial part	<9.5%
Acid insoluble ash content of leaves	<0.66%
Ethanollic extract of pods	7.3-11.3%
Ash content of pods	<7.2%
Acid insoluble ash content of pods	<0.2%

Table 2 : Sennoside contents in *C. angustifolia*¹³

Part	Extract	Average sennoside content
Senna leaves	70% methanol	2.28 %
Senna leaves	Water	1.12%
Senna pods	70% methanol	10.0%
Senna pods	Water	5.9%

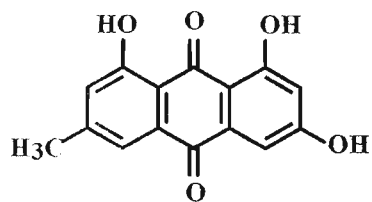
PHYTOCHEMISTRY

C. angustifolia contains chrysoretin, cathartomannite, sennacrol, sennapicrin, mannitol, sodium potassium tartarate, myricyl alcohol, salicylic acid, chrysophanic acid, calcium, potassium, magnesium salts, two aloe-emodin dianthrone diglucosides (I and II), mineral elements Mn, Mg, Zn, Ca, Fe, Ni, Cr, Na, K, Al and Sr^{2,17,18}.

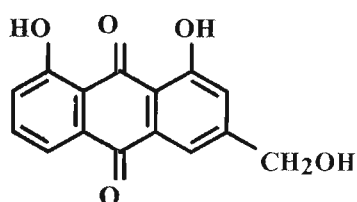
C. angustifolia leaves and pods contain 6-hydroxymusicin glycoside, tinnevellin glycoside, kaemferol, isorhamnating, myricyl alcohol, salicylic acid, phytosterolin, mucilage resin, chrysophanic acid and calcium oxalate, sennoside A, sennoside B, sennoside C, sennoside D, rhein anthrone-8-glycoside, rhein 8-glycoside, rhein-8-glycoside, rhein-8-di-glycoside aloe-emodin-8-glycoside, aloe-emodin anthrone di-glycoside, aloe-emodin, rhein, calcium oxalate, 14 metals K and Ca are the highest of the metals^{5,19-22}.

C. angustifolia pods contain sennoside A, sennoside B, sennoside C, sennoside D, rhein anthrone-8-glycoside, rhein 8-glycoside, aloe-emodin-8-glycoside, aloe-emodin anthrone glycoside²¹.

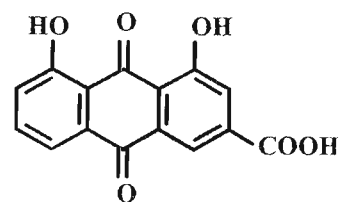
The seeds of *Cassia angustifolia* contain 1-hydroxy-3,6,7,8-tetramethoxy-2-isopropylantraquinone, 1,5,7-trihydroxy-8-methoxy-3-methylantraquinone²³.



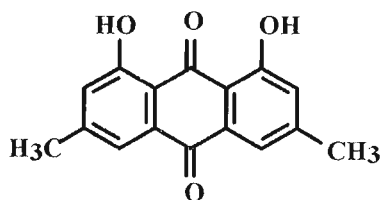
Frangula emodin



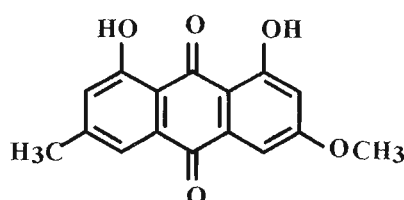
Aloe emodin



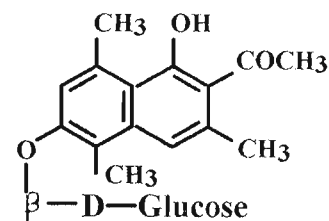
Rhein



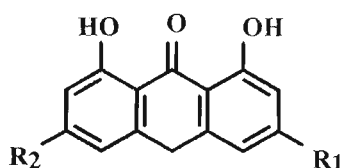
Chrysophanic acid



Physcion

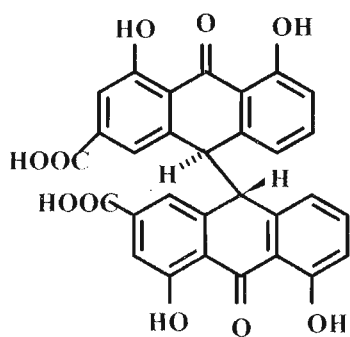


Tinnevellin glycoside

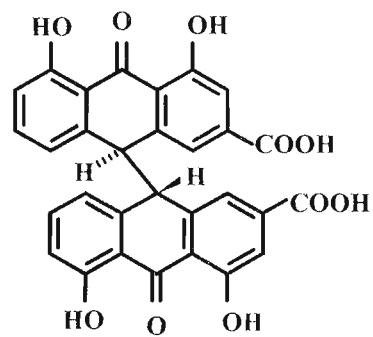


- | | |
|-------------------------|----------------------|
| $R_2 = H, R_1 = CH_3$ | Chrysophunolanthrone |
| $R_2 = H, R_1 = CH_2OH$ | Aloe emodianthrone |
| $R_2 = H, R_1 = COOH$ | Rheinanthrone |
| $R_2 = H, R_1 = CH_3$ | Emodinanthrone |

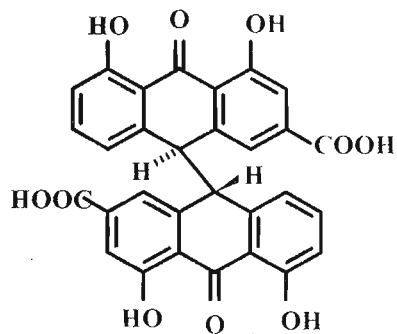
Fig 8 Compounds present in *Cassia angustifolia*



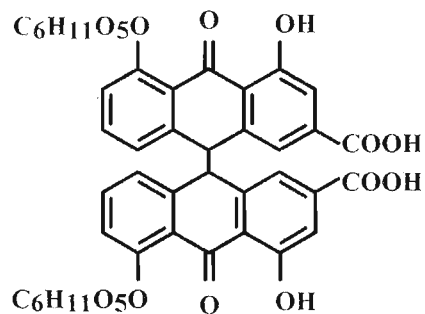
Sennidin A or A1



Sennidin A or A1



Sennidin B



Anthroquinone glycoside

Fig 9 Compounds present in *Cassia angustifolia*

PHARMACOLOGY

The preparations of senna act on the intestine by exciting peristalsis without affecting functions of stomach and duodenum. It is painless in use and the intestine does not become habituated to their use. An infusion of dried senna is activated in the large intestine only, possibly by colon bacillus^{24,25}.

The cathartic action is attributed to the presence of anthraquinones or related compounds. The purgative action depends on the amount of free hydroxy anthraquinone and the ease of decomposition of the corresponding glycosides. The colon bacillus appears to perform hydroxylic cleavage of the anthraquinone glycosides. The aglycones are then activated in the colon. The activated anthraquinone derivatives act directly on the smooth muscles of colon. As the result of which the peristaltic movement of the colon are stimulated and increased. Also the absorption of water is decreased and a softer faecal mass is formed^{25,27,28,29,30}

However 1,8-dihydroxy anthraquinone monoglycoside has shown superior colonic propulsive activity than the aglycone when given orally to mice, resulting in greater purgative activity. The anthraquinone derivatives are more favourably adsorbed in the form of glycosides and also probably glucose moiety protects the active principle against degradation³¹.

Successful treatment of constipation in immediate postpartum period of more than 90% patients was achieved in a clinical trial of standardised senna tablets. Minor abdominal cramps occurred in some 13% of the patients treated with standardised senna. There is no evidence to suggest that standardised senna have any effect whatsoever on a breast-fed baby if taken by the mother²⁶.

The aperient effect of senna ensues in about 7-12 hours. This may be associated with mild colics but without inflammatory intestinal irritation. In order to remove the cause of these colics the resinous components of the drug are often taken out by extraction of the leaves with spirits of wine, this however, results in the loss also of active substances. So the use of folia senna sine resina cannot be advocated⁵.

Cassia angustifolia and their virucidal effects were tested against herpes simplex virus type 1. Aloe emodin inactivated all of the viruses tested. Electron microscopic examination of anthraquinone-treated herpes simplex virus demonstrated that the envelopes were partially disrupted. The anthraquinones extracted are directly virucidal to enveloped viruses^{32,33}.

Two aloe-emodin dianthrone diglucosides (I and II) isolated from the leaves of *Cassia angustifolia*, exerts a potentiating effect of about 1.3 times on the purgative activity of sennoside A in mice³⁴.

Cassia angustifolia galactomannan and *Tamarindus indica* xyloglycan, showed that the variety in the structures and origins of these 2 polysaccharides was also found in their biological benefits, such as energising, anti-UV stress, long-term moisturising, softening and immuno stimulating effects. Thus, these 2 polysaccharides can be used in cosmetic preparations for face and body care, sun-care preparations treating make-ups, anti-age through various galenic forms³⁴.

TLC PROFILE

Sample preparation

- Sample detail - *C. angustifolia* leaves
- Sample preparation - *C. angustifolia* leaves (5.0g) were extracted with ethanol and concentrated 15 μ l (37.8mg/10ml) of extract and 10 μ l (2mg/10ml) of sennoside A & B were applied to TLC plate.
- Adsorbent - Silica gel GF₂₅₄
- Solvent system - Benzene : ethyl acetate (3 : 7)
- Detection
- Direct evaluation - UV₂₅₄nm, UV₃₆₆nm
Rf values (UV₂₅₄)
Extract : 0.04, 0.09, 0.15, 0.47, 0.54, 0.63
Rf values (UV₃₆₆)
Extract: 0.08, 0.20, 0.66, 0.74, 0.85
- Scanning - Densitometer
- Spray reagent - Vanillin – sulphuric acid



Fig : 10

TLC chromatogram of
1. sennoside B
2. *C. angustifolia* leaves extract

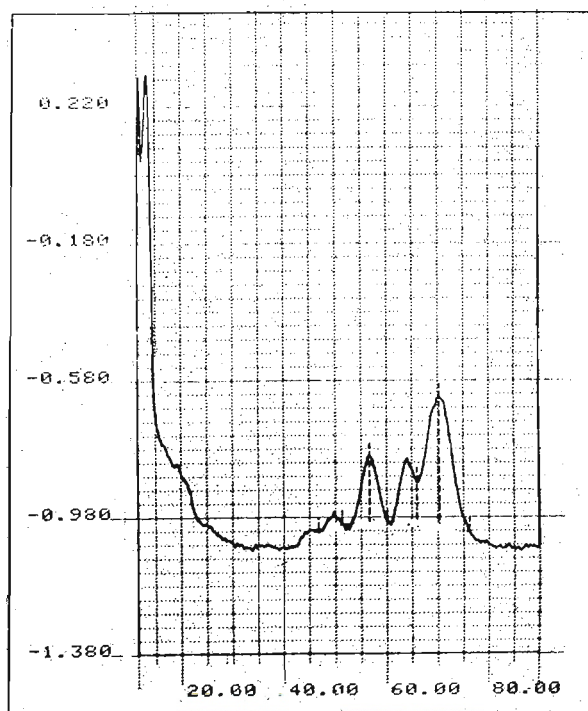


Fig: 11

TLC Densitometer finger print

TLC PROFILE

Sample preparation

Sample detail

- *C. angustifolia* pods

Sample preparation

- *C. angustifolia* pods (5.0g) were extracted with ethanol and concentrated 15 μ l (72.5mg/10ml) of extract and 10 μ l (2mg/10ml) of sennoside A & B were applied to TLC plate.

Adsorbent

- Silica gel GF₂₅₄

Solvent system

- Benzene : ethyl acetate (3 : 7)

Detection

Direct evaluation

- UV_{254nm} UV_{366nm}

Rf values (UV_{254nm})

Extract : 0.04, 0.13, 0.55, 0.65

Rf values (UV₃₆₆)

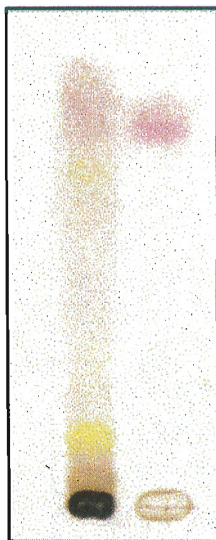
Extract : 0.08, 0.13, 0.66

Scanning

- Densitometer

Spray reagent

- Anisaldehyde and Vanillin – sulphuric acid



1 2

Fig : 12

TLC chromatogram of
1. *C. angustifolia* pods extract
2. sennoside B

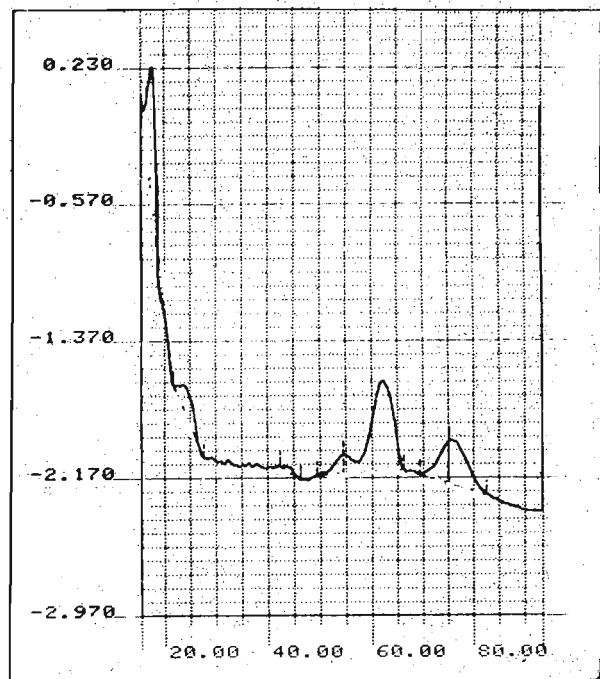


Fig : 13

TLC Densitometer finger print

HPLC PROFILE

C. angustifolia : Leaves

- Sample preparation - *C. angustifolia* leaves (5.0g) were extracted with ethanol (12.8mg/10ml) and purified using Sep-pak C18 cartridge.
- Injection volume - 20 μ l
- Apparatus - Waters 501 HPLC pump.
SPD 10AV Shimadzu uv-vis detector.
- Column - μ Bondapak™ RP18
- Solvent system - Methanol : water (1: 1)
- Flow rate - 0.5ml/min
- Detection - 270nm

Description of the HPLC – Chromatogram

Table 3 : Retention time of main peaks

Peak no	Rt (min)
1	1.47
2	1.90
3	3.02
4	4.27
5	4.70
6	7.03
7	8.11
8	10.05

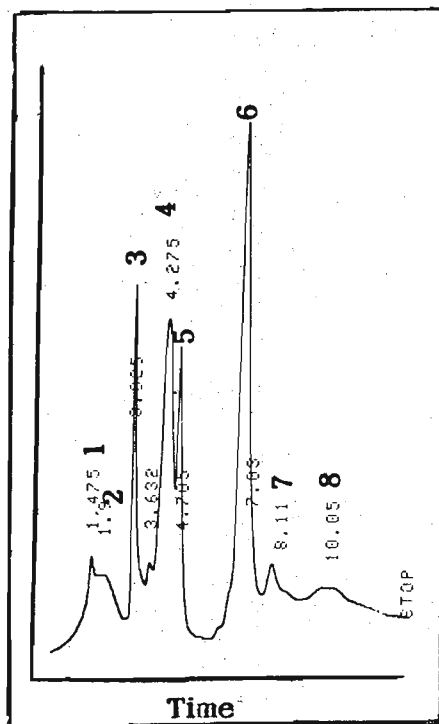


Fig : 14
HPLC chromatogram of leaves

HPLC PROFILE

C. angustifolia : pods

- Sample preparation - *C. angustifolia* pods (5.0g) were extracted with ethanol (4.8mg/10ml) and purified using Sep-pak C18 cartridge.
- Injection volume - 20 μ l
- Apparatus - Waters 501 HPLC pump.
SPD 10AV Shimadzu uv-vis detector.
- Column - μ Bondapak™ RP18
- Solvent system - Methanol : water (1 : 1)
- Flow rate - 0.5ml/min
- Detection - 270nm

Description of the HPLC – Chromatogram

Table 4 : Retention time of main peaks

Peak no	Rt (min)
1	1.43
2	3.08
3	3.69
4	4.28
5	4.73
6	5.59
7	7.04
8	8.06
9	10.38

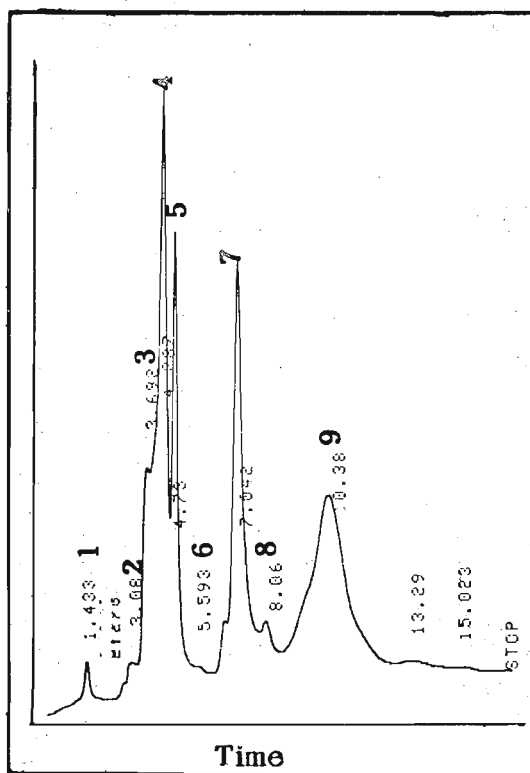


Fig : 15
HPLC chromatogram of pods