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REVIEW ARTICLE

Phytochemical Profiling of Different *Cassia* Species A: Review

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ABSTRACT

The plants have been used in traditional medicines over a long period throughout the world. Species of genus *Cassia* contain many important phytochemicals and are well known in folk medicines. These phytochemicals exhibit interesting biological and pharmacological properties. Alkaloids, flavonoids, tannins, saponins *etc* are some of the useful phytoconstituents used for the preparation of various medicines. This review is compiled to document the alkaloids, flavonoids, saponins and tannins present in species of the genus *Cassia* using different solvents. It will throw a light on the treasure of phytochemicals with a potential for pharmaceutics. Based on this information, species can be selected and characterized to meet the requirements of human health care system.

Key words: *Cassia*, Phytochemicals, Alkaloid, Flavonoid, Saponin, Tannin.

INTRODUCTION

Plants are important for humans in different capacities including their crucial role as source of medicine since long due to the presence of various phytochemicals[42]. Plant based medicines are generally considered to be safe. More than 50% of all modern clinical drugs are natural products that play an important role in drug development in pharmaceutical industries[28]. The use of medicinal plants and their products has increased in the past few years to improve and maintain good health with lesser side effects on the human body [52]. Recent research on the natural molecules and products primarily focuses on plants as they are easily available and selected on the basis of ethno-medicinal uses [49]. *Cassia* L. is a member of family Fabaceae and have approximately 500 species, distributed in different parts of the world [26]. *Cassia* species occurs in India, China, East Africa, South Africa, America, Brazil *etc*. The species are represented as herbs, shrubs, and trees [45]. Some of the common Indian species are *C. obovata*, *C. italica*, *C. sophera*, *C. mimosoides*, *C. siamea etc* [7, 39]. Members of this genus are useful for different purposes including medicines. Different species of *Cassia* play a significant role as antioxidants, antimicrobial, antibacterial, antifungal, anti inflammatory, blood purifier and hepatoprotectant[42, 30, 13, 25]. The species are important in pharmacological research because of the presence of different phytochemicals of medicinal and nutritive value [23]. Phytochemicals are produced in plants as protectants but researchers have demonstrated their role in the management of human diseases as well. The detailed account of phytoconstituents may be useful for the synthesis of complex molecules of medicinal interest [55]. The recent studies related to phytochemicals possessing antioxidant, antimicrobial and anti-inflammatory properties have been increasing because of their therapeutic potential to cure infectious diseases[29]. The medicinal value of the plants lies in bioactive compounds that produce definite physiological actions in human body[36]. The bioactive phytoconstituents include alkaloids, flavonoids, saponins, tannins phenols, essential oils *etc*[10]. The chemical constituents of the plant may vary in different species, varieties, and plant part used and growth conditions as well as age of the plant[49]. There is a variety of phytochemicals present in the plants having unique therapeutic potential. Alkaloids, flavonoids, saponins, and tannins are some of the important phytochemicals. In this review, efforts have been made to comprehensively compile information related to these phytochemicals in various *Cassia* species using different solvents.

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DISCUSSION

This review has highlighted the presence of alkaloids, flavonoids, saponins and tannins in most of the *Cassia* species. Presently, 23 species of the genus have shown these phytochemicals in different solvents. The species include herbs, shrubs and trees. Majority of the studies were conducted on *Cassia occidentalis.* Leaves were the most preferred part for alkaloids, flavonoids, saponins and tannins analysis. The observations of different studies have been compiled. The data indicates that methanol was the most commonly used solvent followed by ethanol and water. Methanol was the most effective solvent whereas, acetone was least. Alkaloids were present in methanol extracts of almost all species in which studies carried out using different solvents except *C. nigricans* and *C. roxburghii*. All the parts of *C. obtusifolia* contain alkaloids. Alkaloids are absent in leaves of *C. nigricans, C. grandis* and *C. roxburghii* in different solvents. These are also absent in ethanol leaf extract and petroleum ether extracts of leaf, flower and seed of *C. occidentalis.* However, methanol, ethanol and petroleum ether leaf extracts of species *C. alata, C. biflora, C. hirsuta, C. occidentalis, C. siamea, C. spectabilis, C. sericea, C. surattensis* and *C. tora* contain alkaloids (Table 1).

Table 1. Alkaloids in *Cassia* species:

Species	PPU	Solvents								Ref.
		Aq.	Met.	Eth.	PE	EA	Hex.	Ace.	Chl.	
C. alata	Lf	-	-	-	-	Ɵ	Ɵ	-	-	38
	Lf	-	+	+	-	+	-	-	-	54
	Lf/St/Rt	+	+	-	-	-	-	Ɵ	Ɵ	46
	Fl	+	+	+	-	-	-	-	-	28
C. auriculata	Lf	-	+	+	-	+	-	-	-	54
	AP	-	+	-	Ɵ	Ɵ	-	-	+	11
	Fl	-	+	-	-	-	-	-	-	39
	Fl	-	+	-	Ɵ	-	-	-	Ɵ	56
	Fl	-	Ɵ	Ɵ	Ɵ	-	-	-	-	13
	Lf/Fl	-	-	+	-	-	-	-	-	22
	Fl	Ɵ	Ɵ	-	-	Ɵ	+	-	+	53
C. absus	Se	-	-	-	-	+	+	-	+	20
C. angustifolia	Lf	Ɵ	-	+	+	-	-	-	+	57
	Lf	-	+	-	+	-	-	+	Ɵ	48
C. biflora	Lf	-	+	+	-	+	-	-	-	55
C. fistula	Lf	-	+	+	-	+	-	-	-	55
	WP	+	+	-	+	-	-	-	-	29
	Lg	-	Ɵ	-	Ɵ	Ɵ	-	-	Ɵ	7
	Rt	-	-	Ɵ	-	-	-	-	-	8
C. glauca	Se	-	+	-	-	-	-	+	-	30
	Lf	-	+	-	-	-	-	+	+	15
C. grandis	Lf	-	-	Ɵ	-	-	-	-	-	18
C. hirsuta	Lf	-	-	+	-	-	-	-	-	41
	Lf	-	+	+	-	+	-	-	-	55
C. javanica	Lf	+	-	+	-	-	-	-	+	31
C. mimosoides	Lf	+	-	-	-	-	-	-	-	12
	Lf	+	+	-	-	-	-	-	-	40
C. nigricans	Lf	-	Ɵ	-	Ɵ	Ɵ	-	-	Ɵ	3
C. obtusifolia	Lf	-	-	+	Ɵ	-	-	-	-	24
	Lf	+	-	+	-	-	-	-	-	50
	Lf/St/Se/Rt	-	-	+	-	-	-	-	-	10
	Lf	+	-	-	-	-	-	-	-	44
C. occidentalis	Lf	-	+	+	-	+	-	-	-	54
	Lf	-	+	-	-	+	+	-	-	36
	Lf	Ɵ	-	-	-	-	Ɵ	-	Ɵ	14
	Fl/Se	-	+	-	Ɵ	-	-	-	+	51
	Lf	Ɵ	-	+	-	-	-	-	-	47
	Lf	Ɵ	Ɵ	-	Ɵ	-	-	-	Ɵ	2
	Lf	Ɵ	Ɵ	Ɵ	-	-	-	-	-	45
	Lf	Ɵ	-	Ɵ	Ɵ	Ɵ	-	-	Ɵ	32
	Lf	Ɵ	-	-	-	-	-	-	-	4
	Se	+	-	-	-	-	-	-	-	4
C. renigera	Fr	-	+	-	Ɵ	-	-	-	-	19
C. roxburghii	Lf	Ɵ	-	Ɵ	-	-	-	Ɵ	Ɵ	26
	Lf	Ɵ	Ɵ	-	Ɵ	Ɵ	-	-	Ɵ	23
C. sophera	Lf	-	+	-	-	-	-	-	-	25
	Lf/Se/Rt	-	Ɵ	-	-	-	-	-	-	5
	Ba	-	-	Ɵ	Ɵ	Ɵ	-	-	Ɵ	35
C. siamea	Lf	+	-	-	-	-	-	-	-	9
	Lf/Ba	-	Ɵ	-	-	-	-	-	-	52
	Lf/Ba	-	+	-	-	-	-	-	-	33,37
	Lf	-	+	+	-	+	-	-	-	55
	Fl	Ɵ	Ɵ	-	-	Ɵ	+	-	Ɵ	53

C. spectabilis	Lf	-	+	+	-	+	-	-	-	55
	Fr	Ɵ	-	+	-	-	-	+	Ɵ	27
C. sericea	Lf	-	+	+	-	+	-	-	-	54
C. surattensis	Lf	-	+	+	-	+	-	-	-	54
	Lf/Fl	-	Ɵ	-	-	-	-	-	-	6
	AP	-	+	-	-	+	+	-	+	16
C. tora	Lf	-	+	+	-	+	-	-	-	54
	Lf/Po	Ɵ	Ɵ	-	Ɵ	-	-	-	Ɵ	17,49
	Lf	+	+	-	Ɵ	-	-	+	+	34
	AP	-	-	Ɵ	-	Ɵ	-	-	+	42
	Se	Ɵ	Ɵ	Ɵ	Ɵ	-	-	-	-	43
C. uniflora	WP	+	+	+	-	-	-	+	-	21

Plant Part Used- PPU, Leaf- Lf, Stem- St, Seed- Se, Root- Rt, Aerial Parts- AP, Flower- Fl, Fruit- Fr, Legumes- Lg, Pod- Po, Bark- Ba, Whole plant- WP. **Solvents** :- Aqueous- Aq., Methanol- Met., Ethanol- Eth., Petroleum Ether- PE, Ethyl Acetate- EA, Hexane- Hex., Acetone- Ace., Chloroform- Chl. **References:** - Ref. [+] = Present, [Ɵ] = Absent, [-] = Not done.

Flavonoids are present in the leaves of all *Cassia* species except *Cassia fistula*, however other parts of this species contain flavonoids. They are present in the bark of *C. siamea* but absent in *C. sophera*. The flavonoids are also reported in the flowers of *C. alata, C. auriculata* and *C. siamea* and in roots of four *Cassia* species in various solvents (Table 2).

Table 2. Flavonoids in *Cassia* species

Species	PPU	Solvents								Ref.
		Aq.	Met.	Eth.	PE	EA	Hex.	Ace.	Chl.	
C. alata	Lf	-	-	-	-	+	+	-	-	38
	Lf	-	+	+	-	+	-	-	-	54
	Lf/St/Rt	+	+	-	-	-	-	+	Ɵ	46
	Fl	+	+	+	-	-	-	-	-	28
C. auriculata	Lf	-	+	+	-	+	-	-	-	54
	AP	-	+	+	Ɵ	-	-	-	+	11
	Fl	-	+	+	Ɵ	-	-	-	-	13
	Fl	-	+	-	-	-	-	-	-	39
	Lf/Fl	-	+	-	+	-	-	-	Ɵ	56
	Lf/Fl	-	-	+	-	-	-	-	-	22
	Fl	+	+	-	-	+	Ɵ	-	+	53
C. absus	Se	-	-	-	-	+	+	-	+	20
C. angustifolia	Lf	+	-	+	Ɵ	-	-	-	+	57
	Lf	-	+	-	+	-	-	+	+	48
C. biflora	Lf	-	+	+	-	+	-	-	-	55
C. fistula	Lf	-	Ɵ	Ɵ	-	Ɵ	-	-	-	55
	WP	+	+	-	Ɵ	-	-	-	-	29
	Lg	-	+	-	Ɵ	+	-	-	Ɵ	7
	Rt	-	-	+	-	-	-	-	-	8
C. grandis	Lf	-	-	+	-	-	-	-	-	18
C. hirsuta	Lf	-	-	+	-	-	-	-	-	41
	Lf	-	Ɵ	+	-	+	-	-	-	55
C. italica	Lf	-	-	-	-	+	-	-	-	1
C. javanica	Lf	+	-	+	-	-	-	-	+	31
C. mimosoides	Lf	+	-	-	-	-	-	-	-	12
C. nigricans	Lf	-	+	-	+	+	-	-	+	3
C. obtusifolia	Lf	-	-	+	Ɵ	-	-	-	-	24
	Lf	+	-	+	-	-	-	-	-	50
	Lf/St/Se/Rt	-	-	+	-	-	-	-	-	10
	Lf	+	-	-	-	-	-	-	-	44
C. occidentalis	Lf	-	+	+	-	Ɵ	-	-	-	54
	Lf	-	Ɵ	-	-	Ɵ	Ɵ	-	-	36
	Fl/Se	-	+	-	+	-	-	-	+	51
	Lf	+	-	+	-	-	-	-	-	47
	Lf	+	+	-	Ɵ	-	-	-	Ɵ	2
	Lf	Ɵ	Ɵ	Ɵ	-	-	-	-	-	45
	Lf	Ɵ	-	+	Ɵ	+	-	-	+	32
	Lf	Ɵ	-	-	-	-	-	-	-	4
	Se	+	-	-	-	-	-	-	-	4
C. renigera	Fr	-	+	-	+	-	-	-	-	19
C. roxburghii	Lf	+	-	+	-	-	-	Ɵ	Ɵ	26
C. sophera	Lf	-	+	-	-	-	-	-	-	25
	Lf/Se/Rt	-	+	-	-	-	-	-	-	5
	Ba	-	-	Ɵ	Ɵ	Ɵ	-	-	Ɵ	35
C. siamea	Lf	+	-	-	-	-	-	-	-	9
	Lf/Ba	-	+	-	-	-	-	-	-	52,33
	Ba	-	+	-	-	-	-	-	-	37

	Lf	-	+	+	-	+	-	-	-	55
	Fl	+	+	-	-	+	Ɵ	-	+	53
C. spectabilis	Lf	-	+	+	-	+	-	-	-	55
	Fr	+	+	-	-	-	-	Ɵ	Ɵ	27
C. sericea	Lf	-	+	+	-	Ɵ	-	-	-	54
C. surattensis	Lf	-	+	Ɵ	-	+	-	-	-	54
	Lf/Fl	-	+	-	-	-	-	-	-	6
	AP	-	+	-	-	+	Ɵ	-	+	16
C. tora	Lf	-	Ɵ	Ɵ	-	+	-	-	-	54
	Lf	+	+	+	-	-	-	-	Ɵ	49
	Po	Ɵ	+	+	-	-	-	-	+	17
	Lf	+	+	-	Ɵ	-	-	+	+	34
	AP	-	-	Ɵ	-	Ɵ	-	-	Ɵ	42
	Se	+	Ɵ	Ɵ	Ɵ	-	-	-	-	43
C. uniflora	WP	Ɵ	+	+	-	-	-	+	-	21

The saponins are found in *C. angustifolia* in four different solvents. They are absent in the leaves of *C. biflora*, *C. roxburghii* and fruit of *C. renigera.* Similar to flavonoids, they are reported in the bark of *C. siamea* but not in *C. sophera*. Seeds of *C. absus, C. glauca, C. occidentalis, C. sophera*, and *C. tora* also contain saponins. Amongst various plant parts, only the leaves of *C. obtusifolia* known to have saponins (Table 3).

Table 3. Saponins in *Cassia* species

Species	PPU	Solvents								Ref.
		Aq.	Met.	Eth.	PE	EA	Hex.	Ace.	Chl.	
C.alata	Lf	-	-	-	-	+	+	-	-	38
	Lf	-	Ɵ	Ɵ	-	Ɵ	-	-	-	54
	Lf/St/Rt	+	Ɵ	-	-	-	-	Ɵ	Ɵ	46
	Fl	+	Ɵ	Ɵ	-	-	-	-	-	28
C. auriculata	AP	-	+	-	Ɵ	+	-	-	Ɵ	11
	Fl	-	+	+	Ɵ	-	-	-	-	13
	Fl	-	+	-	-	-	-	-	-	39
	Lf/Fl	-	Ɵ	-	Ɵ	-	-	-	+	56
	Lf/Fl	-	-	+	-	-	-	-	-	22
	Fl	Ɵ	Ɵ	-	-	Ɵ	Ɵ	-	Ɵ	53
	Lf	-	Ɵ	Ɵ	-	Ɵ	-	-	-	54
C. absus	Se	-	-	-	-	+	+	-	+	20
C. angustifolia	Lf	-	+	-	+	-	-	+	+	48
C. biflora	Lf	-	Ɵ	Ɵ	-	Ɵ	-	-	-	55
C. fistula	Lf	-	+	Ɵ	-	Ɵ	-	-	-	55
	WP	+	+	-	Ɵ	-	-	-	-	29
	Lg	-	+	-	Ɵ	+	-	-	Ɵ	7
	Rt	-	-	Ɵ	-	-	-	-	-	8
C. glauca	Se	-	+	-	-	-	-	-	-	30
C. hirsuta	Lf	-	Ɵ	Ɵ	-	Ɵ	-	-	-	55
C. javanica	Lf	+	-	+	-	-	-	-	+	31
C. mimosoides	Lf	+	-	-	-	-	-	-	-	12
C. nigricans	Lf	-	+	-	Ɵ	Ɵ	-	-	+	3
C. obtusifolia	Lf	-	-	+	+	-	-	-	-	24
	Lf	+	-	+	-	-	-	-	-	50
	Lf/St/Se/Rt	-	-	Ɵ	-	-	-	-	-	10
	Lf	Ɵ	-	-	-	-	-	-	-	44
C. occidentalis	Lf	-	Ɵ	Ɵ	-	Ɵ	-	-	-	54
	Lf	-	+	-	-	Ɵ	Ɵ	-	-	36
	Lf	+	-	-	-	-	+	-	+	14
	Fl/Se	-	Ɵ	-	+	-	-	-	Ɵ	51
	Lf	+	-	Ɵ	-	-	-	-	-	47
	Lf	+	+	-	Ɵ	-	-	-	Ɵ	2
	Lf	+	+	+	-	-	-	-	-	45
	Lf	+	-	+	Ɵ	+	-	-	Ɵ	32
	Lf/Se	+	-	-	-	-	-	-	-	4
C. renigera	Fr	-	Ɵ	-	Ɵ	-	-	-	-	19
C. roxburghii	Lf	Ɵ	-	Ɵ	-	-	-	Ɵ	Ɵ	26
C. sophera	Lf/Rt	-	Ɵ	-	-	-	-	-	-	5
	Se	-	+	-	-	-	-	-	-	5
	Ba	-	-	Ɵ	Ɵ	Ɵ	-	-	Ɵ	35
C. siamea	Lf	+	-	-	-	-	-	-	-	9
	Lf/Ba	-	+	-	-	-	-	-	-	52,33
	Ba	-	+	-	-	-	-	-	-	37
	Lf	-	+	Ɵ	-	+	-	-	-	55
	Fl	Ɵ	Ɵ	-	-	Ɵ	Ɵ	-	Ɵ	53
C. spectabilis	Lf	-	+	+	-	Ɵ	-	-	-	55
	Fr	+	-	Ɵ	-	-	-	Ɵ	Ɵ	27
C. sericea	Lf	-	+	Ɵ	-	Ɵ	-	-	-	54

C. surattensis	Lf	-	Ɵ	Ɵ	-	Ɵ	-	-	-	54
	Lf/Fl	-	Ɵ	-	-	-	-	-	-	6
	AP	-	+	-	-	Ɵ	Ɵ	-	Ɵ	16
C. tora	Lf	-	Ɵ	Ɵ	-	Ɵ	-	-	-	54
	Lf	+	+	-	+	-	-	-	Ɵ	49
	Po	Ɵ	Ɵ	-	Ɵ	-	-	-	Ɵ	17
	Lf	Ɵ	Ɵ	-	Ɵ	-	-	Ɵ	Ɵ	34
	AP	-	-	Ɵ	-	Ɵ	-	-	Ɵ	42
	Se	+	Ɵ	+	+	-	-	-	-	43
C. uniflora	WP	Ɵ	+	+	-	-	-	+	-	21

The information related to tannins in different *Cassia* species have also been gathered. Tannins are present in the leaves of all species except *C. nigricans*. Tannins are present in some of the roots and flowers of *Cassia* species. They are also present in the seeds of *C. obtusifolia, C. occidentalis* and *C. sophera* but not in *C. tora.* As per the available literature, hexane was not an effective solvent for the extraction of saponins (Table 4).

Table 4. Tannins in *Cassia* species

Species	PPU	Solvents								Ref.
		Aq.	Met.	Eth.	PE	EA	Hex.	Ace.	Chl.	
C. alata	Lf	-	+	+	-	+	-	-	-	54
	Lf/St/Rt	+	+	-	-	-	-	+	Ɵ	46
	Fl	+	+	+	-	-	-	-	-	28
C. auriculata	Lf	-	+	+	-	+	-	-	-	54
	AP	-	Ɵ	-	Ɵ	+	-	-	+	11
	Fl	-	+	-	-	-	-	-	-	39
	Fl	-	+	-	Ɵ	-	-	-	+	56
	Lf	-	+	-	+	-	-	-	+	56
	Lf/Fl	-	-	+	-	-	-	-	-	22
	Fl	+	+	-	-	Ɵ	Ɵ	-	Ɵ	53
C. angustifolia	Lf	Ɵ	-	+	Ɵ	-	-	-	Ɵ	57
	Lf	-	+	-	+	-	-	+	+	48
C. biflora	Lf	-	+	+	-	+	-	-	-	55
C. fistula	Lf	-	+	+	-	+	-	-	-	55
	WP	+	+	-	+	-	-	-	-	29
	Lg	-	+	-	Ɵ	Ɵ	-	-	Ɵ	7
C. grandis	Lf	-	-	+	-	-	-	-	-	18
C. glauca	Lf	-	+	-	-	-	-	+	-	15
C. hirsuta	Lf	-	+	+	-	Ɵ	-	-	-	55
C. javanica	Lf	+	-	+	-	-	-	-	+	31
C. mimosoides	Lf	+	-	-	-	-	-	-	-	12
C. nigricans	Lf	-	Ɵ	-	Ɵ	Ɵ	-	-	Ɵ	3
C. obtusifolia	Lf	+	-	+	-	-	-	-	-	50
	Lf/St/Se/Rt	-	-	+	-	-	-	-	-	10
	Lf	+	-	-	-	-	-	-	-	44
C. occcidentalis	Lf	-	+	+	-	+	-	-	-	54
	Lf	-	+	-	-	Ɵ	Ɵ	-	-	36
	Fl/Se	-	+	-	+	-	-	-	+	51
	Lf	+	-	+	-	-	-	-	-	47
	Lf	+	+	-	Ɵ	-	-	-	Ɵ	2
	Lf	+	+	+	-	-	-	-	-	45
	Lf	+	-	+	Ɵ	Ɵ	-	-	+	32
	Lf/Se	+	-	-	-	-	-	-	-	4
C. renigera	Fr	-	+	-	Ɵ	-	-	-	-	19
C. roxburghii	Lf	Ɵ	-	Ɵ	-	-	-	Ɵ	Ɵ	26
	Lf	+	+	-	Ɵ	+	-	-	Ɵ	23
C. sophera	Lf/Se/Rt	-	+	-	-	-	-	-	-	5
	Lf	-	+	-	-	-	-	-	-	25
	Ba	-	-	+	Ɵ	Ɵ	-	-	Ɵ	35
C. siamea	Lf	+	-	-	-	-	-	-	-	9
	Lf/Ba	-	+	-	-	-	-	-	-	52,33
	Ba	-	+	-	-	-	-	-	-	37
	Lf	-	+	+	-	+	-	-	-	55
	Fl	+	+	-	-	+	Ɵ	-	+	53
C. spectabilis	Lf	-	+	+	-	+	-	-	-	55
	Fr	+	-	+	-	-	-	+	Ɵ	27
C. sericea	Lf	-	+	+	-	Ɵ	-	-	-	54
C. surattensis	Lf	-	+	+	-	+	-	-	-	54
	Lf/Fl	-	+	-	-	-	-	-	-	6
	AP	-	+	-	-	Ɵ	Ɵ	-	+	16
C. tora	Lf	-	+	+	-	Ɵ	-	-	-	54
	Lf	+	+	-	Ɵ	-	-	-	Ɵ	49
	Po	Ɵ	Ɵ	-	Ɵ	-	-	-	Ɵ	17

	AP	-	-	+	-	+	-	-	+	42
	Se	Θ	Θ	Θ	Θ	-	-	-	-	43

During the preparation of this database, it has been observed that, presence or absence of phytochemicals may depends upon the species, plant part used, solvents and methods of screening. Due to this, phytochemicals have invariably been reported in different *Cassia* species occurring throughout the world.

CONCLUSION

A thorough study of the relevant literature has suggested that alkaloids, flavonoids, saponins and tannins are present in almost all species of genus *Cassia* when screened using different solvents. These phytochemicals have been reported in different plant parts of *Cassia* species. However, leaf was the most commonly used plant part for analysis. Methanol has been found to be the best solvent. Based on this data, species can specifically be selected for the said cause. Further, the use of a particular plant part instead of whole plant is the best way to conserve the plant diversity while using the species for the welfare of mankind.

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