Hibiscus herbs - a comprehensive botanical, chemical and biological overview

Rajesh Kowti 1, *, Pulak Majumder 2, Harshitha HS 1, Vedamurthy Joshi 3, Rupesh Kumar M 1 and Syed Sagheer Ahmed 1

1 Dept. of Pharmacology, Sri Adichunchanagiri College of Pharmacy, Adichunchanagiri University, B.G. Nagara, Mandya, Karnataka.
2 Dept. of Pharmacognosy, Sri Adichunchanagiri College of Pharmacy, Adichunchanagiri University, B.G. Nagara, Mandya, Karnataka.
3 Dept. of Pharmaceutics, Sri Adichunchanagiri College of Pharmacy, Adichunchanagiri University, B.G. Nagara, Mandya, Karnataka.

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Abstract

Hibiscus cannabinus and Hibiscus sabdariffa are the most multidimensional plants in the Genus Hibiscus. Current overview is an updated comprehensive reported outcome of these plants, for its botanical, chemical and biological activities. It provides mainly botanical features of the plants for identification. It also includes the ethno-traditional medicinal practices of those plants. Till date, the presence of various reported phytochemicals like volatile compounds i.e. E-phytol, linolenic acid, trisiloxa ne-1,1,1,5,5,5-hexamethyl-3,3-bis[(trimethylsilyl)oxy], linoleic acid, caffeic acid, kaempferitrin, vanillic acid etc. are embrace the key of biological activities in these plants which reflects in the traditional uses. The aerial view of In vivo and In vitro reported biological activities like Anti-anemic, Antihyperlipidemic, Antidiabetic, Anthelmintic, Hepatoprotective, Antielcer, Anti–hypercholesterolemic, Antibacterial, Glycosylation Inhibition etc. make this herb a multidimensional in its domain as pharmacologically active herbs. On the other hand the exploration of metabolic profiles, nanoparticulated activities, Cytotoxicity, Anti-oxidant profile etc. indicated the vast usefulness of these herbs. Alteration of fiber by unite copolymerization is a scientific update from Hibiscus cannabinus and Toxicological Studies concluded with safety of these plants were described. The correlation with phytochemicals and related pharmacological actions in these plants were well indicated in this review. Various scopes of biological activities in both the species were clearly visualized and well defined. This review will leads the researches to obtain all aspects of information under one umbrella and help them to explore more scientific date by refereeing this bulk upto date data base of these two plant species. All such information's in one not been reported till date.

Keywords: Hibiscus cannabinus; Hibiscus sabdariffa; Botanical features; Phytochemicals; Biological activities

1. Introduction

The art of utilizing the medicinal plants is known since ages by the man and Medicinal plants found to play crucial role for the creating a healthy society. About 75% of world’s population consumes plant for prevention, therapy and strengthening the immune systems. Art of isolation, formulation and evaluation of active herbal constituents enable to validate the pharmacological activity and to set standards for bulk production as plants tend to vary their constituents periodically. Prior to the presentation of chemical medications, man depended on the recuperating properties of therapeutic plants. It is pondered 80% of the 5.2 billion individuals of the world live in the less evolved nations and the World Health Organization gauges that about 80% of these individuals depend only on customary drug for their essential medicinal service needs. Presently, majority part of the world start respecting and believing the Indian practices in lieu with medicinal plants use. Identified parts of the plants were harvested in a given period, isolated and...
made to the suitable formulation and utilized to treat ailments. These formulations manifest actions with no side effects hence; the plants need of Indian medication framework shows recipient effects [1].

2. Plant descriptions

Kenaf (*Hibiscus cannabinus*), (Figure 1) having a place with the Malvaceae family, is a tall, herbaceous, yearly, woody, tropical plant. It is a normally single-stemmed, erect, and annual to perennial plant growing around 1.8 meters tall. The stems can become more or less woody and persistent its leaves are devoured as a vegetable in specific pieces of the world and have erythrocyte defensive action against medicate incited oxidative pressure [2].

The perennial herb *Hibiscus sabdariffa* has (Figure 2) grown up to 2–2.5 m height. Alternately arranged 3- to 5 -lobed leave of 8–15 cm long. The flowers are 8–10 cm (3–4 in) in diameter, white to pale yellow with a dark red spot at the base of each petal, and have a stout fleshy calyx at the base, 1–2 cm wide. Mature fruits are enlarging about 3–3.5 cm, with fleshy and bright red colour. They take about six months to mature.

3. Origin, geographic distributions, taxonomical status and vernacular name

*Hibiscus cannabinus* is, a common wild plant in most African countries south of the Sahara. It’s been domesticated as a fiber plant already 6000 years ago in Sudan. Kenaf is now widespread in the tropics and subtropics. As a vegetable it is widely grown in Africa, where it is grown on a much smaller scale as a fibre crop. In the past it has been of some importance as a commercial fibre crop in Côte d’Ivoire, Burkina Faso, Togo, Benin, Niger, Kenya, Tanzania and Malawi. India has long been the largest producer of kenaffibre[3].

*H. sabdariffa* originated from Africa. Roselle is now found throughout the tropics. In tropical Africa it is especially common in the savanna region of West and Central Africa.

The taxonomical status [4] and vernacular names of both the plants are describe in table 1 and 2.

**Table 1** Taxonomic classification of *Hibiscus cannabinus* and *Hibiscus sabdariffa* L.

| Kingdom:  | Planate                                      | Kingdom:  | Plantae                                      |
|----------|---------------------------------------------|-----------|---------------------------------------------|
| Subkingdom: | Viridiplantae                                | Subkingdom: | Tracheobionta                                |
| Super division: | Embryophyta                                  | Super division: | Spermatophyta                                |
| Division: | Tracheophyta                                 | Division: | Magnoliophyta                                |
| Subdivision: | Spermatophytina                              | Class:    | Magnoliopsida                                |
| Class: | Magnoliopsida                                | Subclass: | Dilleniidae                                  |
| Superorder: | Rosanae                                      | Order:    | Malvales                                     |
| Family: | Malvaceae                                    | Family:   | Malvaceae                                    |
| Genus: | Hibiscus                                     | Genus:    | Hibiscus L.                                  |
| Species: | *Hibiscus cannabinus*                        | Species:  | *Hibiscus sabdariffa* L.                     |

292
Table 2 Vernacular names:

| **Hibiscus cannabinus** | **Hibiscus sabdariffa** |
|------------------------|------------------------|
| Sanskrit: Ambalika, ambashtha, ambastha | English: Roselle, Hibiscus, Jamaica sorrel, Red sorrel |
| English: Kenaf, vegetable Kenaf, Guinea hemp, Deccan hemp, Brown Indian Hemp | Hindi: LalAmbari |
| Hindi: Patsan | Tamil: Simaikkasuru |
| Tamil: Palungu, Pulimanji | Malayalam: Polechi, puli-cheera |
| Malayalam: Kanjaru | Telugu: Erragomgura, erragonkaya, ettagomgura |
| Telugu: Pimdikura, Gonkura | Kannada: Kempupundrike, plachakiri |
| Kannada: Dirindarani | |

4. Botanical review

Identifications of plant species is the prime objectives of plant research. Descriptions of vegetative parts of plants play a great role for their species identifications. *H. cannabinus* and *H. sabdariffa* also can be identified preliminarily with its organ descriptions like stem, leaves, flowers, fruit and seeds. The comparative descriptions are described in table 3.

Table 3 Botanical descriptions of *Hibiscus cannabinus* and *Hibiscus sabdariffa*

| Botanical descriptions of *Hibiscus cannabinus* | Botanical descriptions of *Hibiscus sabdariffa* |
|-----------------------------------------------|-----------------------------------------------|
| **Stem** | **Stem** |
| Stems aculeate with minor sparse prickles typically directing uphill, otherwise closely glabrous or with a longitudinal line of crisped pubescence changing its radial place at every node | Stems are smooth or nearly smooth, cylindrical, typically red stems. |
| **Leaves** | **Leaves** |
| Leaves narrowly ovate, ovate or sub orbicular in outline, 3–17 × 3–20 cm, un lobed to 3–7-palmatisect to palmatilobed, apex acute, base broadly cuneate to shallowly cordate, margin serrate or dentate, rarely subentire, scaberulous or almost glabrous with a few minute prickles on the veins, usually with a prominent gland on the under surface near the base of the midrib; petiole 6–22 cm long, prickly with a line of pubescence, like the stem; stipules narrowly linear to filiform, 4–5 mm long, caduceus | The petioles are 1 to 6 cm long. Leaves are simple, alternate and narrowly lanceolate to linear stipules. Lamina portions are in variable shape and size. Basal leaves are entire, orbicular, with 3 to 5 palmate veins. Upper leaves slightly to deeply 3–5-palmatilobed with oblong-lanceolate lobes, 5 to 10 cm with lanceolate and serrated margin. The apex is acute, the base is wedged. On the underside, at the birth of the midrib is an elliptical nectar gland, 2 to 3 mm long |
Flower
Flowers solitary in the leaf axils, pedicel 2-6 mm long, articulated at base, aculeate or hispid; epicalyx of 7–8 linear bracts 5–10 × 1–1.5 mm, joined to calyx for about 2 mm at base; calyx lobes 10–20 × 3–5 mm, long-acuminate (sometimes sub caudate) joined for up to a third of their length from the base, aculeate or hispid outside especially nearby the margin with a woolly tomentum, typically with a protuberant gland 1.5–2 mm width on midrib. Deep purple, pale yellow or white, 3–8 cm long Corolla with whitish or greyish pubescent outside, with glabrous Staminal tube at 2–4 cm long; filaments 13 mm long; exerted part of style 3–6 mm long, glabrous.

Fruit
Capsule ovoid-acuminate, 13–18 mm long, 9–12 mm in diameter, appressed-setose.

Seed
Seeds irregularly subreniform, 3–3.5 × 1.5–2.5 mm, sparsely to densely cover with truncate scales.

Flower
The flowers are bisexual, regular, pentamerous, with pedicel 1 to 4 cm long, articulated. Epicalyces consist of about 10 acute lobes, 8 to 10 mm in length, shorter than the calyx. Reddish calyx is 2 cm long, deeply divided into 10 long acuminate, glabrescent or slightly hispid and roughly accrescent lobes, becoming more or less fleshy during fruiting. Corolla is yellow, large, with 5 obovate petals, 4 to 5 cm long, veined and spotted with purple at the base. The staminal column measures half the length of the corolla and has numerous stamens on most of its length. A larger ovary contains 5 loculus topped with 5 branches of style.

Fruit
Spherical-conical capsule, shorter than the calyx, 1.5 to 2 cm long, apiculate at the top and covered with stiff and applied bristles. It remains included in the accrescent calyx, and contains many seeds.

Seed
Kidney-shaped seeds with dark brown colour up to 7 mm long.

5. Phytochemical review
Numerous phytochemicals are being isolated and identified from Hibiscus cannabinus and Hibiscus sabdariffa (Table 4-6). Some of the phytochemicals are also been quantified with modern quantification techniques (table 4). Principle phytochemicals of both the species are been illustrated in figure. 3 and 4.

Table 4 Major chemicals and quantity in Hibiscus cannabinus plant

| Chemicals                        | mg /100gm | References |
|----------------------------------|-----------|------------|
| E-phytol                         | 32.4mg    | [5]        |
| Linolenic acid                   | 47.3mg    |            |
| Trisiloxane-1,1,1,5,5,5-hexamethyl-3,3-Bis[(trimethylsilyl)oxy] | 16.4mg | |
| Linoleic acid                    | 46.4mg    |            |
| Caffeic acid                     | 5.2 mg    |            |
| Kaempferitrin                    | 17.5      |            |
| Vanillic acid                    | 2.1 mg    |            |
| Caffeic acid isomer              | 1.5 mg    |            |
| p-hydroxybenzoic acid            | 1.0 mg    |            |
| Afzelin                          | 4.9 mg    |            |
| Kaempferol glycoside             | 2.9 mg    |            |
| Isoquercitrin                    | 2.8 mg    |            |
| Gallic acid                      | 1.5 mg    |            |
| Stem bark:                       |           |            |
| Kaempferitrin                    | 24.1 mg   |            |
| Afzelin                          | 4.5 mg    |            |
| Kaempferol glycoside isoquercitrin | 4.2 mg | |
The volatile compounds found in most abundant. Other major components in different parts of *Hibiscus cannabinus* are kaemperitrin, caffeic acid, myricetin glycoside, and p-hydroxybenzoic acid in leaves, bark, blossoms, and seeds.

| **leaf** |        |
|----------|--------|
| 3,7,11,15-Tetramethyl-2-hexadecen | 4.4    |
| Tetradecanoic acid | 0.8    |
| 6,10,14-trimethyl-pentadecan-2-ol | 6,10,14-   |
| Trimethyl-2-pentadecanone | 0.9    |
| Hexadecanoic acid | 3.4    |
| 9-Octadecenoic n=6, 0.7acid Phytol acetic acid derivation | 14.3    |
| 9,12-Octadecadienoic acid | 2.9    |
| Phytol | 2.3    |
| 9,12,15-Octadecatrienoic acid | 6.8    |
| 2-5-oxohexyl-cyclopentanone | 32.4   |
| 2,6,10,14,18,22-Tetracosahexaene | 27.6   |

**Figure 3** Major Chemical structures *Hibiscus cannabinus*
Table 5 Phytochemicals from different parts of *Hibiscus cannabinus*

| Phytochemicals                                      | mg /100gm | Reference |
|-----------------------------------------------------|------------|-----------|
| **Leaf**                                            |            | [5]       |
| 3,7,11,15 tetramethyl-2 hexadecen-1-ol (Z-phytol)   | 4.4        |           |
| 13.9 Tetradecanoic acid                             | 0.8        |           |
| 15.1 6,10,14-Trimethyl-pentadecan-2-ol              | 0.9        |           |
| 15.3 2-Pentadecanone, 6,10,14-trimethyl             | 3.4        |           |
| 15.5 Hexadecanoic acid                              | 14.3       |           |
| 18.2 9-Octadecenoic acid                           | 2.9        |           |
| 18.8 Phytol, acetate                                | 2.3        |           |
| 19.4 9,12-Octadecadienoic acid                     | 6.8        |           |
| E-Phytol                                            | 32.4       |           |
| 10 20.7 9,12,15-Octadecatrienoic acid              | 0.7        |           |
| 11 21.0 9,12,15-Octadecatrienoic acid              | 27.6       |           |
| 12 22.4 Cyclopentanone, 2-(5-oxohexyl)              | 1.4        |           |
| 13 26.2 2,6,10,14,18,22-Tetracosahexaene            | 2.1        |           |
| **Bark**                                            |            |           |
| Hexadecanoic acid                                   | 25.4       |           |
| 9-Hexadecanoic acid                                 | 3.0        |           |
| Octadecanoic acid                                   | 3.1        |           |
| 9-Octadecanoic acid                                 | 1.2        |           |
| Phytol                                              | 0.7        |           |
| 9,12-Octadecadienoic acid                          | 10.7       |           |
| E-Phytol                                            | 8.7        |           |
| 9,12,15-Octadecatrienoic acid                      | 47.3       |           |
| **Flower**                                          |            |           |
| Trisiloxane,1,1,1,5,5,5-hexamethyl-3,3-bis[(trimethylsilyl)oxy] | 16.4       |           |
| 3-Isopropoxy-1,1,1,7,7,7-hexamethyl-3,5,5-            | 10.3       |           |
| Tris(trimethylsilyloxy)tetrasiloxane                | 16.1       |           |
| Hexadecanoic acid                                   | 1.6        |           |
| 15-methylhexadecanoic acid                          | 5.3        |           |
| Octadecanoic acid                                   | 8.6        |           |
| Octasiloxane1,1,3,3,5,5,7,7,9,9,11,11,13,13,15,15-Hexadecamethy | 12.5       |           |
| 9-Octadecanoic acid                                 | 4.5        |           |
| 9,12-Octadecadienoic acid                          | 7.2        |           |
| 9,12,15-Octadecatrienoic acid                      | 8.9        |           |
| Hexasiloxane, tetradecamethyl                       | 8.6        |           |
| Heptasiloxane, hexadecamethyl                       |            |           |
| **Seed**                                            |            |           |
| Tetradecanoic acid                                  | 0.1        |           |
| Hexadecanoic acid                                   | 20.9       |           |
| 9-Hexadecanoic acid                                 | 0.6        |           |
| cis-10-Heptadecanoic acid                          | 0.3        |           |
| Octadecanoic acid                                   | 2.2        |           |
9-Octadecadienoic acid (trans) & 1.2
9-Octadecenoic acid (cis) & 27.4
9,12-Octadecadienoic acid & 46.4
Nonadecanoic acid & 0.3
9,12,15-Octadecatrienoic acid & 0.6

Figure 4 Major chemical structures of *Hibiscus sabdariffa*

### Table 6 Major Phytochemicals from *Hibiscus sabdariffa* L.

| Phytochemicals                                                                 | Reference   |
|------------------------------------------------------------------------------|-------------|
| Delphinidin-pentoside-glucoside                                              | [6]         |
| Delphinidin-3-sambubioside, delphinidin-3-monoglucoside, cyanidin-3-monoglucoside, delphinidin | [6]         |
| Delphinidin-3-sambubioside                                                   | [6]         |
| Cyanidin-3, 5-diglucoside, cyanidin-3-2Gglucosylrutinoside                   | [7]         |
| Flavonolglycoside, hibiscitrin, hibiscetin, Gossypitrin, sabdaritrin, hibiscitrin, gossypitrin and sabdaritrin. | [9]         |
| Gossypetin-8-glucoside, gossypetin-7-glucoside, gossypetin-3-glucoside, 8-glucoside, gossypin, anthocyanins 8-glucoside, gossypin, gossypitrin, sabdaritrin. | [9]         |
| Hibiscin, gossypetin, gossypetrin, quercetin, probably myricetin, hibiscetin, hibiscetin, sabdaritrin, possibly sabdaretin | [10]        |
6. Biological overview

The biological activities of *Hibiscus cannabinus* and *Hibiscus sabdariffa* are reported by various researchers. The *in vitro* and *in vivo* biological activities of *H. cannabinus* and *H. sabdariffa* have been tabulated in Table 7 - 9.

### Table 7 In vitro activities of *Hibiscus cannabinus*

| Part of the plant               | Activity                                           | Extract used                                                                 | Reference |
|---------------------------------|---------------------------------------------------|------------------------------------------------------------------------------|-----------|
| Leaves                          | Anti-diabetic                                     | Methanolic extract                                                           | [14]      |
|                                 | Inhibition of glycosylation                        | Methanolic leaf concentrate                                                  | [16]      |
|                                 | Anti-oxidant activity                              | Methanolic and dichloromethane extracts                                       | [17]      |
|                                 | Anti-inflammatory activity                         | Methanolic and dichloromethane extracts                                       | [17]      |
|                                 | Antimicrobial activity                             | Union of mono dispersed silver nanoparticles                                  | [18]      |
| Seed concentrate and seed oil   | Cytotoxic effect on human breast cancer            | 3-(4,5-dimethylthiazol-2-yl)-2,5-diphenyltetrazolium bromide and sulfhorodamine B | [19]      |
|                                 | Cytotoxic effect on human colon cancer            | 3-(4,5-dimethylthiazol-2-yl)-2,5-diphenyltetrazolium bromide and sulfhorodamine B |           |
|                                 | Cytotoxic effect on human lung cancer             | 3-(4,5-dimethylthiazol-2-yl)-2,5-diphenyltetrazolium bromide and sulfhorodamine B |           |
|                                 | Cytotoxic effect on human cervical cancer         | 3-(4,5-dimethylthiazol-2-yl)-2,5-diphenyltetrazolium bromide and sulfhorodamine B |           |
| Seed                            | Anti-oxidant activity                             | Kenaf phenolic fraction                                                      | [20]      |
| Seed                            | Antibacterial activity                            | *Hibiscus cannabinus* stem-assisted silver and gold nanoparticles             | [21]      |
| Stem                            | Dye removal activity                              | graft copolymerization                                                       | [22]      |
| Fiber                           | Cytotoxic activity                                | acetone extraction                                                           | [23]      |
| Core and bark                   | Cytotoxic effect                                  | Supercritical carbon dioxide extraction fluid                                | [24]      |
Table 8 In vitro activities of *Hibiscus sabdariffa*

| Part of the plant     | Activity                                      | Extract used                       | Reference |
|-----------------------|-----------------------------------------------|------------------------------------|-----------|
| Whole plant           | Antibacterial and Cytotoxic activity          | Aqueous methanolic extract         | [25]      |
| Whole plant           | Inhibitory activity against porcine pancreatic α-amylase | 50% methanol and acetone extracts | [26]      |
| Seed and plant calyx  | Anti-oxidant                                  | Methanolic extract                 | [27]      |
| Whole plant           | Diuretic                                      | Aqueous extract                    | [28]      |
| leaves                | Phytochemistry                                | Leaf extract                       | [29]      |
| leaves                | Antioxidant capacity                          | Leaf extract                       |           |
| leaves                | Total phenolic content                        | Leaf extract                       |           |
| leaves                | Anti-inflammatory activity                    | Leaf extract                       |           |

Table 9 In vivo activities of *Hibiscus cannabinus*

| Parts used  | Activity                      | Animal           | Extraction                  | Significant dose  | Reference |
|-------------|-------------------------------|------------------|-----------------------------|--------------------|-----------|
| Leaf        | Anti-anemic                   | Male albino rats | Aqueous extract             | 400 mg/kg          | [30]      |
|             | Antihyperlipidemic            | Rats             | Hydro alcoholic extract     | 400 mg/kg p.o      | [31]      |
|             | Antidiabetic Properties       | Albino rats      | Methanolic concentrate      | 400mg/kg           | [32]      |
|             | Antidiabetic activity         | Albino rats      | Ethanolic extract           | 400mg/kg           | [33]      |
|             | Anthelmintic activity         | Earthworm Pheritimapostoithuma    | Methanolic leaf extract    | 10,20,30,and40mg/ml | [34]      |
| Seeds       | Anti-ulcer                    | Rats             | Seed separate               | 600 mg/kg          | [36]      |
|             | Antihypercholesterolemic effect| Male Sprague dawley | Phenolic extract        | 500 mg/ kg         | [37]      |
Table 10 In vivo biological actions of Hibiscus sabdariffa

| Parts used     | Activity              | Animal   | Extraction       | Significant dose           | Reference |
|---------------|-----------------------|----------|------------------|---------------------------|-----------|
| Flower        | Hepatoprotective      | Rat      | Crude extract    | 0.20mg/ml                 | [38]      |
| Whole plant   | Anti-inflammatory     | -------- | Aqueous extract  | 500mg/kg orally           | [39]      |
| Whole plant   | Action on obesity and its problems | Mice    | Phenolic extract | 1 mg/kg                   | [40]      |
| Whole plant   | Antimicrobial         | Staphylococcus aureus | Aqueous extract | 10-160 mg/ml              | [41]      |
| Whole plant   | Obesity               | MSG mice | Aqueous concentrate | 120 mg/kg                 | [42]      |
| Whole plant   | Atherosclerosis       | Rabbit   | Aqueous concentrate | 30 mg/kg i.v.            | [43]      |
| Whole plant   | Hepatoprotective      | Wistar rats | -------- | 200 mg/kg body weight, orally | [44]      |

Hibiscus sabdariffa – human clinical trials

| Whole plant   | Essential hypertension | -------- | -------- | 150 g of sour or ordinary tea | [45] |
| Whole plant   | Blood pressure lowering | -------- | -------- | 720 mL/dl                      | [46] |
| Whole plant   | Reduced serum cholesterol | -------- | -------- | 15.8- 8.1 mg/dl                | [47] |

7. Conclusion

This review evaluates data regarding the botanical, phyto-pharmaceutical and biological potential of H. cannabins and (figure, 1) and H. sabdariffa (figure, 2). This review will facilitate the researcher for its potential identification and further more exploration of these herbs in terms of biological activities guided phytochemical identification and finding out the drug mechanism of action of phytochemicals in treatment of several diseases. These hibiscus groups of plats need of more investigation on the pharmacological properties and phytochemical compositions for futuristic use.

Compliance with ethical standards

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Disclosure of conflict of interest

There is no conflict of interest.

Author’s contribution statement

Rajesh Kowti, conceptualized and gathered the data of this work, Pulak Majumder, analyzed the data and put necessary inputs towards the designing of the manuscript, Harshitha HS, gathered the data with regard to this work, Vedamurthy Joshi, Rupesh Kumar M & Syed Sagheer Ahmed given necessary inputs for designing of the manuscript. All authors discussed the methodology and results and contributed to the final manuscript.
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