

## RESEARCH ARTICLE

# Botanical Overview and Chemical Composition of some *Grewia* spp. “Gudeim plant” in Sudan

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## Abstract:

This research is conducted to study the Taxonomy of the genus *Grewia* in Sudan. The chemical compositions of fruits of four species of *Grewia* in the Sudan have been studied. These species were: *G.tenax*, *G.villosa*, *G.flavescens* and *G.mollis*. This plant has a common vernacular Sudanese Arabic name: "Gudeim". It is mainly cultivated in Milleit and Kutum (North Darfur-Western Sudan). Common uses of *Grewia* species were overviewed in areas of nutrition, folk medicine and famine food. Fruits of the four *Grewia* species components were chemically analyzed for content of: ash, moisture, proteins, fats, fibers, carbohydrates, reducing sugars, sucrose, minerals (potassium, iron and phosphorus), vitamin C and anti – nutritional factors (tannins and phytate). International methodologies for chemical measurements had been used. The results of chemical analysis were statistically analyzed via Duncan's New Multiple Range Test (DNMRT). The results of morphological characteristics and the chemical components were used to construct taxonomic keys. The study found a statistically significant difference ( $p < 0.05$ ) among the 4 *Grewia* species in all of the studied chemical components.

**Keywords:** *Grewia* spp, Gudeim, Sudan, Chemical, Botanical, Taxonomic key.

## Introduction

Sudan is a country with diverse climates and therefore different types of plants. The uses of the products of these plants vary from nutritional, feedstuffs and medicinal uses. Many of these plants cultivators hadn't been adequately studied. A number of species of genus *Grewia* have been used as medicinal agents to treat several diseases. The large flowering plant genus *Grewia* belongs to family *Tiliaceae* and reported for its medical importance. *Grewia* is a genus of 150 species in the tropical and subtropical areas of Africa, Asia and Australia.[1]

Eleven species of *Grewia* were identified in the Sudan, particularly on sandy or clay soils in the savanna zone of Central Sudan, Darfur, Kordofan and Red Sea Hills [2]. These species were: *Grewia tenax*, *G.villosa*, *G.flavescens*, *G.mollis*, *G.bicolor*, *G occidentalis*, *G.ferruginea* *G.asiatical*, *G.erythraea*, *G.tembensis* and *G.stolzii*. *Grewia* "Gudeim plant" is classified locally in Sudan into two distinct types: 1- Sharwi type, which is preferred by consumers because of its high quality (shiny red color, sweet scent, stores well). 2- Early maturing type which is produced in Southern Kordofan and is considered of inferior quality [2].

Common uses as a Food: The *Grewai* spp. fruit may be eaten fresh or dried for later consumption, but after chewing is not actively sought after. In Sudan, a drink is prepared by soaking the fruits "Gudeim drink", *Grewai* spp. flour may be mixed with custard to form (Nesha drink) which is given to pregnant and lactating women to improve their health and milk production. It may be used as fermented drink in Sudan and Southern Africa [3]. The dead leaves are eaten, but only while they remain on the plant. There is a high and increasing demand on the fruits of this species due to the general belief that it cures malaria and iron deficiency anemia. The fruit is an important economic commodity, both locally, where it is used as food and folk medicine, and internationally where it has great export value for use in food and pharmaceutical industries [4].

Determination of different chemical components of the *Grewai* spp. may help in constructing a taxonomic key for these species, and provide a scientific data to the profile of this plant frequently used in Sudan.

## Material and methods

Mature dry fruit of *Grewia* spp. were collected from Elmonzafa village, Omsidir village, Serba village and Abuharas village. All these villages are west of Elobied in Western Central Sudan.

### *Preparation of fruits for chemical analysis*

The collected fruits were washed with distilled water to remove dirt and foreign materials and the samples were then ice-dried. Finally, the fruits were then ground using electric crusher and were stored in a refrigerator at 5° C for chemical analysis.

Moisture, ash, fiber, protein and fat were analyzed by the Methods described in AOAC (Association of Official Agriculture Chemists) [5]. Moisture was

determined by drying a representative sample (2g) in an oven with air circulation at 100-150 °C for 3 hrs. Ash content was determined by incineration of a sample (4g) in a muffle furnace at 600 °C for 6 hrs until the Ash turned white.

For crude fiber, a moisture free sample was first digested with dilute KOH solution and then extracted with ether. Crude protein was estimated by the micro-Kjeldahl method. Total protein was calculated by multiplying the evaluated nitrogen by 6.25. Fat was determined by Petroleum ether extraction in a Soxhlet Apparatus, a representative sample (3g) was extracted for 6 hrs. Carbohydrates content was estimated by subtracting the sum of the weights of protein, crude fiber, ether extract, and Ash from the total dry matter. This was reported as nitrogen-free extract (NFE) by difference [6]. All determinations were in triplicates.

Reducing sugars were determined by the method of Lane and Eynone [7] (Titration using Fehling's solution, Methylene indicator). After determining the quantity (mg) of inverted sugars in the juice solution after titration, the following equation was used to calculate the percentage of reducing sugars:

$$\% \text{ of reducing sugar} = \text{inverted sugars} \backslash 1000 \times \text{wt of sugar solution (g)}.$$

Sucrose was determined by the method of Lane and Eynon as described by Okoye and Ugwu [8]. Total Phosphorus was determined according to Murphy and Riley [9]. Potassium was determined by the method described in AOAC [5] using flame photometer (model pfp7 UK). Iron was determined by the method described in AOAC [5] using Atomic absorption (model buck 2011USA). Determination of ascorbic acid was done by the method described in AOAC . [5]

Tannins content was estimated quantitatively using modified vanillin HCl method [10]. The absorbance was plotted against catechin concentration to get the standard curve. Tannins content was expressed as catechin equivalent (CE) as follows:

$$CE = C \times 10 \times 100 \backslash 1000 \times \text{wt}$$

Where :

CE = Catechin equivalent .

C = Concentration of catechin corresponding to optical density.

10 = Volume of extract.

1000 = Conversion from mg to g.

wt = weight of sample.

The phytic acid content was determined by the method described by Wheeler Ferrel [11] using spectrophotometer at 480 nm. The computation of ferric iron concentrations and phytate was done by plotting a standard curve of the different  $\text{Fe}(\text{NO}_3)_3$  concentrations to calculate the ferric iron concentrations. The phytate phosphorus was calculated from the ferric iron concentration assuming 4:6 iron: phosphorus molar ratio.

Authentication of the 4 *Grewia* ssp. studied: Herbarium of the Department of Botany, Faculty of Science, University of Khartoum, and, Herbarium of the Forest Research Center at Soba- Sudan.

#### Statistical analysis of data:

The chemical data were analyzed using Duncan's New Multiple Range Test (DNMRT).

## ***Botanical overview***

### ***Grewia species in Sudan:***

“Gudeim” is the most commonly used vernacular name for *Grewia* spp. in the Sudan, this name “Gudeim” is used alternately with *Grewia* spp. in Sudan. Eleven species of *Grewia* were identified in the Sudan and these were distributed among the States of Blue Nile, White Nile, Kordofan, Darfur, Kassala, Gedarif beside the Red Sea Hills and the Nuba Mountains. These species were: *Grewia tenax*, *G.villosa*, *G.flavescens*, *G.mollis*, *G.bicolor*, *G.occidentalis*, *G.ferruginea*, *G.asiatical*, *G.erythraea* *G.tembensis* and *G.stolzii*.

This study is concerned with four species of *Grewia* in Sudan, those are: *G.mollis*, *G.flavescens*, *G.villosa* and *G.tenax*.

Some findings represent the earliest evidence of *Grewia* spp. it is reported – so far – from archaeological sites in Central Sudan. The previous archaeological record of *Grewia* spp. in Central Sudan consisted of large amounts of charred and desiccated fruit stones and charred seeds recovered from the care-site of Shagadud and radiocarbon dated to 4123 + 86 bp [12]. *Grewia* spp. (Gudeim) in Sudan is found on rocky, sandy depressions or dunes and clay and temporary pools [13]. The plant was also found in Africa, and Asia [14].

The fruit is an important economic commodity, both locally where it is used as food and folk medicine and internationally where it has great export potential for use in food and pharmaceutical industries [4].

The *Grewia* fruits contain triterpenes, alkaloids, hydrocarbons, fatty acids, and leuco- anthocynidins. The fruit is also very rich in minerals particularly iron. The fruit is locally used to make a drink. *Grewia* spp is excellent source of iron [13].

Young leaves of *Grewia* spp are also consumed by livestock. *Grewia* has a high increasing demand in Sudan due to the general belief that it cures malaria and iron deficiency. Therefore *Grewia* spp has a good prospect in the pharmaceuticals industry [4].

#### **1- *Grewia tenax* (Forssk.) Fiori.:**

Synonym(s): *G.populifolia* Vahl; *Chadara tenax* Forssk. and *G.betulifolia* Juss [15]. A multistemmed shrub up to 2 m tall. bark smooth, grey. Leaves smooth, apex pointed or rounded, margins toothed. Flowers white. Fruits orange – red at maturity , with 1-4 fleshy round spheroid lobes, about 5 mm across. T he plant is very common in western states and some other areas in Sudan. The fruits are eaten fresh or dried for later consumption. There is a high and increasing demand on the fruits of this species due to the general belief about its therapeutic effects.

#### **2- *Grewia villosa* Willd. in Ges. Nat. Fr. Berl. Neue Schr 4: 205 (1803)**

*Grewia villosa* is a shrub of arid areas in Africa and India, often on river banks liable to flooding or on stony ground or in the shade of larger trees [16]. It is common on sandy or clay soils in the savanna zone of Central Sudan, Darfur , Kordofan and Red Sea Hills [2]. The fruit may be eaten, but is not actively sought after, although it may be found in some local markets, for instance in the Sudan, as a substitute for *G.tenax* [17]. It is also fed to lactating mothers to

improve their health and lactating abilities. Moreover, the fruits are made into a fermented drink in Sudan and Southern Africa [3]. The leaves are very palatable to livestock, making it a good fodder in its native range [17].

**3- *Grewia flavescens* Juss. in Ann. Mus. Nat. Hist. Nat. Par.4:91(1804).**

Synonym(s): *G.flava* and *G.pilosa*.

Two varieties are recognized (a) var. *flavescens* which has narrower leaves with round or square bases and flower stalks less than 10 mm. (b) var. *olukondae* (Schinz) Wild which has broader, almost circular leaves. The flower stalk longer than 10 mm. [18]

In the Sudan it is found in Savanna Zone of Central Sudan, Red Sea Hills, Kassala and Equatoria [2]. The species is distributed throughout tropical Africa. In Asia, it is mainly found in Yemen and India [19].

The fruits are eaten raw or they are mashed together with water and eaten as porridge. The fruit are eaten by birds, especially hornbills, and also by monkeys [20].

**4-*Grewia mollis* Juss. In Ann. Mus. Nat. Hist. Nat. par 4:91 (1804).**

Synonym(s): *G.venusta* Fresen.

Shrubs or small trees up to 10.5 m tall, often multi- stemmed. In the Sudan, the species is mainly found near rivers in the dry Savanna Zones of Central and South Sudan, Red Sea Hills, Kassala, Kordofan, Darfur (J.Marra) [2]. *G.mollis* occurs widely in tropical Africa, but in Asia, the species occurs in Yemen [21].

*Grewia mollis* will remain useful as multipurpose plant, providing a wide range of products, including timber for local use, food, fiber, fodder and traditional medicines [22].

The mucilaginous bark and leaves are applied to ulcers, cuts, sores and snake bites. Bark and root preparations are taken to treat cough. Extracts of bark and leaves are drunk to treat fever, or the fruit is eaten for this purpose. *G.mollis* is frequently used in traditional rituals in Sudan and Ethiopia [23].

**A.** Shrubs up to 9 m high; bark tomentose; leaves elliptic; or lanceolate, base asymmetrical; mature fruits brownish, glossy, glabrous. .... *G.bicolor*.

**AA.** Shrubs up to 4 m high; bark smooth or villous or deeply fissured; leaves ovate or orbicular or rounded or ovate – elliptic or oblanceolate, base symmetrical; mature fruits yellow – brown, or orange – red or orange – yellow becoming black or purple becoming black:

**B.** Stems villous; leaves ovate or orbicular, base rounded or cordate; mature fruits orange or rusty brown. .... *G.villosa*.

**BB.** Stems glabrous; leaves oblanceolate or ovate – elliptic or elliptic – oblong or broadly rounded:

**C.** Stems 4 – angled; leaves oblanceolate; mature fruits yellow – brown, Usually 2- seeded. .... *G.flavescens*.

**CC.** Stems terete; leaves elliptic or lanceolate or ovate rhomboid; mature fruits brown or purple becoming black or orange – red, usually 4-seeded:

**D.** Stipules filiform; flower 2-4 together, fruits orange – red. .... *G.tenax*.

**DD.** Stipules not as above; flower 1-1 together, brown or purple becoming black:

- E. Bark deeply fissured; leaves elliptic – oblong, base cuneate; mature fruits yellow becoming black, whitish – hairy. .... *G.mollis*.
- EE. Bark smooth or white – dotted:
- F. Bark white – dotted. .... *G.occidentalis*.
- FF. Bark smooth. .... *G.tembensis*.
- G. Stems densely ferruginous:
- H. Leaves ovate or broadly elliptic; fruits hairy. .... *G.stollzii*.
- HH. Leaves ovate – elliptic; fruits glabrous. .... *G.ferruginea*.
- GG. Stems not as above :
- I. Shrubs up to 9 m high ; leaves broadly rounded; mature fruit purple becoming black, glabrous. .... *G.asiatica*.
  
- II. Shrubs up to 9 m high; leaves ovate or rhomboid; fruits brown, rugose. .... *G.erythraea*.

**Table 1.** Chemical composition of fruits of the four *Grewia* species

Parameter	Ash content (%)	Moisture content (%)	Protein content (%)	Fat content (%)	Fiber content (%)	Carbohydrate content (%)
G.tenax	3.555B	12.92A	6.700C	0.40393B	25.50B	51.287
G.villosa	3.577B	7.805C	8.400B	0.4037B	13.79C	66.040
G.flavescens	3.400B	9.505B	10.54A	0.4041B	31.87A	44.330
G.mollis	4.303A	8.000C	10.50A	1.631A	33.33A	42.300
Mean	3.709	9.559	9.035	0.621	26.123	
sig	**	***	***	***	***	
SE +	0.13	0.23	0.37	0.02	0.54	
C.V%	6.13	4.10	7.06	5.03	3.60	
LSR(p=0.05)	0.4294	0.7389	1.201	0.05854	1.771	

\*\* , \*\*\* Significant at 0.01 and 0.001 probability levels, respectively.

Means, within the same column, sharing similar letter(s) are not significantly different at probability levels of 0.05 according to Duncan's new Multiple Range Test (DNMRT).

**Table 2.** Reducing sugars (%) and Sucrose (%) of four *Grewia* species.

Parameter	Reducing sugars (%)	Sucrose content (%)
Species		
G.tenax	29.35B	27.87B
G.villosa	30.19A	28.55A
G.flavescens	29.28B	27.81B
G.mollis	25.54C	25.30C
Mean	28.864	27.40
sig	***	***
SE +	0.13	0.13
C.V%	0.80	0.80
LSR(p=0.05)	0.3475	0.4125

\*\* , \*\*\* Significant at 0.001 probability levels.

Means, within the same column, sharing similar letter(s) are not significantly different at probability levels of 0.05 according to Duncan's new Multiple Range Test (DNMRT).

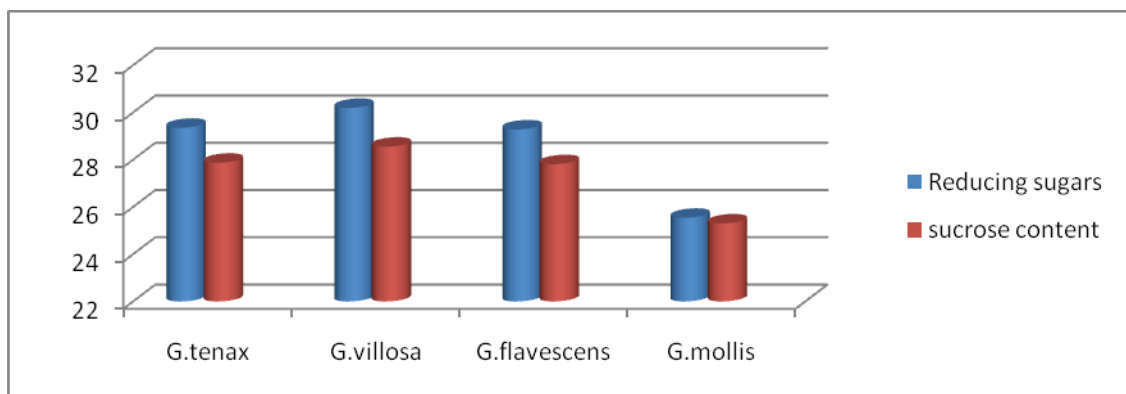


Fig. 1: Comparing the content of Reducing Sugars and Sucrose content of the four *Grewia* species.

Table 3. Tannins, Phytic acid and Ascorbic acid contents of fruits of four *Grewia* species.

Parameter	Tannin content (%)	Phytic acid content (%)	Ascorbic acid content (%)
Species			
<i>G.tenax</i>	0.3333A	0.08903B	0.03573C
<i>G.villosa</i>	0.2777C	0.08940B	0.04880B
<i>G.flavescens</i>	0.2055D	0.1777A	0.01950D
<i>G.mollis</i>	0.3277B	0.09007B	0.05870A
Mean	0.286	0.112	0.041
sig	***	***	***
SE ±	0.00	0.00	0.00
C.V%	5.83	1.93	6.96
LSR(p=0.05)	0.001883	0.001883	0.001883

\*\*, \*\*\* Significant at 0.001 probability levels

Means, within the same column, sharing similar letter(s) are not significantly different at probability levels of 0.05 according to Duncan's new Multiple Range Test (DNMRT).

***Taxonomic Key to the Grewia species, based on chemical composition of fruits.***

- A. Moisture content up to 12.92% ; protein content < 7 ; fat content <0.05% ..... *G.tenax*.
- AA . Moisture content up to 9.50% ; protein content < 8 – 10.5% ; fat content < 0.04 – 1.6% .
- B . protein content < 5 % ; fiber content 13.79% ; carbohydrates content up to 66% ..... *G.villosa*.
- BB . protein content > 10% ; fiber content 31 - 33% ; carbohydrates content up to 44%.

C . Ash content 3.4% ; moisture content 9.5% ; fat content about 0.4%.

.....*G.flavescens*.

CC . Ash content 4.3% ; moisture content about 8% ; fat content about 1.6%.

.....*G.mollis*.

There were significant differences ( $p=0.05$ ) among the four *Grewia* species in their chemical components.

The ash content of the four species ranged from 3.4% (*G.flavescens*) to 4.3% (*G.mollis*). A Significant difference ( $p=0.01$ ) was found between the ash content of fruits of *G.mollis* and those of *G.tenax*, *G.villosa* and *G.flavescens*. However, an insignificant difference was found between the fruits of *G.flavescens*, *G.tenax* and *G.villosa* in their ash content.

The moisture content ranged from 7.8% in *G.villosa* to 12.9% in *G.tenax*. A highly significant difference ( $p=0.001$ ) was found between the moisture content of *G.tenax* and those of *G.villosa*, *G.mollis* and *G.flavescens*. No variation was observed between *G.villosa* and *G.mollis* in their moisture content.

The four *Grewia* species contained low amounts of protein. There was a highly significant difference ( $p=0.001$ ) between the protein contents of fruits of *G.mollis* and *G.flavescens* on one hand and those of *G.villosa* and *G.tenax* on the other hand. An insignificant difference ( $p=0.001$ ) was found between *G.mollis* and *G.flavescens* in their protein content.

In the four studied *Grewia* spp, the fat levels were consistently low. There was a highly significant difference ( $p=0.001$ ) between the fat contents of fruits of *G.mollis* on one hand and those of *G.tenax*, *G.villosa* and *G.flavescens* on the other hand. No variation was observed between *G.villosa* and *G.flavescens* in their fat content.

Fiber content ranged from 13.7% in *G.villosa* to 33.3% in *G.mollis*. A highly significant difference ( $p=0.001$ ) between the fiber content of fruits of *G.mollis* and *G.flavescens* on one hand and those of *G.tenax* and *G.villosa* on the other hand. There was an insignificant difference ( $p=0.001$ ) between *G.mollis* and *G.flavescens* in their fiber content.

*G.villosa* had the highest carbohydrate content (66.04%) compared with the other three species. Similarly, this species had the highest values of reducing sugars (30.19%) and sucrose (28.55%). There was a highly significant difference between the values of reducing sugars in *G.villosa* and those of *G.tenax*, *G.flavescens* and *G.mollis*. An insignificant difference ( $p=0.001$ ) was found between the fruit of *G.tenax* and those of *G.flavescens* in their reducing sugars contents.

A highly significant difference was found between sucrose content of fruits of *G.villosa* and those of *G.tenax*, *G.flavescens* and *G.mollis*. No variation was observed between the fruits of *G.tenax* and *G.flavescens* in their sucrose content.

The four species contained remarkably high amounts of iron with values ranging from 0.04% (*G.villosa*) to 0.07% (*G.mollis*). This finding supports the traditional use of *Grewia* spp. in the treatment of anemia.

A highly significant difference ( $p=0.001$ ) was found between the iron content of fruits of *G.mollis* and those of *G.tenax*, *G.flavescens* and *G.villosa*. The three *Grewia* spp contained remarkably high amounts of iron with values ranged from 20.8 mg/100g (*G.tenax*) to 29.6 mg/100g (*G.villosa*).



Potassium was the most predominant mineral in the four species; it was ranged from 1.79% (*G.flavescens*) to 2.511% (*G.mollis*). A highly significant difference ( $p=0.001$ ) was observed between the potassium content of fruits of *G.mollis* on one hand and those of *G.tenax*, *G.villosa* and *G.flavescens* on the other hand. An insignificant difference was found among the fruits of *G.tenax*, *G.villosa* and *G.flavescens* in their potassium content.

The phosphorus content ranged from 0.024% in *G.flavescens* to 0.035% in *G.mollis*. A highly significant difference ( $p=0.001$ ) was found between the phosphorus content of fruits of *G.mollis* on one hand and those of *G.villosa*, *G.tenax* and *G.flavescens* on the other hand.

Tannins content was low and ranged from 0.2% (*G.flavescens*) to 0.3% (*G.tenax*). A highly significant difference ( $p=0.001$ ) was found in the tannins content of the fruits of *G.tenax* on one hand and those of *G.mollis*, *G.villosa* and *G.flavescens* on the other hand.

The phytic acid (phytate) content in the four *Grewia* spp. was low and ranged from 0.08% (*G.tenax*) to 0.17% (*G.flavescens*). A highly significant difference ( $p=0.001$ ) was found between the phytic acid of fruits of *G.flavescens* on one hand and those of *G.mollis*, *G.tenax* and *G.villosa* on the other hand. No significant variation was observed among the fruits of *G.mollis*, *G.tenax* and *G.villosa* in their phytate content.

Ascorbic acid was highest in *G.mollis* as compared to the other three *Grewia* spp. A highly significant difference ( $p=0.001$ ) was found between the ascorbic acid content of fruits of *G.mollis* and those of *G.villosa*, *G.tenax* and *G.flavescens*.

Our findings are almost similar to the results found by Elmuez Alsir [24], a Sudanese researcher who detected that *Grewia Tenax* fruits contains 66.59% carbohydrate, while moisture, crude fiber, ash, crude protein and crude fat were 11.72%, 9.41%, 4.12%, 7.68% and 0.48%, respectively, he found that the content of potassium was the highest mineral (856.25 mg/100g).

Our findings are also nearly similar to the results found by Mohammed Elhassan [25], another Sudanese researcher which referred to (%) dry weight, he found that *G.tenax*, *G.flavescence* and *G.villosa* contained 13, 15 and 14% moisture; 20.5, 42.8 and 25.5% crude fibre; 5.2, 3.4 and 4.0% ash, and 66, 75 and 84% carbohydrates, respectively.

He found that *G.tenax* had the highest value of reducing sugar (13.8%) and starch content (44.4%). The three species contained low amount of protein and fats, which ranged from 6.7% (*G.villosa*) to 8.7% (*G.flavescens*) and 1.30% (*G.flavescens*) to 1.7% (*G.tenax*), respectively.

Our finding about the predominant of potassium in the species is in accordance with M. Elhassan [25] results which ranged the potassium content from 817 mg/100 g (*G.tenax*) to 966 mg/100g (*G.villosa*). The three *Grewia* spp contained remarkably high amounts of iron with values ranged from 20.8 mg/100g (*G.tenax*) to 29.6 mg/100g (*G.villosa*). M. Elhassan [25] found that Tannin content was low and ranged from 1.13% (*G.flavescens*) to 2.46% (*G.villosa*), these values are slightly more than what we found in this study. The difference in Tanning values may be due to some factors such as the storage conditions.

These findings (especially the iron and other minerals contents) are supporting the traditional usage of *Grewia* spp. in the treatment of anemia, and

could be important contributors to improve the nutritional content of rural and urban people.

For comparison purposes, the chemical composition of *G.villosa* (as (%) on dry weight basis): by Elhassan and Yagi [25] reported as that *G.villosa* contained: 14% Moisture, 4.0% Ash, 25.5% Fiber, 6.7% Protein, 1.5% Fat, 48.3% Carbohydrates, 14% Reducing Sugars, 0.966% K, 0.0296% Fe, 2.46% Tanins. The extract of *G.villosa* also contains harran- alkaloids. [26]

Ehassan and Yagi [25] had also reported the chemical composition of *G. flavescens* (values are expressed as (%) on dry weight basis), as that *G. flavescens* contained: 15% Moisture, 4.3% Ash, 42.8% Fiber, 8.7% Protein, 1.3% Fat, 28.8% Carbohydrates, 10% Reducing Sugars, 0.877% K, 0.0269% Fe, and 2.18% Tanins. The extract of *G.villosa* also contains harran- alkaloids. [26]

The following tables show the results of chemical analysis of *G.tenax* in Sudan reported by some authors in two different periods: (1986-1999) (Table 4), and (2006-2011) (Table 5).

**Table 4:** Chemical composition of *G.tenax* as reported by some authors (1986-1999). Boutros [27], Abdlelmuti [13], Hamed [28], Rahamtalla [29], reported the following chemical compositions for *Grewia tenax* :

Parameter	Boutros (1986)	Abdlelmuti (1991)	Hamed (1995)	Rahamtalla (1999)
Moisture %	5.3	4.5	5.3	12.79
Ash %	-	-	-	4.60
Protein %	8.0	6.3	7.50	7.50
Fiber%	14.3	8.1	9.5	-
Carbohydrates%	85	80.7	71.5	-
Sucrose %	-	-	16	-
Fe %	0.0031	0.0074	0.0077	0.0093
K%	-	-	1.45	-
P %	-	-	0.08	-

**Table 5:** Chemical composition of *G.tenax* as reported by some authors (2006-2011). Eltom [30], Elhassan and Yagi [25], and Mustafa *et al* [31], reported the following chemical compositions for *G.tenax*. (Expressed as (%) on dry weight basis)

Parameter	Eltom (2006)	Elhassan and Yagi (2010)	Mustafa et al. (2011)
Moisture %	13.4	13.0	17.50
Ash %	3.7	5.2	4.31
Fat %	0.35	1.7	0.52
Protein %	8.4	7.7	5.60
Fiber%	8.82	20.5	8.30
Carbohydrates%	65.33	52.40	63.77
Sucrose %	-	-	27.12
Fe %	0.0128	0.0208	0.0073
K%	0.58	0.817	1.40
P %	0.12	-	0.085
Vitamin "C" %	0.0550	-	0.07025
Reducing Sugars%	12.30	13.8	3.92
Tannins%	1.290	1.130	-
Phytic acid%	0.021	-	-

## Conclusion

*G.mollis* had high levels of minerals such potassium (K), iron (Fe) and phosphorus (P). Hence *Grewia* spp. can be considered as a rich source of iron, potassium and phosphorus supplements.

The four species contained remarkably high amounts of iron with values ranging from 0.04% (*G.villosa*) to 0.07 (*G.mollis*). This finding supports the traditional use of *Grewia* spp. in the treatment of anemia.

The predominant mineral in the four species was potassium, which is ranged from 1.79% (*G.flavescens*) to 2.511% (*G.mollis*).

Fruits of the four *Grewia* spp. were rich in nutrients and hence could be used to improve the nutritional status of rural and urban areas in Sudan. Fruits of *Grewia* spp. are good source of phytic acid (antioxidant) which lowers blood cholesterol.

There is a distinct lack of literature on the Sudanese *Grewia* spp.

Darfur is the main producer of Gudeim (*Grewia* spp.) but for security reasons the author could not reach the area.

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