Identification of Macroelements and Microelements in the Leaves of the Synadenium Grantii Hook Used as Medicinal Plant in the Brazil

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Abstract

Introduction: The Synadenium grantii Hook f. species is a medicinal plant of the Euphorbiaceae family and is popularly known in the Midwest regions of Brazil as leitosinha or janaúba. All the parts of Synadenium grantii Hook f. as stem, latex, leaves and flowers are used for the treatments of various disease, but no elemental composition has been done.

Objective: The aim of present work was to measure the macroelements (K, Mg, Mo and P) and microelements (Cr, Cu, Fe, Mn, Mo, Zn, Si, Ni, Co, Cd and Al) in the leaves of medicinal plant Synadenium grantii Hook f. used in the treatment of diseases by rural and urban communities of the Campo Grande, State of Mato Grosso do Sul, Brazil.

Method: The chemical digestions of samples were prepared utilizing HNO₃ and H₂O₂ and microwave digestion system Speedwave Berghof, Germany. After digestion, the concentrations of the elements in leaves were determined by technique of Inductively Coupled Plasma – Optical Emission Spectrometer (ICP-OES) with a Dual Plasma (Thermo Scientific – iCAP 6000 Series)

Results: Results demonstrated that the Synadenium grantii Hook f. leaves are source of K but aren’t the best source of Na and P. Its leaves are rich in elements such as Mg, Cr, Cu, Fe, Mn, Mo and Zn. The leaves of Synadenium grantii Hook f. showed a high content of Mg values tolerable upper intake level. However, Fe, Na, P, Mn, Mo and...
Introduction
Frequently indigenous and urban populations used plants as a mode of treatment of variety of ailments. However, they do not know in detail how a particular plant work- even though in medicinal benefit is well established. In Pakistan, an effort has been made to review the elemental contents of ethno medicinally important plants [1]. As far as herbal remedy chemical composition is concerned, especially for traditional Indian [2] and Chinese remedies [3]. Also, to the best of our knowledge, studies recent to on ancient Chinese herbal medicine and molecular biology in the treatment of myocardial infarction have been undertaken [4,5]. As well as additional studies confirmed the use of herbal medicine for the treatment of vascular dementia [6].

On the others hand in Brazil, few studies focused on detailed chemical analysis of the applied medicinal plant. However, several Brazilian authors have reported studies on the antimalarial plants used by indigenous people [7], plants used as antidiabetics and basic traditional knowledge on the medical application of most commonly used plants in some States of Brazil [8, 9]. A recent Brazilian review showed that for the majority of the medicinal plants used for weight loss, there is a little scientific evidence corroborating its usage [10]. Thus, the knowledge on compounds present in medicinal plants and its role in health is scarce and necessary.

The vegetation of Brazil has great wide variety of medicinal plants, some of which are yet to be fully studied. Medicinal plants species as Synadenium grantii Hook f. grows in the fields and pastures or urban area of Brazil and develops in hot tropical climate with low rainfall. This species belongs to the family Euphorbiaceae and is popularly known in Brazil as leitosinha or janaúba, also is commonly called African Milk Bush. It is small tree native to East Central Africa. In nature, the plants will reach up to 5 m in height [11].

In folk medicine the latex of Synadenium grantii Hook f. to treat neoplasic diseases and gastric disorders such as peptic ulcers and gastritis inflammatory [12]. Moreover, studies in animals showed that the latex extracts of Synadenium grantii Hook f. has anti-ulcer activity without causing toxicity [12]. The cytotoxicity as well as the antiparasitic activity of the CHCl3 extract of Synadenium grantii Hook f. leaves was performed and proved to be active [13]. According with others studies, the Synadenium grantii Hook f. have antioxidant properties; results showed these biological activities may be associated

Zn are below the values tolerable upper intake level. The leaves of this plant have elements as Ni, Cu, Cr and Cd above the permissible limit set by WHO and FAO.

Conclusions: The gaps in knowledge about the level of contents in the Synadenium grantii Hook f. was completed in this work and would serve as a tool for deciding the dosage of prepared from this plant with medicinal purposes. Brazil should create legal standards for the use of medicinal plants based on internationally practiced requirements.

Keywords
Medicinal Plants; Synadenium Grantii Hook; Inductively Coupled Plasma Mass Spectrometry.
with the presence of flavonoids and terpenes, as revealed by HPLC and NMR analyses of the crude stem bark extract [14].

All the parts of Synadenium grantii Hook f. as stem, leaves and flowers reported are used for the treatments of various disease, but no elemental composition has been done. It is very important determine the concentration of macroelements and microelements in medicinal plants to know if these concentration are above the limits Tolerable Upper Intake Level, that is, maximum daily intake of nutrients that can pose a risk of adverse effects on health. Macroelements (sodium, potassium, calcium, magnesium, phosphorus) and microelements (iron, manganese, zinc, cobalt, copper, chromium, lead, nickel, cadmium, aluminum, selenium, sulfur, arsenic, selenium) are elemental constituents of these medicinal plants and often poses human lives at risk, these elements can also be dangerous and toxic [15].

In addition, the above considerations, the deficien-
cy of certain elements also cause disease in human and plants. Several ethnopharmacology studies have proved that there was relationship between microe-
lements or macroelements and efficacy of herbal medicine, human health, and disease prevention [1]. In Brazil, the dose rate of medicinal plants is not well defined. These precautions are indispensable when larger amounts of the products are consumed and long-term therapy is undertaken. Thus, know the concentration of minerals in medicinal plants is very important and need to be screened for their quality control.

The aim of present work was to measure for the first time the macroelements and microelements in the leaves of medicinal plant Synadenium grantii Hook f. used in the treatment of diseases by ru-
al and urban communities of the Campo Gran-
de, State of Mato Grosso do Sul, Brazil. There are no studies published on chemical composition of leaves this plant in Brazil or others country. The macroelements and microelements content, after microwave digestion, were determined by inductively coupled plasma - optical emission spectros-
copy (ICP-OES).

Materials and Methods

Research area

The leaves of Synadenium grantii Hook f. were col-
lected in June 2016 in an urban area in the city of Campo Grande, Mato Grosso do Sul, with the coordenates 20°28’43”S and 54°38’28”W, altitude of 551 m. The Figure 1 has the Geographic coordi-
nates of Campo Grande, State of Mato Grosso do Sul, Brazil, which was used in mapping and navigation, including GPS satellite navigation system (the Global Positioning System).

In the Figure 2, there are images of Synadenium grantii Hook f. (Euphorbiaceae), popularly known as Janaúba, Campo Grande, Mato Grosso do Sul State, Brazil. The specimen was identified by Fábia Alves and deposited (No 53971) in the herbarium of the Federal University of Mato Grosso do Sul (UFMS), Brazil.
Elemental analysis by ICP-OES technique

The leaves were oven dried at the temperature of 50°C for 24 hours. The dried samples were then ground with a manual grinder into powder and sieved to get very fine powder. It was then weighed and digested in HNO₃ + H₂O₂ mixture. Digestions of the samples in triplicate were prepared as follows: processed with mixture of 0.5 g sample plus 5 mL HNO₃ (65% Merck) and 3 mL H₂O₂ (35%, Merck Millipore) in the microwave digestion system Speedwave Berghof, Germany. After digestion, samples were diluted to 100 mL with ultrapure water. Since the final acid concentration of the samples was quite high (4% HNO₃).

The concentrations of the elements in leaves were determined by technique of Inductively Coupled Plasma – Optical Emission Spectrometer (ICP-OES) with a Dual Plasma (Thermo Scientific – iCAP 6000 Series). ICP-OES elemental analysis technique that uses the emission spectra of a sample to identify, and quantify the elements present. The emission line selected for the determination of elements (wavelength in nm) were: K (766.490), Mg (285.213), Na (589.592), Cr (283.563), Cu (327.396), Fe (259.940), Mn (259.373), Mo (202.030), Zn (206.200), P (177.495), Si (212.412), Ni (221.647), Co (228.616), Cd (226.502) and Al (167.079). The concentrations of the different elements in these samples were determined using the corresponding standard calibration curves obtained by using standard solutions of the elements of interest. Triplicate analyses were performed on each sample.

Basic requirements of comparative.

The concentration of elements obtained in the leaves of *Sinadenium grantii* Hook f. was compared with the following recommended values:

- **Recommended dietary allowance (RDA):** average daily level of intake sufficient to meet the nutrient requirements of 98% of healthy people.
- **Adequate Intake (AI):** used where no RDA has been established. It is a recommended average daily nutrient intake level for a group (or groups) of apparently healthy people.
- **Tolerable upper intake levels (ULs):** the highest level of daily nutrient consumption that is considered to be safe for, and cause no risk of adverse health effects in, 97.5% of healthy individuals in each life-stage and sex group.

In the absence of established RDA or data on Adequate Intake (AI), the values of concentration of macroelements and microelements obtained in this manuscript are compared with permissible limit set by FAO/WHO (Food and Agriculture Organization of the United Nations/World Health Organization) or with evidence of medicinal plants’ results published.

Elemental concentration of leaves of *Synadenium* *grantii* were compared with the Ricinus *communis* L. and Chrozophora *tinctoria* (L.) Raf., both plants belong to the family Euphorbiaceae.

Results and Discussion

In Table 1, the concentrations of the elements determined in the analyzed leaves of *Synadenium grantii* Hook f. are shown as an arithmetic means and standard deviation. In addition, results average concentration of elements measured in the lea-
ves of *Ricinus communis* L., leaves of *Chrozophora tinctoria* (L.) Raf. and values tolerable upper intake levels (ULs) for adults.

Table 1. Elemental concentration (mg/100g ± standard deviation) of leaves of *Synadenium grantii* Hook f. compared to *Ricinus communis* L., *Chrozophora tinctoria* (L.) Raf. and values tolerable upper intake levels (ULs) for adults.

<table>
<thead>
<tr>
<th>Element</th>
<th>Our data <em>Synadenium grantii</em></th>
<th><em>Ricinus communis</em> L. [16]</th>
<th><em>Chrozophora tinctoria</em> (L.) Raf. [16]</th>
<th>Tolerable Upper Intake Levels (ULs)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Leaf (mg/100g)</td>
<td>Leaf (mg/100g)</td>
<td>Leaf (mg/100g)</td>
<td>mg/day(adults)</td>
</tr>
<tr>
<td><strong>Macroelements</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>K</td>
<td>1,364.317±51.320</td>
<td>2.71±0.00</td>
<td>2.707±0.002</td>
<td>ND</td>
</tr>
<tr>
<td>Mg</td>
<td>133.188 ±16.904</td>
<td>0.9992±0.2226</td>
<td>0.9083±0.0636</td>
<td>350¹</td>
</tr>
<tr>
<td>Na</td>
<td>63.833±0.206</td>
<td>0.2235±0.010</td>
<td>0.1555±0.0108</td>
<td>2,300</td>
</tr>
<tr>
<td>P</td>
<td>50.94±23.00</td>
<td>ND</td>
<td>ND</td>
<td>4,000</td>
</tr>
<tr>
<td><strong>Microelements</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cr</td>
<td>0.489±0.016</td>
<td>ND</td>
<td>ND</td>
<td>ND</td>
</tr>
<tr>
<td>Cu</td>
<td>0.910±0.001</td>
<td>0.005±0.0059</td>
<td>0.006±0.0023</td>
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<tr>
<td>Fe</td>
<td>8.345±0.275</td>
<td>2.735±0.0113</td>
<td>0.2989±0.0258</td>
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<tr>
<td>Mn</td>
<td>1.047±0.125</td>
<td>0.0216±0.006</td>
<td>0.013±0.0017</td>
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<tr>
<td>Mo</td>
<td>0.522±0.004</td>
<td>0.0027±0.0045</td>
<td>0.001±0.0048</td>
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<tr>
<td>Zn</td>
<td>3.621±1.580</td>
<td>0.170±0.0025</td>
<td>0.232±0.0025</td>
<td>40</td>
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<tr>
<td>Si</td>
<td>23.524±3.012</td>
<td>ND</td>
<td>ND</td>
<td>ND</td>
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<tr>
<td>Ni</td>
<td>1.951±0.222</td>
<td>ND</td>
<td>ND</td>
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<tr>
<td>Co</td>
<td>1.723±0.117</td>
<td>ND</td>
<td>ND</td>
<td>ND</td>
</tr>
<tr>
<td>Cd</td>
<td>0.044±0.004</td>
<td>ND</td>
<td>ND</td>
<td>ND</td>
</tr>
<tr>
<td>Al</td>
<td>13.498±0.072</td>
<td>0.033±0.0558</td>
<td>1.183±0.375</td>
<td>ND</td>
</tr>
</tbody>
</table>

¹: The UL for magnesium is determined by supplementation only and does not regard the ingestion from food or water.
ND: Not detected

Microelements

Potassium (K)

It is observed that amongst all the elements studied in the analysed sample, potassium accumulation is the highest in *Synadenium grantii* Hook f. than the concentration of other metals. The present study revealed that the concentration of potassium in leaves of *Synadenium grantii* was 1,364.317 mg/100g, being much higher than the concentration in leaves of *Ricinus communis* L. 2.71 mg/100g followed by 2.70 mg/100g of *Chrozophora tinctoria* (L.) Raf. [16]. For healthy adults, the adequate intake (AI) for potassium is set 4,700 mg/day [17], our results demonstrated that the *Synadenium grantii* Hook f leaves are good food source in potassium. The plant *Trigonella foenum-graecum* L. of family Euphorbiaceae also exhibit higher potassium concentration 910.3 mg/100g.
Potassium is of great importance for electrolyte balance in systems in the body. The tolerable upper intake levels (ULs) are not established for potassium. However, according studies the higher potassium intake was associated with a lower risk of stroke [19].

**Magnesium (Mg)**

In Table 1, a higher concentration of magnesium is found in the leaves of *Synadenium Grantti* Hook f. 23.34 mg/100g, while for *Ricinus communis* L. and *Chrozophora tinctoria* (L.) Raf. are 0.9992 mg/100g and 0.9083 mg/100g [16]. The recommended dietary allowance (RDA) of magnesium for adults is established the mean intake of 355 mg/day [20]. So, the *Synadenium grantii* Hook f. is food rich of magnesium. There is not current data to establish a safe upper level for the magnesium intake. Magnesium is important to cells, enzymes involved in proteins and metabolism [21]. The UL for magnesium is determined by supplementation only (350 mg/day) and does not regard the ingestion from food or water [20]. Although in lower concentrations when compared to UL, the magnesium content obtained of the leaves of plants would pose a risk of adverse effects on health. That is, some macroelements consumed at very high levels and during long time could cause toxicity. Our results indicated that the *Synadenium grantii* Hook f. plant showed a high content of Mg as well as previous findings of *Trigonella foenum-graecum* L. [18, 22].

**Sodium (Na)**

In Table 1, in relation to macroelements, the lowest concentration detected of Na in the leaves of *Synadenium grantii* Hook f. were 63.83 mg/100g, which differed from the findings of others results as *Ricinus communis* L. (0.2235 mg/100g) and *Chrozophora tinctoria* (L.) Raf. (0.155 mg/100g) [16]. In Table 1, similar to our present study, all plants show low concentration of sodium. Considering the adequate intake of sodium for adults of 1,500 mg/day [17], *Synadenium grantii* Hook f. is not considered a source of sodium. Moreover, the tolerable upper intake level (UL) for consuming of sodium in adults is 2,300 mg/day [17]. So, the results in Table 1 are below the values tolerable upper intake level. High dietary sodium intakes increase the development of hypertension and the atherosclerotic vascular diseases [23].

**Phosphorus (P)**

In Table 1, concentration detected of phosphorus in the leaves of *Synadenium grantii* Hook f were 50.94 mg/100g. In work published in Ref. [16] was not detected the phosphorus concentrations in the leaves of the *Ricinus communis* L. and leaves of *Chrozophora tinctoria* (L.) Raf. The RDA for daily Phosphorus in adults is established the mean intake of 700 milligrams per day [20]. From this comparison, the present study indicates that leaves of the *Synadenium grantii* are not source in phosphorus. The tolerable upper intake level (UL) for phosphorus is 4,000 mg/day for generally healthy adults [20]. In this case specifically, the contents of phosphorus obtained of the leaves *Synadenium grantii* Hook f. were well below the permissible limit. Phosphorus is estrogenic, immuno stimulant and anti-osteoporotic [24].

**Macroelements**

**Chromium (Cr)**

In Table 1, chromium (Cr) contents were 0.489 mg/100g for the *Synadenium grantii* Hook f. leaves. In work published in Ref. [16] is not informed the average value of the chromium concentration obtained for *Ricinus communis* L. and *Chrozophora tinctoria* (L.) Raf. Considering the adequate intake of chromium for adults of 0.030 mg/day [25], leaves of this plant is rich in chromium. The permissible limit set by FAO/WHO (1984) in edible plants was 0.002 mg/100g. The permissible limit of chromium in finished herbal products is 0.02 mg/day recom-
mended by WHO [26]. After cooperation of researches data above, the concentration of chromium in *Sinadenium grantii* Hook f. was recorded above the permissible limit set by FAO/WHO.

Moreover, the tolerable upper intake level (UL) for consuming of chromium in adult is not established yet. The beneficial effects of supplemental chromium in individuals with type 2 diabetes were observed at levels higher than the upper limit of the estimated safe and adequate daily dietary Intake [27].

**Copper (Cu)**

Copper contents were 0.910 mg/100g for the *Synadenium grantii* Hook f. leaves respectively (Table 1). In our study, copper content in the leaves of *Synadenium grantii* Hook f. is highest than the concentration obtained for *Ricinus communis* L. (0.005 mg/100g) and *Chrozophora tinctoria* (L.) Raf. (0.006 mg/100g) [16]. The recommended dietary allowance (RDA) of copper for adult men and women is 0.9 mg/day [25]. The present results indicate that leaves of *Synadenium grantii* Hook are rich in copper.

The permissible limit of copper set by FAO/WHO (1984) in edible plants is 0.3 mg/100g, and according to ref. [28], the permissible limit recommended by WHO of copper for plants is 1mg/100g. However, some countries as China and Singapore had set limits for copper in medicinal plants at 20 and 0.150 mg/g [26]. Our results indicate that the copper concentration detected in the *Synadenium grantii* Hook f. leaves are above the values established by FAO/WHO (1984) and smaller than the stipulated value for plants by the WHO, but within the limits adopted by other countries. The tolerable upper intake level (UL) for consuming of copper in adults is 10 mg/day [25]. Therefore, the results in Table 1 for copper are below the values adequate intake and tolerable upper intake level. In humans, Cu is necessary for bones and for proper absorption of iron and for vitamin C. Acute Cu intoxication leads to gastrointestinal effects in the form of nausea, vomiting and crampy abdominal pain [29].

**Iron (Fe)**

In our study, the iron content obtained were 8.345 mg/100g in the leaves of *Synadenium grantii* Hook f., its value is highest than the concentration obtained for *Ricinus communis* L. 2.735 mg/100g) and *Chrozophora tinctoria* (L.) Raf. (0.2989 mg/100g). Recommended dietary allowance (RDA) of iron for adults is established the mean intake of 13 mg/day [25]. After comparison, the present study indicates that leaves of the *Synadenium grantii* are rich in iron. The regulatory limits of the WHO/FAO (2005) have not been established yet for the iron in herbal medicines. The permissible limited set by FAO/WHO (1984) in edible plants was 2 mg/100g [30]. However, the concentrations of iron presented in the Table 1 are minor that the values tolerable upper intake level (45 mg/day) [25], so that, concentration of iron obtained in leaves of *Synadenium grantii* Hook f. are below the values tolerable upper intake level. Iron (Fe) is necessary for the proper functioning of the liver and transporting oxygen in the blood to all parts of the body [31]. Iron deficiency negatively influences the normal defense systems against infections.

**Manganese (Mn)**

In Table 1, our results show that the manganese contents were 1.047 mg/100g in the leaves of *Synadenium grantii* Hook f. Unlike the present study [16] reported low Mn contents (0.0216 mg/100g) in the *Ricinus communis* L. and *Chrozophora tinctoria* (L.) Raf. (0.013 mg/100g). Considering the adequate intake of manganese of 2.5 mg/day [25], the leaves of *Synadenium grantii* is food rich in manganese. However, for manganese in medicinal plants limits not yet been established by WHO (2005) [26]. The upper intake level (UL) for consuming of manganese in adults is 11 mg/day [25]. Therefore, the results in Table 1 for manganese are below the values to-
lerable upper intake level. Manganese is a part of enzymes involved in urea formation, pyruvate metabolism and the galactotransferase of connective tissue biosynthesis [32].

**Molybdenum (Mo)**
Molybdenum contents in the leaves of *Synadenium grantii* Hook f. were 0.522 mg/100g respectively (see Table 1). In our study, molybdenum content in the leaves of *Synadenium grantii* is highest than the concentration obtained for *Ricinus communis* L. (0.001 mg/100g) and *Chrozophora tinctoria* (L.) Raf. (0.001 mg/100g) [16]. The RDA of molybdenum for adults is established the mean intake of 0.045 mg/day [25]. The present results indicate that leaves of *Synadenium grantii* Hook f. are rich in molybdenum. The values of dietary intake of Mo are scarce in the literature reports in Brazil and others countries. This is important information required in assessing risks to human health due to their overburden. In animals and man, molybdenum has been recognized as an essential component of the metalloenzyme xanthine oxidase, aldehyde oxidase and sulphite oxidase [33]. Dietary molybdenum affects copper metabolism in man [34]. The tolerable upper intake level (UL) for consuming of molybdenum in adults is 2 mg/day [25]. Thus, the results in table 1 for molybdenum are below the values tolerable upper intake level.

**Zinc (Zn)**
In our work, in relation to *Synadenium grantii* Hook f. leaves were obtained the amount of zinc 3.621 mg/100g, others works ranged between 0.170 mg/100g for *Ricinus communis* L. and 0.232 mg/100g for *Chrozophora tinctoria* (L.) Raf. There are no limits of zinc concentration in medicinal plants by the World Health Organization [26]. Recommended dietary allowance (RDA) of zinc for adults is established the mean intake of 9.5 mg/day [25]. Therefore, leaves of the *Synadenium grantii* Hook f. are food rich in zinc. Recommendation of zinc is beneficial in the treatment of several disorders, such as several pro-inflammatory conditions and cancer [35]. The concentrations of zinc presented in the Table 1 are minor that the values tolerable upper intake level (40 mg/day) [25].

**Silicon (Si)**
According to data in Table 1, the contents silicon was 23.524 mg/100g in *Synadenium grantii* Hook f. leaves. In work published in Ref. [16] was not detected the silicon concentrations in the leaves of the *Ricinus communis* L. and leaves of *Chrozophora tinctoria* (L.) Raf. There are no established a permissible criteria for level of silicon in herbs medicinal. The daily intake from the British diet has been estimated to 20-50 mg corresponds to 0.3-0.8 mg/kg body weight/day in a 60 kg person [36]. There is evidence that silicon is important in bone formation. Although the main source of silicon for humans is the diet, the bioavailability of silicon from solid foods is not fully understood [37]. There is not tolerable upper intake level (UL) for consuming of silicon in adults. However, the result in Table 1 for silicon is within limit the daily intake from the British diet.

**Nickel (Ni)**
Nickel concentrations detected in the leaves of *Synadenium grantii* Hook f. were 1.951 mg/100g (Table 1). In Ref. [16] was not detected the nickel concentrations in the leaves of the *Ricinus communis* L. and leaves of *Chrozophora tinctoria* (L.) Raf. The recommended daily amounts of nickel are not fixed. However, according to Food and Agriculture Organization (FAO) of the United Nations in 1984 the permissible limit in edible plants is 0.163 mg/100g [30]. From of information about metal limit in medicinal plants proposed by FAO/WHO (1984) it is found that the leaves of *Synadenium grantii* Hook f. accumulate Ni above this limit. No limit yet been given by WHO in 2005 for Ni in medicinal plants. Studies have shown that Ni is toxic as evidenced by lipid peroxidative damage to placental membrane;
in this case, the metabolic change may be responsible for decreased placental viability, altered permeability, and potential subsequent embryotoxicity [38]. The concentration of nickel presented in the Table 1 are above of the values tolerable upper intake level (1 mg/day).

Cobalt (Co)
The contents of cobalt varied from 1.723 mg/100 g in the leaves of Synadenium grantii Hook f. Results on Mentha piperita shown 0.026 mg/100 g of cobalt in a Spanish study [39]. In work published in Ref. [16] was not detected the cobalt concentrations in the leaves of the Ricinus communis L. and leaves of Chrozophora tinctoria (L.) Raf. A safe recommended dietary allowance (RDA) or adequate intake for cobalt (Co) hasn’t been set yet. Neither has cobalt been assessed in relation to the WHO guidelines for drinking-water. Until now, cobalt has not been evaluated by competent organs in order to establish a tolerable upper intake level. Cobalt is part of vitamin B12; the recommended daily intake of vitamin B12 for an adult in the USA was 3 μg, corresponding to 0.012 μg of cobalt [39]. Cobalt is not easily absorbed from the digestive tract. In fact, clinical studies have shown that maximum cobalt whole blood concentrations between 9.4 and 117 μg/L were not associated with clinically significant changes in hematological and basic clinical variables [40]. However, cobalt(II) complexes have been synthesized with a series on non-steroid anti-inflammatory drugs. Complexes exhibit noteworthy antioxidant activity and significant binding affinity for serum albumins and calf-thymus DNA [41].

Cadmium (Cd)
The contents of cadmium varied from 0.044 mg/100g in the leaves of Synadenium grantii Hook f. In work published in Ref. [16] was not detected the cadmium concentrations in the leaves of the Ricinus communis L. and leaves of Chrozophora tinctoria (L.) Raf. A safe recommended dietary allowance (RDA) or adequate intake for cadmium (Cd) hasn’t been set yet. For medicinal plants the permissible limit for cadmium set by WHO and others countries was 0.03 mg/100g [26]. The FAO/WHO (1984) has set in edible plants was 0.021 mg/100g [30]. There is not tolerable upper intake level (UL) for consuming of cadmium in adults. The average daily cadmium obtained in our work is above the guidelines established by the WHO e FAO/WHO. Cadmium is not at present believed to be an essential nutrient for animals or man. Humans normally absorb cadmium into the body either by ingestion or inhalation. According to published studies, cadmium causes acute and chronic poisoning [42]. There is little general agreement about acceptable safety limits for cadmium intake. Evidence is insufficient to determine an association between exposure to cadmium and reproductive effects in humans.

Aluminum (Al)
Aluminum contents were 13.498 mg/100g for the Synadenium grantii Hook f. leaves respectively. On others works published ranged between 0.033 mg/100g for Ricinus communis L. and 1.118 mg/100g for Chrozophora tinctoria (L.) Raf. There are not RDA and adequate intake for aluminum (Al). According to FDA’s 1993 total diet study dietary exposure model and the 1987–1988 U.S. Department of Agriculture (USDA) Nationwide Food Consumption Survey, the authors estimated daily aluminum intakes 0.12 mg Al/kg/day for adult males and females [43]. However, excessive intake of aluminum results in pathological aberrations such amnesia in young people. Aluminum is present in the brain of patients with Alzheimer disease [44].

Conclusions
First comprehensive study on determination of contents in the leaves of the Synadenium grantii is of great importance to understand the pharmacological action of this plant. The data obtained in the
A manuscript on elemental compositions of leaves of *Synadenium grantii* will be useful in deciding the dosage of the drugs prepared from the plant and thus will be helpful in synthesis of new modern drugs. Our studies demonstrated that the *Synadenium grantii* Hook f. leaves are good source in K but not Na and P. However, leaves of *Synadenium grantii* Hook f. are rich in elements such as Mg, Cr, Cu, Fe, Mn, Mo and Zn. The aluminum does not have nutritional function. There are not Recommendation (RDA) and Adequate Intake for aluminum (Al).

Unlike the *Ricinus communis* L. and plants *Chrozophora tinctoria* (L.) Raf. in leaves of the *Synadenium grantii* Hook f. was detected elements as phosphorus, silicon, nickel, cobalt and cadmium. The contents of macroelements and microelements in the leaves of *Synadenium grantii* is highest than contents in the leaves of *Ricinus communis* L. and *Chrozophora tinctoria* (L.) Raf. These different was could be due to mineral composition of the soil and its surrounding climatological conditions.

The leaves of *Synadenium grantii* showed a high content of Mg values tolerable upper intake level. However, Fe, Na, P, Mn, Mo and Zn are below the values tolerable upper intake level.

After comparison, metal limit in the studied medicinal plants with those proposed by FAO/WHO (1984) it is found that this plant have Ni, Cu, Cr, Cd above this limit above the permissible limit set by WHO and FAO.

There are no established a permissible criteria for level of silicon in herbs medicinal. Silicon is within limit the daily intake from the British diet. Cobalt has not been evaluated by competent organs in order to establish a tolerable upper intake level.

As *Synadenium grantii* Hook f. has macroelements and microelements in ample amount, it can be used as a good natural dietary supplementary as well as therapeutics uses. Since it not exceed allowable limits set by WHO and FAO, RDA and UL.

The use of Medicinal plants acquired in public markets, herbal shops, by urban populations cannot be ignored because the element toxicity risk assessment is bases rather on habitual than on incidental intake. Brazil should create legal standards for the use of medicinal plants based on internationally practiced requirements.

**Conflict of interest disclosure**

The authors declare that there is no conflict of interest regarding the publication of this paper.

**References**


