Characterization of *Cymbopogon Schoenanthus* Leaves, Spikes and Roots

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Abstract: *Marhabaib (Cymbopogon schoenanthus), is one of the most famous and popular aromatic herbs that, find extensive nutritional and medicinal use in Sudanese homes. This work was conducted to measure, moisture, ash, protein, fat, fiber, carbohydrates and minerals content of leaves, spikes, and roots of the plant. The samples were collected from Northern Darfur, River Nile, and Gedarif States of Sudan. Carbohydrates and fibers were found to be the major constituents in the three parts. ICP analysis of acid digested ash samples showed high total Mg in the three states ranging from (223.36- 335.33mg/l) followed by Ca (213.77- 220.03mg/l) and Na (52.24- 60.25mg/l). Trace levels were shown for Al, Cu, Fe, As, and Pb. Cr, Ni and Cd were not detected. AAS analysis for aqueous extracts showed mean minerals content of leaves as K (898.93mg/l), Mg (126.37mg/l), Ca (100.26 mg/l), Na (25.65mg/l), Pb (3.77mg/l), Mn (1.84mg/l), Zn (0.473mg/l), Fe (0.35 mg/l), Cu(0.0443 mg/l). The mineral means of the spikes were K (377.08 mg/l), Mg (52.17 mg/l), Na (26.13 mg/l), Ca (24.09 mg/l), Pb (1.27 mg/l), Mn (0.87 mg/l), Zn (0.59 mg/l), Fe (0.20 mg/l), Cu (0.02 mg/l), whereas the roots means were, K (240.63mg/l) Mg(45.28mg/l), Ca (16.91mg/l), Na(20.30mg/l), Mn(3.44mg/l), Zn (1.80mg/l), Fe(0.74mg/l), Cu (0.0495mg/l).*

Keywords: Aromatic herbs, Spikes, Minerals, ICP, Aqueous extract

Introduction

Cymbopogon is a tropical perennial herb that, commonly found traditional and medicinal uses in India, China, and Brazil (Negrelle, R. R. B, et al., 2007). The genus *Cymbopogon* belongs to the grass family Poaceae (Gramneae) that, contains nearly 184 species, sub species, varieties and sub varieties, out of which 54 species are known and accepted worldwide (Bertea & Maffei 2010, K. J. Thara Saraswathi et al., 2016). According to Brito, L. C. F et al., (2021), Wei et al., (2013), and Bayala et al., (2020), the gender *Cymbopogon* which, belongs to the family Poaceae, subfamily Panicoideae, is consisting of eighty-five species. The plant is natively growing in tropical Asia and Africa countries, India, Iraq, Oman, Saudi Arabia, Yemen, Algeria, Egypt, Libya, Morocco, Chad, Djibouti, Ethiopia, Somalia, Sudan, Kenya, Benin, Burkina Faso, Ghana, Guinea, Mali, Mauritania, Niger, Nigeria, Senegal and Togo (USDA, ARS, 2015, Al-Snafi A E, 2016). The herb grows in a wide range of soil and climatic conditions. It requires a hot and humid climate with high rainfall and long sunlight (Aftab et al., 2011; Thorat et al., 2017). In developing countries, millions of people live under extreme poverty where, they may seriously suffer and may even die because of lack in good quality water, medicine and primary health care alternatives (Adeniyi, S. A. et al, 2012). Under such conditions, the traditional medicine of Africa constitutes an important source for ethno-pharmacological investigations (Dame, Z.T.D, et al., 2013). In Africa and other developing countries most of the populations in rely on herbal medicine to meet their primary health care needs (Falkenberg, 2002, Singh, 2015, Nkansah *et al*., 2016, Nitsuh Birhanu et al., 2021). The species *Cymbopogon schoenanthus* is an aromatic perennial herb, commonly known as lemongrass. Its leaves and essential oil are largely employed in the traditional medicine as sedative, stomachic, analgesic, antispasmodic and antimicrobial (Ayda Khadri et al., 2010). It is widely distributed and cultivated in tropical and subtropical countries of Asia, Africa, and America (Shah, 2011; Anal, 2014; Avoseh et al. 2015, Nitsuh Birhanu et al., 2021). In Sudan, *Cymbopogon schoenanthus,* is growing wildly in many parts of the country and finds extensive nutritional and medicinal uses almost in any home as one of the most famous and popular aromatic herb (Figs. 1, 2, 3). In Northern Darfur *Cymbopogon schoenanthus* dry leaves and roots are boiled in water and given to the mothers of the newly born infants as only drinking water source for the first three weeks of delivery. This practice may provide the mother or/and her infant with high levels of water extractable minerals and organic constituents.

Fig.1: Wildly growing Marhabaib at the beginning of the rainy season

Fig .2: Marhabaib grass at the end of the rainy season

Fig. 3: Mature Marhabaib leaves and roots

Medicinal and pharmacological uses

As an aromatic herb, *Cymbopogon schoenanthus* is consumed in traditional medicine, as antihelminthes, antidiarrhea, antirheumatic, carminative, diaphoretic, stomachic, diuretic, emenagogue, antipyretic, for treatment of jaundice, and as tonic (Khadri A. et al., 2008, Ali Esmail Al-Snafi., 2016). It was also reported to contain tannins, saponins, sapononin glycoside, flavonoids, alkaloids, triterpens, balsams, cardiac glycosides, glycosides, steroids and volatile oils. In addition it showed antioxidant, antimicrobial, anthelmintic, insecticidal, protective, acetylcholinesterase inhibitory activity and other pharmacological effects (Ali Esmail Al-Snafi., 2016). In morocco and Egypt, the plant parts were used as, febrifugal, diuretic, antirhumatism, and antigastralgic (Atyat A, 1995; IUCN, 2005). *Cymbopogon* species were reoprted to be extremely valuable because, their leaves roots, aerial parts, rhizomes, and essential oils were rich with many phytochemicals, where some of the ethnopharmacology observed include, aromatherapy, ansect repellent, antitumor, antispasmodic, antihermetic, analgesic, anti-inflammatory, antipyretic, tranquilizer, and inhibitor of respiratory tract infections (Xiaobo Wang et al., 2022).Quality control is important for medicinal herbs to identify and discover the active and minimal components, and help in their extraction, separation, or isolation process (Wang et al., 2019). *C. schoenanthus*, could be attributed to inhibition of glycolic acid metabolism, increasing urine output, and preventing calcium oxalate crystals formation (Al-Ghamdi et al., 2007). *C. schoenanthus* is used in Sudan for the treatment of gout, prostate inflammation, kidney disease and for stomach pains (El Ghazali G E B, 1997). The areal parts of the plant can be used in dry form, powder, or fresh (Rizk A, 1986). According to Wright et al., (2009) *C. citratus* leaves oil was used to heal oral thrush caused by Candida albicans in HIV/AIDS patients within 1-5 days (Wright et al., 2009) and both, lemon juice and lemon grass are better than gentian violet aqueous solution (0.5%) in the treatment of oral thrush in HIV/AIDS patients. The pharmacological effects of *Cymbopogon* in the central nervous system, anti-inflammatory, antimicrobial, antioxidant, and anticancer were confirmed by many studies (Aliya A. Z. et al., 2020). Lemongrass is used in Nigeria for the treatment of fever, convulsion in children, stomach upset, skin diseases, and ears/eyes infections, pepper soup ingredient, curries, and in preparation of local drinks (Samson O. et al., 2022). The minerals mean values were in the order, Ca >K> Si> Cl>Br> S> P> Fe> Sr> Ti> Co> Zn (Al-Salman et al., 2022). XRF analysis of Pakistan lemongrass for tea making showed mean minerals availability in the order, K>Ca>Si>Mg>P>Fe>Al>S>Sr>Br>Cu=Zn>Mn (Aftab, K. et al., 2011). In Nigeria minerals content of Lemongrass was reported to be as Mg (14.59 mg/kg), Pb (1.379 mg/kg), Zn (0.844 mg/kg), Hg (0.728 mg/kg), Cr (0.530 mg/kg), Cu (0.267 mg/kg), Fe(0.167 mg/kg), Cd (0.080 mg/kg) and Mn (0.009mg/kg) Samson O. et al., (2022).

Minerals content

Although, *Cymbopogon* is safe when used orally, topically, or as aromatherapy, undesirable effects may result from wrong consumption and high levels of hazardous soil minerals (Ekpenyong et al., 2015a, Tibenda et al., 2022). A Mubark et al., (2014) reported mean minerals content of Maharaib samples from Butana as K (5950 mg/kg), Ca (1170mg/kg), Mn (209 mg/kg), Fe (189 mg/kg), Zn (22 mg/kg), Sr (7.7 mg/kg), Ni and Cu (1 mg/kg), Co and Cr (0.6 mg/kg). minerals content of *C. schoenanthus* at early bloom stage, were reported by, Sultan J I et al., (2008) as, K(0.56%), Ca (0.38%), Mg (0.036%), P(0.013%), Cu (17.5 ppm), Zn (11.0 ppm), Mn (6.5 ppm) and Co (0.011 ppm), whereas at maturity stage were, Ca (0.49%), K (0.48 %), P (0.032%) , Mg (0.022 %), Cu (23.0 ppm), Zn (3.5 ppm), Mn (2.7 ppm) and Co (0.023 ppm). Lemongrass samples collected from different sites in Ethiopia showed mineral ranges as, K (743.8- 1020mg/kg), Ca (123.1- 129.3 mg/kg), Mg (23.9- 36.3 mg/kg), Fe (10.35- 22.3 mg/kg), Mn (10.0- 12.7 mg/kg), Cu (1.48- 2.5 mg/kg), Zn (0.59- 1.07 mg/kg), and Pb (0.13- 0.20 mg/kg) (Nitsuh Birhanu et al., 2021). Gibla O. A. et al., (2022) reported minerals content of *Cymbopogon* leaves as, S(2.88mg/100g), P(1.025mg/100g), I(0.83mg/100g), Fe (0.54mg/100g), Si (0.23mg/100g), Ca (0.21mg/100g), Mg and Al(0.16mg/100g), Na (0.043mg/100g), and K (0.031mg/100g), whereas the spikes minerals were P (2.5mg/100g), Fe (0.63 mg/100g), S(5.mg/100g), I (1.9 mg/100g), Al (0.69mg/100g), Si (0.425mg/100g), Mg (0.18mg/100g), Ca (0.16mg/100g), Na (0.095mg/100g), and K(0.078mg/100g). Eid I Brima (2018) stated that, the intake of essential minerals in *C. schoenanthus* did not exceed the daily intake set by the World Health Organization (WHO) and European Food Safety Authority (EFSA) and showed the availability of some minerals in the sequence Fe>Mn>Cu> Zn>Se.

Methodology

Dry *Cymbopogon schoenanthus* leaves, spikes and roots samples were collected from Northern Darfur, River Nile, and Gedarif States (Fig. 1, 2 and 3). Moisture, ash, protein, fat, fiber and carbohydrates contents were determined. ICP analysis was carried for 0.5g acid digested ash of each sample. 30g of coarsely crushed leaves spikes and roots samples were boiled in 250ml distilled water for 30 minutes and left overnight. The aqueous extract of the each sample was quantitatively filtered and analyzed by AAS. All the chemicals used were of analytical grade.

Results and discussion

The major constituents

As shown by (table. 1) the three parts of *C. schoenanthus* were dominated by fibers and showed almost similar moisture content. The leaves were characterized by relatively high ash and carbohydrates but, on the other hand showed low protein and fat compared with that of spikes and roots. The aerial parts of *C. schoenanthus* were reported to consist of, moisture (20%), total ash (10%), acid insoluble ash (8%), and sulfated ash (4.8%) (EL-Kamali H. H et al., 2010, Al-snafi E. A. et al., 2016).

Table.1: The major constituents of *C. schoenanthus* parts (mean %)

Constituent	Leaves	Spikes	Roots
Moisture	8.48	7.91	8.66
Ash	10.72	7.45	8.61
Protein	0.46	2.65	0.59
Fat	0.34	4.52	4.18
Carbohydrates	6.49	8.22	3.17
Fiber	76.84	69.24	74.8

ICP analysis

The ICP analysis of leave samples showed nearly similar concentrations of Ca, relatively small differences in Na and significantly high Mg in the three states (Fig. 4). Trace levels of micro minerals were shown in the three areas with means as Al (0.60 mg/l), Cu (0.28 mg/l), Fe (0.27 mg/l), As (0.24 mg/l), Pb(0.17 mg/l) and Ni (0.08mg/l).

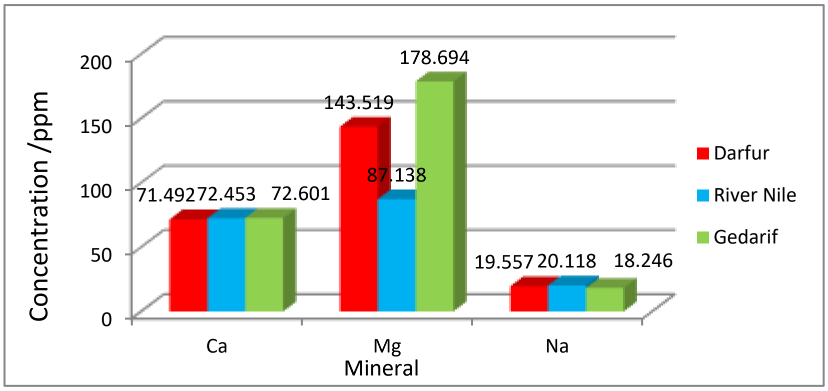

Fig.4: *C.schoenanthus* leaves content of Ca, Mg and Na

In *C. schoenanthus* spikes, Ca was the highest available mineral with almost similar concentrations in the three states, whereas, clear differences can be observed for Mg and Na (Fig.5). The micro minerals here also were of low levels as Al (0.54mg/l), Fe (0.46mg/l), Cu (0.28mg/l), As (0.17mg/l), and pb (0.12mg/l).

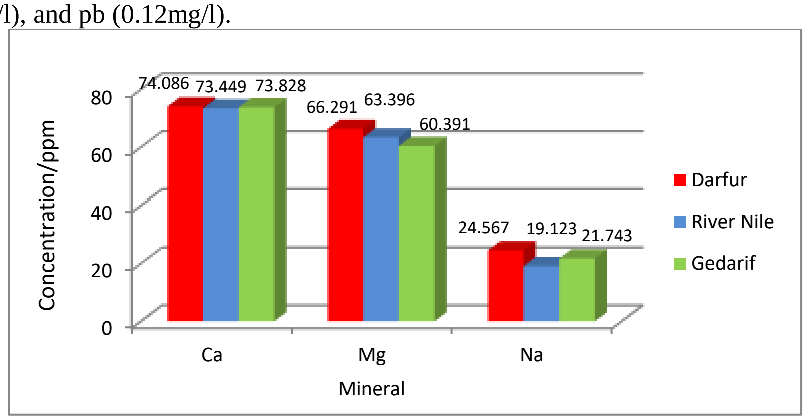

Fig.5: *C.schoenanthus* spikes content of Ca, Mg and Na

In *C. schoenanthus* roots, Ca was relatively low in Darfur than Gedarif and R. Nile where it showed almost similar availability. Significantly high Mg was observed in Gedarif compared with typical concentrations in Darfur and R. Nile. Na was lower in R. Nile than that of the other two states (Fig. 6). When compared with leaves and spikes the root samples showed significantly high Fe in the three states with a mean of (1.37 mg/l) followed by Al (0.78 mg/l), Cu (0.43 mg/l), As (0.16 mg/l), Ni (0.13 mg/l)and Pb (0.12 mg/l).

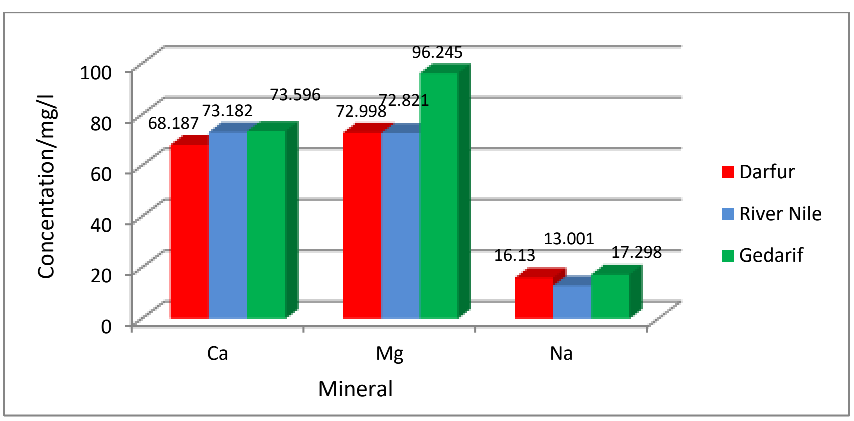

Fig.6: *C.schoenanthus* roots content of Ca, Mg and Na

International Journal of Academic Multidisciplinary Research (IJAMR)
ISSN: 2643-9670
Vol. 7 Issue 2, February - 2023, Pages: 242-249

The three sampling areas showed high total Mg content followed by Ca and relatively low Na (Fig. 7). Highest Mg was shown by Samson O. et al., (2022), but many other previous studies reported Ca as the second highest mineral after K in *C. schoenanthus* (Aftab, K. et al., 2011, A Mubark et al., 2014, Nitsuh Birhanu et al., 2021, and Sultan J I et al., 2008).

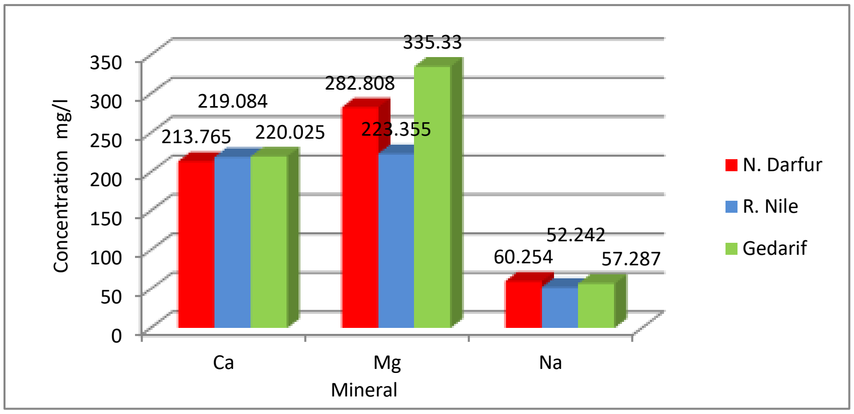

Fig .7: Total *C.schoenanthus* Ca, Mg and Na content

Aqueous extract analysis (AAS)

In *C. schoenanthus* leaves K was the highest mineral in the three states, with a mean value as (898.93ppm) followed by Mg with a mean as (126.37mg/l). The highest Ca (186.92 mg/l) and the lowest Na (22.7 mg/l) were shown in River Nile. The availability of Na was almost similar in Darfur and Gedarif as (27.7and 26.6 mg/l) (Fig. 8). Seriously high Pb was shown in Darfur (7.33 mg/l) compared with (2.39 mg/l) in River Nile and (1.60 mg/l) in Gedarif with a mean of (3.77 mg/l). The three states showed low Mn, which was relatively high in Gedarif (2.27 mg/l) compared with (1.82 mg/l) in Darfur and in River Nile (1.44 mg/l). Low mean concentrations were shown by, Fe (0.354 mg/l), Zn (0.473 mg/l) and Cu (0.0443 mg/l). Ni showed trace level in River Nile only as (0.056 mg/l), whereas Cr and Cd were not detected in the three states.

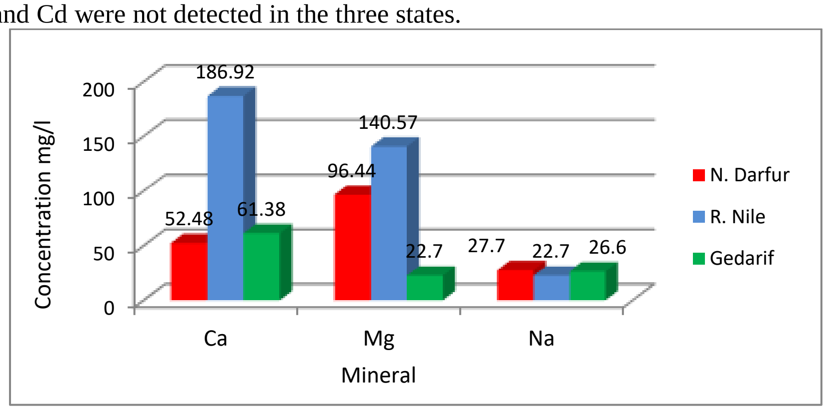

Fig.8: leaves content of Ca, Mg and Na (AAS)

In *C. schoenanthus* Spikes aqueous extracts, the highest availability was shown by K as (337.40 mg/l) in Darfur, (454.34mg/l) in River Nile, and (339.5mg/l) in Gedarif with a mean concentration (377.08mg/lmg/l). The second mineral was Mg in the three states with a mean availability (52.17mg/l). In Darfur Na was (29.10mg/l), River Nile (28.20mg/l), Gedarif (21.10mg/l) with a mean value (26.13mg/l). Significantly high Ca was observed in River Nile (32.55mg/l) compared with that of Darfur (19.67mg/l) and Gedarif (20.04mg/l) with a mean (24.09mg/l) (Fig. 9). Pb was the fifth available mineral in Darfur (1.39mg/l), River Nile (1.65mg/l) and Gedarif (0.78mg/l) with a mean of (1.27mg/l). Low mean concentrations were shown by Fe (0.202), Mn (0.87mg/l), and Zn (0.593mg/l). The lowest mineral in the three areas was Cu with a mean of (0.023 mg/l), whereas Cr, Ni and Cd were not detected.

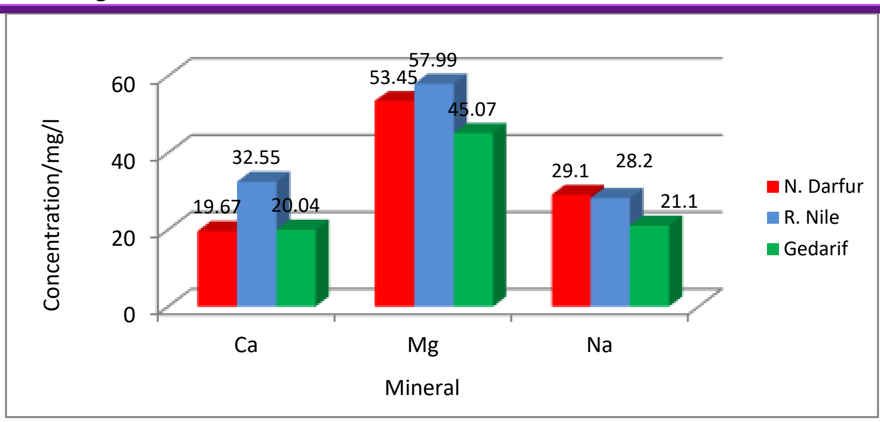

Fig.9: Spikes content of Ca, Mg and Na (AAS)

C. schoenanthus roots showed significantly high K in the three regions, Darfur (311.30mg/l), River Nile (149.20mg/l), and Gedarif (261.40mg/l). Mg was low in River Nile (22.89mg/l) compared with that of northern Darfur (47.36mg/l), and Gedarif (65.60mg/l). Lower Ca was shown by Northern Darfur sample (12.86mg/l), than that of River Nile (18.08mg/l) and Gedarif (19.80mg/l). Na in Northern Darfur was (19.10mg/l), in River Nile (16.30mg/l) and in Gedarif (25.50mg/l) (Fig. 10). The lowest Mn was shown in River Nile (0.42mg/l) compared with (2.32mg/l) in northern Darfur and (7.59mg/l) in Gedarif. Fe was relatively low in the three regions. Zn showed clearly different concentrations. Cu showed low concentrations in Northern Darfur and Gedarif. Cr and Cd were not detected in the three states, whereas, Ni was detected only in Gedarif sample. Pb was not detected in River Nile, but almost similar concentrations were shown in Northern Darfur and Gedarif as (0.75 and 0.77 mg/l) which may be risky levels.

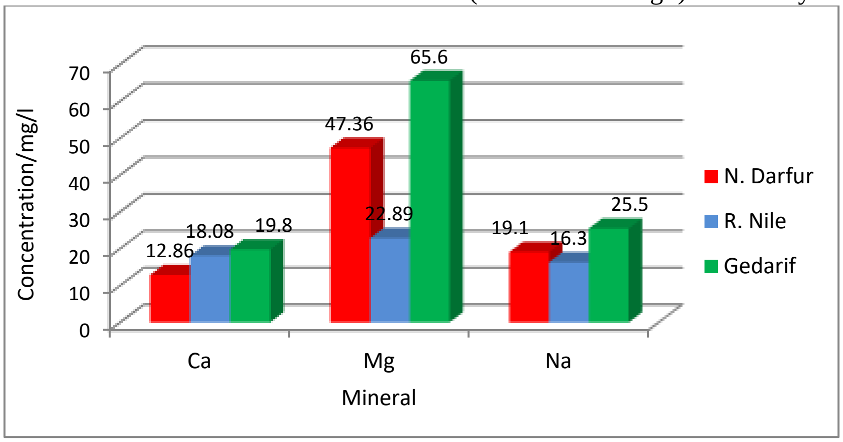

Fig. 10: Roots content of Ca, Mg and Na (AAS)

Potassium content AAS

Potassium (K) was the significantly highest available mineral in *C.schoenanthus*, leaves, spikes and roots in the three states. Leaves showed highest K in Darfur (1018.2mg/l) followed by R. Nile (940.83mg/l) and Gedarif (737.76mg/l). The highest K for spikes was (454.34mg/l) in R. Nile and for roots (311.3mg/l) in N. Darfur. This may strongly agree with the findings reported by Nitsuh Birhanu et al., (2021), A Mubark et al., (2014) and Sultan J I et al., (2008).

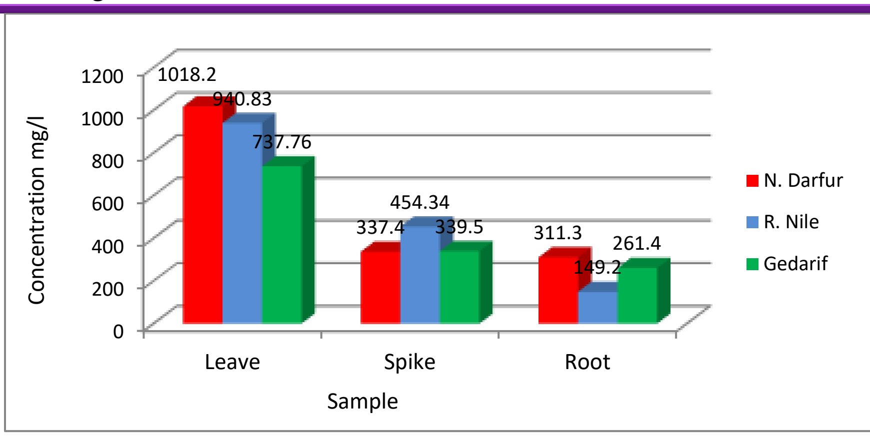

Fig. 11: K content of leaves, spikes and roots in the three states

Conclusion

- The most available mineral in *C. schoenanthus* leaves, spikes and roots was K. In the aqueous extracts the highest Ca was shown by leaves whereas Mg was the highest in spikes and roots. In the ICP analysis Mg was the highest available mineral in leaves and roots followed by Ca and Na, whereas highest Ca was shown by spikes in the three states. The minerals Cr, Ni and Cd were not detected. Roots showed high Fe content in ICP and AAS analysis Compared with leaves and spikes. Lead showed relatively high levels in some samples therefore it may need further confirmatory investigations.

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