

THE CHARACTERISTICS OF CAMEL GRAZED RANGELAND IN THE BUTANA PLAIN, GADARIF STATE, SUDAN

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ABSTRACT

Camel production is very important in the Sudan and Butana plain (BP) due to high population, reputed breeds and socioeconomic impacts. However, camel contribution to milk and meat production and the national economy is less than expected due to many obstacles. Nutrition is a main constraint for camel production as it depends mainly on rangeland, which is deteriorating for many reasons. In addition, modern nutritional concepts such as the new protein systems are not applied. Butana plain, Gadarif State is a very important camel grazing area, but there is no available information on rangeland characteristics in the area to allow better exploitation and conservation. Consequently, rangeland characteristics including plants inventory, density, frequency distribution and biomass were studied in the northern and southern areas of Butana plain, Gadarif State, Sudan using a 1x1m iron quadrat. Data was statically analysed according to the completely randomised design. Plant diversity was very high in the area and in the southern area (34 and 33 plants, respectively). The plants were in 20 families, mainly Poaceae, and all families were found in the southern area. Plants inventory, families, density and grasses and forbs frequency distribution and fresh and dry biomass varied highly between areas and month. Plants and family numbers were highest in September and least in August. Plants numbers were highest in the southern area in September and October and in the northern area in August. Plants density was higher in the southern area in all month and was highest in August and least in October in the two areas. The study demonstrated higher plants numbers, diversity, density and biomass.

Key words: Butana plain, Gadarif state, month, rangeland characteristics

Camels are very important in Butana plain (Darosa, 2005), but their contribution to milk and meat production and national economy is too low compared with their population due to many reasons. Nutrition is a main constraint for camel production in Butana plain, Gadarif State as they depend mainly on rangeland plants which are deteriorating due to many factors (Mohamed, 2001; Abusuwar and Darrag, 2002). In addition there are seasonal variations in feeds quantity and quality associated with rainfall (Mohamed, 2013) with serious shortages and effects on animal performance and health, especially in the dry season (Ali, 2003). Successive droughts reduced frequency distribution of high quality plants and increased invaders with low nutritive value. Information on rangeland characteristics including plants inventory, frequency distribution and biomass are important for optimum rangeland plants conservation and exploitation. These parameters are affected by many factors such as rainfall (Abusuwar and Yahia, 2010; Abusuwar *et al*, 2011; Mohamed, 2013), soil (Fdial, 2013; Elimam *et al*, 2024), and areas

(Abusuwar and Yahia, 2010; Mohamed, 2013; Elimam *et al*, 2024). They are also affected by season and years (Abusuwar and Yahia, 2010) and rangeland protection (Mohamed *et al*, 2014, Abdelsalam *et al*, 2017). However, this information is not available in Butana plain, Gadarif State, Sudan. In addition modern concepts of ruminant nutrition such as the new protein systems (ARC, 1982) which are based on microbial yield and feeds rumen degradation are not applied due to lack of information. Consequently, this study was conducted to furnish vital information to improve camel nutrition and production. This paper reports information on rangeland characteristics in Butana plain, Gadarif State, Sudan.

Materials and Methods

Study area

The study described below was conducted in the northern and southern areas in Butana plain, Gadarif State, Sudan. It is a very important camel grazing area, especially in autumn. Livestock rearing

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and cropping are the main occupations. The area is located at latitude 14° 08' N and longitude 34° 07' E. There are two climatic zones in Butana plain, Gadarif State with summer seasonal rains from July to October with a peak in August (Farouk and Mohamed, 1982). The semiarid zone in the north and northwest areas and average rainfall is 345- 385 mm. The wet climate zone is in the eastern and southern areas of the state with 500-900 mm average rainfall and 47°C maximum mean temperature. The northern area is in Elbutana Locality in the north of Gadarif State. The Locality is bordered by Central Gadarif Locality in the south, River Nile State in the north, Khartoum State from the west, Kassala State from the east and Gezira State from the south west. Elsubag is the Locality capital and is 174 km north of Gadarif city and 265 km east of Khartoum. The southern area is in Gadarif Locality and it is 111 km north-west of Gadarif city. Sampling sites in the northern area were Elekharesh, Um Ruwashid, Elhagar and Shemal Khat Elmaraa (North pasture area). Sampling sites in the southern area were Wadi Abuganafid, Wadi Abugrad, Elaadeed, Altakoon, south- east Elsaada and Wadi Abumatarig. The study was conducted from August to October 2017 and was terminated in October due to overgrazing and the area was bare after that.

Rangeland characteristics

An iron quadrat (1×1m) was used to determine plants inventory, distribution and biomass. The quadrat was thrown four times on different sampling sites and plants in the quadrat were identified, counted, weighed and stored in paper bags. Shrubs and trees samples were collected and stored in paper bags. The plants samples were air dried in the laboratory and stored in polyethylene bags for laboratory analysis.

Results

Rangeland plants inventory

Table 1 shows rangeland plants inventory in the northern and southern areas, Butana plain, Gadarif State.

Thirty four plants were identified with 33 plants in the southern area and 17 plants in the northern one. Plants diversity was very high, especially in the southern area. Sixteen plants were found in the two areas and 17 plants were found in the southern area and were not found in the northern one. One plant (Seyal) was found in the northern area and was not found in the southern one.

The plants were in 20 families and the main families were Poaceae and Fabaceae. There were variations in plants numbers among families. There were 20 families in the southern area and the main family was Poaceae and 13 families in the northern area where the main family was Convolvulaceae. Six families were found in the southern area and were not found in the northern one.

Effects of month on rangeland plants inventory

Table 2 shows effects of month on rangeland plants inventory in the northern and southern areas of the Butana plain, Gadarif State.

There were high monthly variations in plants inventory in the two areas in the Butana plain. Plants numbers were highest in September (44 plants) and least in August (13 plants). Plants inventory was also affected by sites and areas in different month. It was highest in the southern area in September and October and in the northern area in August. Plants' family numbers were also affected by month. Six families were found in the northern area and 5 families were found in the southern area in August. Twelve families were found in the northern area and 17 families were found in the southern one in September. Four families were found in the northern area and 6 families were found in the southern one in October. Families numbers were higher in the northern area than the southern one in August and October and was higher in the southern area in September.

In August 7 plants were found in the northern area and 6 plants were found in the southern one. Only one plant was found in the two areas (Hantout). In September 27 plants were found in the southern area and 17 plants were found in the northern one. Thirteen plants were found in the northern and southern areas. Four plants were found in the northern area and were not found in the southern one. Fourteen plants were found in the southern area and were not found in the northern one. In October 9 plants were found in the southern area and 6 plants were found in the northern one. Four plants were found in the two areas (Senamaka, Laout, Kitir and Eifain). Only one plant was found in the northern area and was not found in the southern one (Seyal). Five plants were found in the southern area and were not found in the northern one (Fagus, Um glageila, Sikiran, Safari and Tuffa).

Plants density

Table 3 shows that plants density was highly affected by month and areas in the northern and southern areas of Butana plain, Gadarif State.

Plants density was higher in the southern area than in the northern one in all month. It was significantly ($P>0.05$) highest in August and least in October in the two areas. Mean area plant density was higher in the southern area, but not significantly ($P>0.05$). Mean month plants density varied significantly ($P<0.05$) among month and it was highest in August and least in October.

Frequency distribution

Grasses

Table 4 shows effects of areas on grasses frequency distribution in the northern and southern areas, Butana plain. Grasses frequency distribution varied highly among areas in the southern and northern areas. All grasses frequency distributions were very high in the southern area compared

Table 1. Rangeland plants inventory in the northern and southern areas of the Butana plain, Gadarif State, Sudan.

| Plants type | Arabic name | Botanical name | Family | North | South |
|-------------|----------------|---------------------------------|-------------------------|-------|-------|
| Forbs | Eifain | <i>Chenopodium murale</i> | Amaranthaceae | ✓ | ✓ |
| Forbs | Lablab | <i>Digera alternifolia</i> | Convolvulaceae | ✓ | ✓ |
| Forbs | Turba | <i>Boerhavia erecta</i> | Nyctaginaceae | ✓ | ✓ |
| Forbs | Bassal elkilab | <i>Celosia argentea L.</i> | Amaranthaceae | | ✓ |
| Forbs | Dereisa | <i>Tribulus terrestris L.</i> | Zygophyllaceae | ✓ | ✓ |
| Forbs | Fakha | <i>Justicia palustris</i> | Acanthaceae | | ✓ |
| Forbs | Gubbein | <i>Solanum dupium fersen</i> | Solanaceae | ✓ | ✓ |
| Forbs | Um libaina | <i>Euphorbia uegyptica</i> | Euphorbiaceae | ✓ | ✓ |
| Forbs | Raba | <i>Trianthema pentandra</i> | Aizoaceae | ✓ | ✓ |
| Forbs | Khudra | <i>Cenchorus fascicularis</i> | Tiliaceae | ✓ | ✓ |
| Forbs | Safari | <i>Crotalaria senegalensis</i> | Fabaceae or Leguminosae | | ✓ |
| Forbs | Umglagila | <i>Aristolachia bracteolate</i> | Cruciferae | | ✓ |
| Forbs | Sharaya | <i>Indigofera hochstetteri</i> | Violaceae | ✓ | ✓ |
| Forbs | Soreeb | <i>Sesbania Arabica</i> | Fabaceae or Leguminosae | | ✓ |
| Forbs | Lablab ahmar | <i>Digera muricate L.</i> | Amaranthaceae | ✓ | ✓ |
| Forbs | Tabar | <i>Ipomoea cordofana</i> | Convolvulaceae | ✓ | ✓ |
| Forbs | Sikiran | <i>Datura stramonium</i> | Solanaceae | ✓ | ✓ |
| Forbs | Tamalaika | <i>Acalypha indica L.</i> | Euphorbiaceae | | ✓ |
| Forbs | Rehan | <i>Ocimum basilicum</i> | Lamiaceae | | ✓ |
| Forbs | Fagus | <i>Cucumis melo</i> | Cucurbitaceae | | ✓ |
| Forbs | Senamaka | <i>Cassia senna L.</i> | Fabaceae or Leguminosae | ✓ | ✓ |
| Forbs | Hantot | <i>Ipomea sinensis</i> | Convolvulaceae | ✓ | ✓ |
| Forbs | Hanzal | <i>Colocynthis vulgaris</i> | Cucurbitaceae | | ✓ |
| Forbs | Alhirasha | <i>Alysicarpus monilifer</i> | Fabaceae or Leguminosae | | ✓ |
| Tree | Laout | <i>Acacia nubica</i> | Fabaceae or Leguminosae | ✓ | ✓ |
| Tree | Seyal | <i>Acacia tortilis</i> | Mimosaceae | ✓ | |
| Tree | Sonout | <i>Acacia nilotica</i> | Mimosaceae | | ✓ |
| Grass | Asslug | <i>Saponaria officinalis</i> | Caryophyllaceae | | ✓ |
| Grass | Abolisag | <i>Setaria verticillata</i> | Poaceae | | ✓ |
| Grass | Tuffa | <i>Urochloa trichopus</i> | Poaceae | | ✓ |
| Grass | Donbolab | <i>Schima ischaemoides</i> | Poaceae | | ✓ |
| Grass | Muhutriba | <i>Acalypha indica</i> | Poaceae | | ü |
| Shrub | Kitir | <i>Acacia mellifera L.</i> | Mimosaceae | ✓ | ✓ |
| Shrub | Ghabash | <i>Guiera senegalensis</i> | Combretaceae | | ✓ |
| Total | | | | 17 | 33 |

Table 2. Effects of month on rangeland plants inventory in northern and southern areas of Butana plain, Gadarif State, Sudan.

| Sites Plants | Month | | | | | |
|---------------------|--------|-------|-----------|-------|---------|-------|
| | August | | September | | October | |
| | North | South | North | South | North | South |
| Basal elkilab | | ✓ | | | | |
| Donbolab | | ✓ | | | | |
| Fagus | | | | ✓ | | ✓ |
| Dereisa | | | ✓ | ✓ | | |
| Gubbein | | | ✓ | ✓ | | |
| Hanzal | | | | ✓ | | |
| Sharaya | ✓ | | ✓ | ✓ | | |
| Tabar | | | ✓ | ✓ | | |
| Umglagila | | | ✓ | | | ✓ |
| Turba | | ✓ | ✓ | | | |
| Khudra | ✓ | | ✓ | ✓ | | |
| Sanamaka | ✓ | | ✓ | | ✓ | ✓ |
| Umlibaina | | | ✓ | ✓ | | |
| Sikiran | ✓ | | ✓ | ✓ | | ✓ |
| Rehan | | | | ✓ | | |
| Hantout | ✓ | ✓ | ✓ | ✓ | | |
| Laout | | | ✓ | ✓ | ✓ | ✓ |
| Kitir | ✓ | | ✓ | ✓ | ✓ | ✓ |
| Tamalaka | | | | ✓ | | |
| Eifain | | ✓ | | ✓ | ✓ | ✓ |
| Rabaa | | | ✓ | ✓ | ✓ | |
| Safari | | | | ✓ | | ✓ |
| Asslug | | ✓ | | | | |
| Seyal | ✓ | | ✓ | | ✓ | |
| Muhutriba | | | | ✓ | | |
| Sureeb | | | | ✓ | | |
| Lablab | | | ✓ | ✓ | | |
| Lablab ahamar | | | ✓ | ✓ | | |
| Sonout | | | | ✓ | | |
| Abolisag | | | | ✓ | | |
| Fakha | | | | ✓ | | |
| Ghabash | | | | ✓ | | |
| Tuffa | | | | ✓ | | ✓ |
| Alhirasha | | | | ✓ | | |
| Total | 7 | 6 | 17 | 27 | 6 | 9 |

to the northern one. Donbolab had the highest grass frequency distribution in the southern area. Five grasses were not found in the northern area (Donbolab, Aslag, Abolisag, Muhutriba and Tuffa). Plants mean frequency distribution varied among grasses. Mean grasses frequency distribution was significantly ($P>0.05$) very high in the southern area.

Table 5 shows effects of month on grasses frequency distribution in the northern and southern areas, Butana plain, Gadarif State.

Grasses frequency distribution varied highly among month in all sites and in the southern and northern areas of Butana plain. Grasses frequency distribution was highest for Donbolab in August

and least for Abolisag in September. The number of absent grasses was highest in October and least in September. Mean grasses frequency distribution varied among grasses and was highest for Donbolab and least for Abolisag. Grasses frequency distribution was highest in August and was highest for Donbolab and least for Asslug. It was highest in Muhtriba and least in Abolisag in September. Plants mean frequency distribution was highest for Donbolab and least for Abolisag in October.

Table 3. Effects of month and area on plants density (plant/m²) in northern and southern areas in the Butana plain, Gadarif State, Sudan.

| Month | Areas | | Month mean |
|-----------|---------------------------|---------------------------|---------------------------|
| | Northern | Southern | |
| August | 131.00±85.00 ^b | 160.25±56.12 ^c | 145.63±68.49 ^a |
| September | 66.25±63.39 ^b | 79.25±33.08 ^b | 72.75±47.32 ^b |
| October | 3.00±0.00 ^b | 8.75±6.65 ^a | 7.06±6.31 ^c |
| Area mean | 66.75±79.25 ^a | 82.75±73.14 ^a | 75.15±73.90 |

Means followed by similar letters were not significantly different ($P>0.05$) and by different letters were significantly different ($P<0.05$).

Table 4. Effects of areas on grasses frequency distribution in the northern and southern areas in Butana plain, Gadarif State, Sudan

| Plants | Areas | | Plants mean |
|-----------|----------|--------------------------|--------------------------|
| | Northern | Southern | |
| Muhtriba | | 31.55±23.89 | 31.55±23.89 |
| Donbolab | | 31.87±31.08 | 31.87±31.08 |
| Aslag | | 11.52±3.49 | 11.51±3.49 |
| Abolisag | | 2.86±0.00 | 2.86±0.00 |
| Tuffa | | 12.26±4.54 | 12.26±4.54 |
| Area mean | | 18.01±23.32 ^a | 18.01±23.32 ^a |

Means followed by similar letters were not significantly different ($p>0.05$) and by different letters were significantly different ($p<0.05$).

Table 5. Effects of month on grasses frequency distribution in Butana plain, Gadarif State, Sudan.

| Plants | Month | | | Plants mean |
|------------|--------------------------|-------------------------|-------------------------|-------------|
| | August | September | October | |
| Muhtriba | | 31.56±23.89 | | 31.56±23.89 |
| Donbolab | 31.87±31.08 | | | 31.87±31.08 |
| Asslug | 11.52±3.49 | | | 11.52±3.49 |
| Abolisag | | 2.86±0.00 | | 2.86±0.00 |
| Tuffa | | 9.54±13.40 ^b | 14.97±4.54 ^a | 12.26±4.54 |
| Month mean | 21.69±27.19 ^a | 14.65±20.33 | 14.97±3.56 | 18.01±23.32 |

Means followed by similar letters were not significantly different ($P>0.05$) and by different letters were significantly different ($P<0.05$).

Forbs

Table 6 shows effects of areas on forbs frequency distribution in the northern and southern areas in Butana plain, Gadarif State.

Forbs' frequency distribution varied highly among sites for most plants. It was higher in the northern area than in the southern one for Khudra, Turba, Hantoot and Sharaya. It was higher in the southern area for Eifain, Sikiran and Soraib. There were no significant differences ($P>0.05$) in forbs frequency distribution between the two areas. In the northern area it was highest for Turba and least for Soraib. In the southern area it was highest for Gubbein and least for Soraib. Soraib had the least frequency distribution in the two areas. Forbs mean frequency distribution varied highly among plants and was highest for Turba and least for Sanamaka. Mean forbs frequency distribution was higher in the northern area than in the southern one.

Table 6. Effects of areas on forbs frequency distribution in the northern and southern areas, Butana plain, Gadarif State, Sudan.

| Plants | Sites | | Plants mean |
|--------------|--------------------------|--------------------------|---------------------------|
| | Northern | Southern | |
| Khudra | 5.99±5.70 ^a | 2.91±3.62 ^a | 4.23±4.48 ^a |
| Turba | 80.89±16.18 ^a | 5.49±0.00 ^b | 70.12±32.10 ^c |
| Sharaya | 22.53±20.75 ^a | 6.37±3.50 ^b | 15.80±17.56 ^{ab} |
| Eifain | 33.33±0.00 ^a | 43.87±27.50 ^a | 42.55±25.73 ^{bc} |
| Gubbein | | 45.16±36.16 | 45.16±36.16 ^{bc} |
| Soraib | 2.44±0.00 ^a | 2.84±2.21 ^a | 2.71±36.16 ^a |
| Dereisa | | 18.12±8.79 | 18.12±8.79 ^{ab} |
| Um libaina | 5.50±6.02 ^a | | 5.50±6.02 ^a |
| Sanamaka | 2.48±0.00 | | 2.48±0.00 ^a |
| Hantout | 54.29±0.00 ^a | 5.90±1.86 ^b | 15.58±21.70 ^{ab} |
| Lablab ahmar | 2.86±0.00 | | 2.86±0.00 ^a |
| Sikiran | 34.29±0.00 ^a | 39.44±26.51 ^a | 38.80±24.61 |
| areas mean | 33.37±34.01 | 21.47±26.34 | 26.54±30.14 |

Means followed by similar letters were not significantly different ($P>0.05$) and by different letters were significantly different ($P<0.05$).

Table 7 shows that forbs frequency distribution varied highly among month in the northern and southern areas, but this effect was only significant ($P<0.05$) for Gubbein, Soraib and Sikiran. Forbs frequency distribution was highest in August for khudra, Turba, Sharaya, Soraib, Sikiran and Dereisa than in September and October. It was highest for Eifain in October than in August and September. In August it was highest for Turba and least for Soraib. In September it was highest for Turba and least for

Gubbein. In October it was highest for Gubbein and least for Sikiran. Forbs frequency distribution was highest for Turba in August and September. Gubbein had the highest frequency distribution in October and the least one in September. Plants mean frequency distribution was highest for Turba and least for Sanamaka.

Biomass

Table 8 shows effects of areas and month on rangeland plants biomass in the northern and southern areas, Butana plain, Gadarif State.

Mean fresh and DM biomasses varied among sites and areas and were higher in the northern area than in the southern one. However, this effect was only significant ($P < 0.05$) for fresh matter biomass. Mean fresh and DM biomasses varied with month in the two areas, but not significantly ($P > 0.05$). Fresh biomass was higher in the southern area in August and in the northern area in September. It was almost

similar in the two areas in October. Dry matter biomass was higher in the northern area in August and in the southern area in September and October. It was not significantly affected by month ($P > 0.05$).

Discussion

Rangeland plants inventory

High plants number and diversity indicated that the study area is a very good grazing area in Butana plain, Gadarif State. High rangeland plants diversity is very important indicating good ecosystems and improved plants palatability and nutritive value. It also has ecological and economic values (Oldeland *et al*, 2010). High plants diversity was also found in central Sudan (Braun *et al*, 1991). The high plants diversity was mainly due to good soil fertility and rainfall, especially in the southern area. The higher plants inventory in the southern area (33 plants) than the northern one (17 plants) was mainly due to relatively higher rainfall and lower grazing intensity

Table 7. Effects of month on forbs frequency distribution in Butana plain, Gadarif State, Sudan.

| Plants | Month | | | Plants mean |
|--------------|--------------------------|---------------------------|---------------------------|---------------------------|
| | August | September | OctobeOctober | |
| Khudra | 7.20±7.50 ^a | 3.04±3.15 ^a | | 4.23±4.48 ^a |
| Turba | 71.97±44.51 ^a | 67.65±10.14 ^a | | 70.12±32.10 ^c |
| Sharaya | 16.53±25.90 ^a | 15.28±10.84 ^a | | 15.80±17.56 ^{ab} |
| Eifain | 26.37±0.00 ^a | 35.17±15.95 ^a | 57.78±36.718 ^a | 42.55±25.73 ^{bc} |
| Gubbein | 12.09±0.00 ^b | 1.28±0.00 ^b | 70.80±10.91 ^a | 45.16±36.16 ^{bc} |
| Soraib | 4.40±0.00 ^a | 1.86±0.82 ^b | | 2.71±36.16 ^a |
| Dereisa | 25.34±0.00 ^a | 14.51±8.74 ^a | | 18.12±8.79 ^{ab} |
| Um libaina | | 5.50±6.02 | | 5.50±6.02 ^a |
| Sannammaka | | 2.48±0.00 | | 2.48±0.00 ^a |
| Hantoat | | 15.58±21.70 | | 15.58±21.70 ^{ab} |
| Lablab ahmar | | 2.86±0.00 | | 2.86±0.00 ^a |
| Sikiran | 54.39±24.03 ^a | 25.06±16.15 ^{ab} | 17.65±0.00 ^b | 38.80±24.61 |
| Month mean | 30.21±36.54 ^b | 18.00±21.72 ^b | 64.29±25.26 ^a | 25.68±30.14 |

Means followed by similar letters were not significantly different ($P > 0.05$) and by different letters were significantly different ($P < 0.05$).

Table 8. Effects of areas and month on rangeland plants fresh and DM biomass (tons/Fadden) in the northern and southern areas, Butana plain, Gadarif State, Sudan

| Sites/Month | Fresh | | | Dry matter | | |
|-------------|-------------------------|------------------------|-------------------------|------------------------|------------------------|------------------------|
| | Northern | Southern | Mean | Northern | Southern | Mean |
| August | 1.255±1.32 ^a | 0.313±.24 ^a | 0.784±1.02 ^a | 0.384±.43 ^a | 0.125±.09 ^a | 0.254±.32 ^a |
| September | 0.795±.37 ^a | 0.515±.16 ^a | 0.655±.31 ^a | 0.263±.12 ^a | 0.328±.23 ^a | 0.295±.17 ^a |
| October | 0.280±0.00 ^a | 0.285±.10 ^a | 0.284±.08 ^a | 0.210±00 ^a | 0.231±.03 ^a | 0.226±.02 ^a |
| Mean | 0.942±.91 ^a | 0.371±.19 ^b | 0.616±.66 | 0.310±.28 ^a | 0.228±.15 ^a | 0.263±.22 ^a |

Means followed by similar letters were not significantly different ($P > 0.05$) and by different letters were significantly different ($P < 0.05$).

in the southern area. Effects of rainfall (Yates *et al*, 2000, Mendez *et al*, 2011), soil (Elimam *et al*, 2025) and grazing intensity (Abdelsalam *et al*, 2017) on rangeland plants are well documented. Absence of *Seyal* in the southern area was mainly because trees were cut to allow cropping. Plants diversity in the study area was higher than in Abu Haraz area, Butana plain, Gezira State, Sudan (28 plants) (Elimam *et al*, 2013) and Elmanagel Plateau (EMP), Gezira State (Elimam *et al*, 2025). However, it was lower than in the Butana plain, Gezira State (35 plants) (Mohamed, 2013).

The variations in plants inventory among sites and areas in this study were also found in Butana plain, Gezira State, Sudan (Mohamed, 2013) and EMP (Elimam *et al*, 2025) and were attributed to soil types (Mohamed, 2013; Elimam *et al*, 2025) and rangeland management (Mohamed, 2013). Monthly variations in plants inventory in the two areas in this study were mainly due to variations in rainfall and grazing intensity. Similar results were reported by many authors (Mohamed, 2013; Elimam *et al*, 2025). The highest plants inventory in September was also found in the Butana plain, Gezira State and was mainly due to higher rainfall (Mohamed, 2013).

Rangeland plants types

The variations in rangeland plants types between the southern and northern areas and among month in this study were mainly attributed to variations in rainfall and grazing intensity. Grazing intensity was expected to be relatively lower in the southern area which is a main cropping area. Similar variations among areas in plants types were reported by many workers (Elsadig *et al*, 2008; Mohamed, 2013; Elimam *et al*, 2025). Forbs were the main plants in the two areas indicating higher plants nutritive value and improved palatability. However, it was reported that perennial and desired plants decreased in the Sudan due to rangeland deterioration (Yagoub, 1998). The least shrubs and trees were due to their absence in the southern area due to cutting for cropping. The number of plants types was higher in August and September than October (Elimam *et al*, 2025). But, they were lower in August and October than in Butana plain, Gezira State (Mohamed, 2013).

Rangeland plants families

The high number of plants families in the study area and in the southern area indicated high plants diversity which is highly desired. The higher numbers of plants families in the southern area were similar to that in Butana plain, Gezira State (Mohamed,

2013). The variations in the main families between the two areas (Poaceae in the southern area and Convolvulaceae in the northern area) reflected the variations in dominant plants between the two areas. Poaceae was also the main family in the Butana plain, Gezira State (Mohamed, 2013). Similar variations in numbers of plants families between areas were also found in Blue Nile State, Sudan (Abdelsalam *et al*, 2017). Plants family numbers in this study were higher than those in Butana plain, Gezira State (Mohamed, 2013). Forbs families also dominated in Butana plain, Gezira State. Plants family number was affected by month and areas as in Butana plain, Gezira State (Mohamed, 2013). The variations in plants family numbers among month were mainly due to variations in rainfall and grazing intensity.

Plants density

The high variations in plants density among month and areas in this study were mainly due to variations in rainfall and grazing intensity. The variations among areas in plant density were also found in the Blue Nile State, Sudan (Abdelsalam *et al*, 2017). Plant density also varied between plants and years (Mohamed, 2021). The higher plant density in the southern area than in the northern one was mainly associated with higher plant inventory in the former, and was also influenced by soil and rainfall. It was also affected by grazing intensity. The highest mean plants density in August and the least in October were associated with higher rainfall in August and higher grazing intensity in October. Plant density was very high than that in the Blue Nile State (Abdelsalam *et al*, 2017), indicating better rangeland in the Butana plain, Gadarif State.

Frequency distribution

Grasses

The high variations in grasses frequency distribution between the southern and northern areas could be mainly due to the variations in rainfall and grazing intensity. Similar results were found in the Butana plain, Gezira State and were attributed to variations in rainfall, soils and grazing intensity (Mohamed, 2013; Elimam *et al*, 2025). These variations were also found between open and protected rangelands (Elhag, 2011; Abdelsalam *et al*, 2017). The higher grasses frequency distribution in the southern area was also found in the Butana plain, Gezira State and it was associated with higher rainfall and plant inventory and density in this study. Donbolab highest frequency distribution among grasses in the southern

area was the contrary to that in the Butana plain, Gezira State, where it had the least value together with Tuffa (Mohamed, 2013).

The high monthly variations in the frequency distribution between the southern and northern areas were mainly due to variations in rainfall and grazing intensity. Similar results were found in EMP (Elimam *et al*, 2025). Donbolab highest frequency distribution among grasses in August was associated with peak rainfall. Abolisag least frequency distribution among grasses in September was due to high palatability. The highest number of grasses that disappeared in October was associated with least plants inventory in the southern area and was mainly due to higher grazing intensity. The variations among grasses in mean frequency distribution and the highest value for Donbolab and the least for Abolisag could be mainly due to variations in plants palatability.

The highest monthly grasses frequency distribution in August and the least in October was mainly due to high rainfall and biodiversity in August and lower rainfall and higher grazing intensity in October. The variations among grasses in frequency distribution in August and highest values for Donbolab and least for Asslug could be mainly due to variations in plants palatability. Similar results were reported in the Butana plain, Gezira State. Muhtriba highest frequency distribution and the least value for Abolisag in September could be mainly due to variations in plants palatability and grazing intensity. Tuffa was the only grass in October could be due to low palatability. Tuffa ranked second in frequency distribution among grasses in September in the Butana plain, Gezira State and was attributed to reduced palatability (Mohamed, 2013). The variations in plants mean frequency distribution where it was highest for Donbolab and least for Abolisag could be mainly associated with plants palatability.

Forbs

The high variations in forbs frequency distribution between the two areas for most plants were similar to those for grasses, and were mainly due to rainfall, grazing intensity and variations in plants inventory. It was also found in EMP (Elimam *et al*, 2025) and in the Butana plain,

Gezira State (Mohamed, 2013) and were attributed to variations in rainfall, soils and grazing intensity. The variations in frequency distribution and mean frequency distribution among forbs in the southern and northern areas were mainly associated with rainfall and grazing intensity. High variations

among forb in mean frequency distribution were also found by Elimam *et al* (2025) and Mohamed (2013). Sannammaka least mean frequency distribution was also found in September in the Butana plain, Gezira State and was mainly attributed to animal high preference (Mohamed, 2013).

Monthly variations in most forbs frequency distribution were mainly due to variations in rainfall and grazing intensity. Similar variations in and among sites were also found in EMP (Elimam *et al*, 2025) and Butana plain, Gezira State (Mohamed, 2013). Gubbein least frequency distribution in September and the highest one in October suggested that it was not highly preferred by animals in October. Gubbein least frequency distribution in September was also found in Butana plain, Gezira State and was attributed to limited distribution in one site (Mohamed, 2013). The higher frequency distribution in October could be mainly due to low plants preference. The variations in forbs mean frequency distribution was also found for grasses. Turba highest frequency distribution in August and September and absence in October could be due to intensive grazing in October. The variations in plants frequency distribution in August, September and October in this study and in Butana plain, Gezira State (Mohamed, 2013) were mainly due to soils and rainfall.

Biomass

Fresh biomass

The significantly higher mean biomass in the northern area than the southern one was mainly because the southern area was mainly cultivated. Areas also affected biomass in the Sudan (Elsadig *et al*, 2008; Abusuwar and Yahia, 2010; Abdelsalam *et al*, 2017, Elimam *et al*, 2025). Monthly variations in plants biomass in the two areas in this study were associated with variations in plants inventory and frequency distribution and were also affected by rainfall. It was reported that biomass was associated with rainfall (Abusuwar and Yahia, 2010) and was positively correlated with rainfall (Elsadig *et al*, 2008). It was also affected by seasons (Abusuwar and Yahia, 2010). The higher biomass in the northern area in August and September was mainly because the southern area was cultivated and the northern one is mainly a grazing site. The highest mean fresh biomass in August and least in October was associated with rainfall.

Rangeland plants biomass in Butana plain, Gadarif State was higher than that reported by many workers in the Sudan (Abusuwar and Yahia,

2010, Abdelsalam *et al*, 2017; Mohamed, 2021) and lower than in Baggara area in Kordofan and Darfur (Suleiman, 1985/87) and Elodaya protected belts (Elham, 1988). Rangeland biomass in the southern area was higher in August and September and lower in October than in Kadugli Locality, South Kordofan State, Sudan (Abdelsalam *et al*, 2016). However, in the southern area it was higher in September and lower in August and October than in Kadugli Locality.

Dry matter biomass

The variations among areas in DM biomass were also found for fresh biomass in this study and were reported by many workers (Elsadig *et al*, 2008; Abusuwar and Yahia, 2010; Abdelsalam *et al*, 2017, Elimam *et al*, 2025). The least DM biomass in October in the two areas was mainly due to lower rainfall and higher grazing intensity. It was found that grazing intensity had affected DM biomass (Abdelsalam *et al*, 2017). Dry matter biomass in this study was close to that in the protected area in the Blue Nile State, Sudan (Abdelsalam *et al*, 2017) and higher than that in the White Nile State, Sudan (Saleh *et al*, 2018). The higher mean DM biomass in the northern area was associated with higher fresh biomass. Mean biomass was highly positively correlated with rainfall (Elsadig *et al*, 2008) and negatively correlated with grazing intensity (Abdelsalam *et al*, 2017). Mean monthly variations in DM biomass in the two areas in this study were also found for fresh matter and were associated with variations in rainfall and grazing intensity. August higher DM biomass in the northern area was also found for fresh biomass. The higher DM biomass in the northern area and higher fresh biomass in the southern area in September were mainly due to high DM in some plants and may be associated with plants maturity.

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