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# Assessment of natural vegetation cover at the vicinity of Makkah city, Saudi Arabia

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***Abstract***. makkah - Saudi Arabia, is one of the most important cities, which faced a reduction in natural vegetative cover, due to the hot aridity, with a maximum temperature around 40-49°C, and scarcity of rainfall, the rate of rainfall is between 50-80 mm/year. A plant is supposed to be native if it has occurred naturally in a particular region, ecosystem, or habitat without human intervention. The aim of this study was to study the flora around Makkah city by choosing eight stands from different localities. The field work included relevé, the plots were about 10 × 10 meters in size. The study revealed that the eight stands were represented by 20 species belong to 8 families, Fabaceae and Apocynaceae were dominant by (34%), (25%) followed by Amaranthaceae (13%), Poaceae (12%) and Cucurbitaceae (5%); then (Apiaceae & Asteraceae) were represented by (4%), while Solanaceae was represented by only (3%) of the vegetation. Phanerophytes (40%) were the dominant while Hemicryptophytes (He) were the lowest value of life form (10%). The Floristic categories Saharo-Arabian (SA) and Sudano-Zambezian (AZ) were the dominant (38%), while Mediterranean (ME), Saharo-Sindian (SSI), Tropical (TR), Irano-Turanian (IT) were lowest value (6%). *Rhazya stric*ta has a high number of species that were observed in native plants in study area (17%), while *Cenchrus biflorus, Leptadenia pyrotechnica, Lycium shawii, Panicum turgidum, Senegalia asak*, Senna *italica*, *Stipellula capensis*, *Vachellia flava* and *Vachellia tortilis* were the lowest with 3% over the stands. Finally, the diversity in species deficiency in Makkah.
**Keywords**: Vegetation, Shannon, Simpson, indices, families, western region.

## INTRODUCTION:

Around 2,250,000 km$^2$, or nearly 80% of the total area of the Arabian Peninsula, is occupied by the Kingdom of Saudi Arabia. Which is located between 15.2° and 32.6° north and 34.1° and 55.5° east. A vast area of semi-arid, arid, and hyper-arid regions covers Saudi Arabia, and it is characterized by many ecosystems that differ in their plant diversity (Al-Yasi *et al*., 2019& Elaidarous, *et al*., 2022). According to Al-Sherif *et al*. (2013) and Al-Yasi (2015), there are several physiographical regions, such as mountains, Valleys (Wadis), sandy and rocky deserts, salt planes (Sabkhahs) and lava areas (Harrats), etc. The flora of Saudi Arabia is one of the most diverse in the Arabian Peninsula, with plentiful original resources for agriculture and medicinal plants (Rahman *et al*., 2004). The flora of Saudi Arabia is intricate, sharing similarities with the floras of North Africa, East Africa, the Mediterranean, and Irano-Turanian nations. About 137 families and 2284 species including naturalized and alien plants have been reported from various habitats of Saudi Arabia (Aljeddani *et al*., 2021). Although there are many wild plants in Saudi Arabia, there are fewer species per square kilometer than there are elsewhere, particularly in the Central, Eastern, and Northern regions; the regions along the northwestern and southwestern regions have dense vegetation and contain the highest number of species (Al-Eisawi, & Al-Ruzayza, 2015& Noor *et al*.,2022). Around 80% of Saudi Arabia's total flora is found in the south-western regions, which also have the largest number of species (Abbas *et al*., 2020). Desert vegetation is majority and distinctive type of natural plant life and covers large areas mostly with xerophytic sub-shrubs and shrubs

(Elaidarous, *et al*., 2022). However, xerophytic vegetation is a distinguished feature of the plant life in Saudi Arabia (Zahran, 1982).

Makkah situated in Wadis between the mountainous region of the west of Saudi Arabia with an arid system (Alshareef, 1984 & Khalik *et al*., 2013). In Makkah, there is a reduced in the natural vegetative cover due to the degradation, which shows in hot aridity, with a maximum temperature around 40-49°C, and scarcity of rainfall, the rate of rainfall between 50-80 mm/year, with most of the precipitation falling during the winter (Ashrae, 2005; Al-Eisawi & Al-Ruzayza, 2015; Abdelrahman *et al*., 2020). Climate change and human activity are both important causes in the spread of desertification and drought (Shalaby & Tateishi, 2007; Cetin *et al*., 2019).

Also, the natural vegetation and biodiversity are seriously threatened locally and globally by disturbances to it, such as total clearance, urban expansion, overgrazing, invasive species invasion, soil erosion and salinity, natural disasters, and poor management that result in differences in microclimate and vegetative cover (Tehrany, *et al*., 2017). Because of the importance of biodiversity and the intrinsic relationship between human activities and policies and the state of native vegetation, monitoring and assessment of changes in the condition of natural plants are high-priority tasks for governments (Raymond *et al*., 2011). Moreover, there are several structural, functional, and compositional traits found in natural vegetation. Natural plants are certain species that have a significant environmental tolerance that developed a distinct plant association with unique floristic and structural attributes to adapt to a certain environment.

Subsequently, there is a need to conserve the natural vegetation that can resist these conditions and provide a habitat for terrestrial-based species. The aim of this work is to assess the natural vegetation cover by using field surveys by dividing the area into eight stands (to cover all important sites in Makkah) and collecting the plants. Then, analyze the natural plant composition to assist in the afforestation project of the holy city by the plants originally growing in limitation of resources to reduce the efforts.

## 2. Materials and Methods

*Study area*

Eight different study stands were chosen around the city of Makkah to represent all the vegetation and ecological sites. Makkah is a city situated in the middle of the western part of the kingdom of Saudi Arabia within an area called the Arabian shield (longitude 39.826°E and latitude 21.43°N) in a fragile system in Wadis, in Saudi Arabia's western mountainous region, 80 km from Jeddah on the Red Sea coast (Al-Eisawi& Al-Ruzayza, 2015; Osman, 2012; Abdel Khalik *et al*., 2013). It is a portion of Al Hejaz Hill, which stretches parallel to the Red Sea from the Kingdom's borders to the Al-Sarwat Mountains in the south. It is surrounded by the regions of Al Medina in the north, Riyadh in the east, Abha in the south, and the Red Sea in the west as obviously in (Fig 1).

*Climate of the study area*

The climate in Makkah is tropical and arid. The monthly average of meteorological conditions showed that the monthly average ambient air temperatures ranged between 24.5°C and 36.7 °C during January and June, respectively from 2003 to 2019 according to the data of Meteorological Station at Makkah Al-Mukaramah (Presidency Meteorology and Environment) (Fig 2).

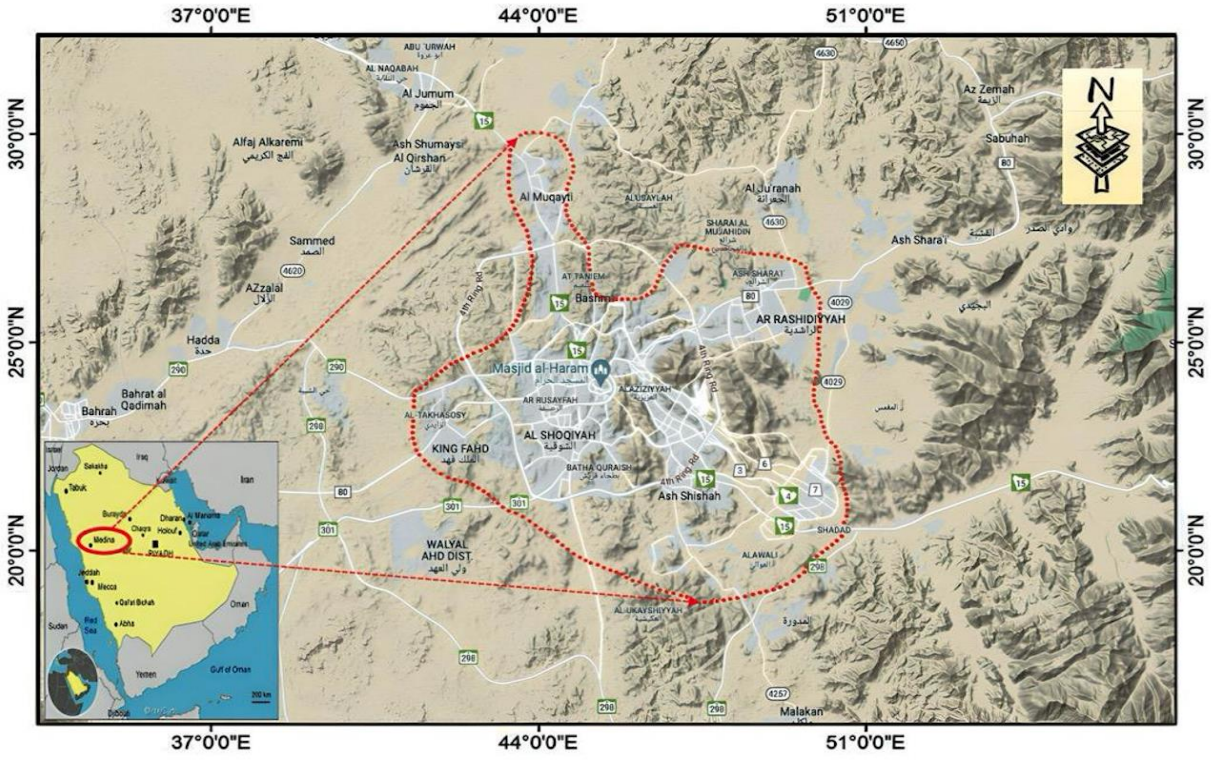



Figure 1. A map of Saudi Arabia (left bottom corner) inside the black box with a zoomed-in map showing The Makkah region.

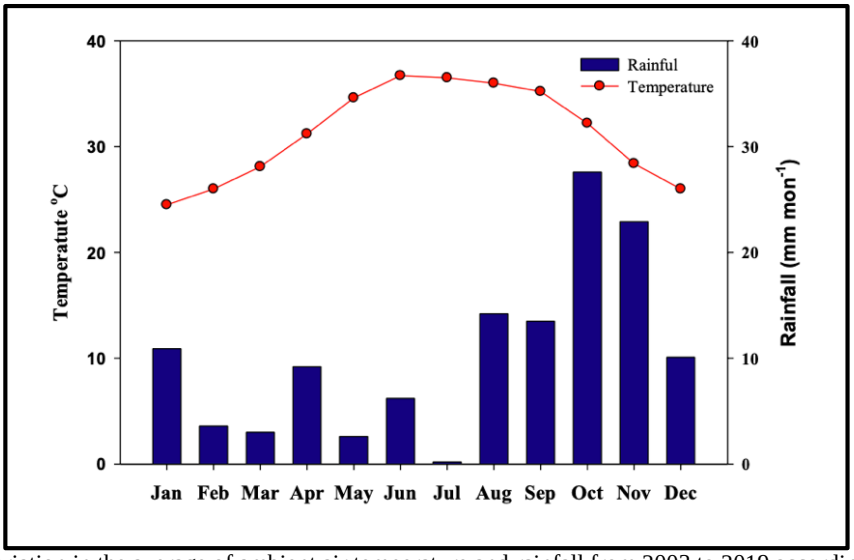



Figure 2. Monthly variation in the average of ambient air temperature and rainfall from 2003 to 2019 according to the data of Meteorological Station at Makkah Al-Mukaramah (Presidency Meteorol ogy and Environment)

*Vegetation sampling and Assessment*

Locations and samples were selected as an example of a large range of physiographic and environmental variability in every area. Eight stands were studied as showed in table1and (Figure 3). Sample plots in each stand were randomly selected using the relevé process in every site described by Mueller- Dombois and

| No. | Longitude | Latitude | Slope | The aspect |
|---|---|---|---|---|
| 1 | 39°59'27"E | 21°30'53"N | ˚3.4143996 | Northeast |
| 2 | 39°38'09"E | 21°31'52"N | ˚0.7359542 | Northwest |
| 3 | 39°39'55"E | 21°20'36"N | ˚3.4144068 | Southwest |
| 4 | 39°56'48"E | 21°20'40"N | ˚23.1043825 | Southeast |
| 5 | 39°48'55"E | 21°17'36"N | ˚22.5860828 | South |
| 6 | 39°59'52"E | 21°25'N | ˚3.4166964 | East |
| 7 | 39°39'41"E | 21°25'41"N | ˚3.4166964 | West |
| 8 | 39°48'02"E | 21°35'47"N | ˚3.4166465 | North |

Ehlenberg (Mueller-Dombois and Ellenberg, 1974). Using relevés for vegetation study involves two broad considerations. One is the method by which relevé plots are placed in the study area. The second is how the data on plant species cover are collected in the plot. Both considerations are influenced by the objectives and requirements of the study (Minnesota Department of Natural Resources, 2013).


Figure3. Locations of the study sites.

The study areas were visited from December to February 2021- 2022. According to relevé, the plots were about 10-meter × 10 meters in size (Figure 4) and samples were taken through the winter and spring seasons when taxa were expected to be growing and flowering.

Figure 4. According to relevé, the plots were about 10-meter × 10 meters in size.

The vegetation sampling includes collecting the plants, drying and recording all plants taxa in the plots. Then, the recorded species' identification and name were done in accordance with Migahid, 1978; Chaudhary, 1999; Collenette, 1999 and Boulos, 1999; 2000; 2002; 2005; 2009.

Table 1. The locations of each stand.

*Abundance*

The abundance of plant species was determined according to Braun- Blanquet cover abundance scale as follows:

| SCALE | COVER-ABUNDANCE |
|---|---|
| 5 | >75% |
| 4 | 50 - 75% |
| 3 | 25 - 50% |
| 2 | 5 - 25% |
| 1 | 1 - 5% |
| + | Few |
| R | Solitary |

*Life forms*

The life form analysis is supplying supplemental data that makes it easier to comprehend the intricate interactions of plant species with abiotic and biotic elements in the surrounding environment (Ayyad & El-Ghareeb, 1982). The distribution of life forms among plants growing in dry regions is influenced by landforms and topography (Galal *et al*. 2021).

Life forms of the species were identified following the Raunkiaer scheme as follows (Raunkiaer, 1937):

| CODE | LIFE FORM |
|---|---|
| PH | Phanerophytes |
| CH | Chamaephytes |
| HE | Hemicryptophytes |
| TH | Therophytes |

*Chorotype*

The global geographical distribution of the recorded species in the study area will be determined from Zohary 1973 and Boulos 2005. This will help in assessing the rarity forms of these species. The global distributions (i.e., floristic regions) are coded as follows:

| *Code* | *Floristic region* |
|---|---|
| ME | *Mediterranian* |
| SA | *Saharo-Arabian* |
| SSI | *Saharo-Sindian* |
| SZ | *Sudano-Zambezian* |
| TR | *Tropical* |

*Analysis of species richness and Density*

There are various indices for examining species richness in a region based on estimations of the relative abundance of the species derived from samples (Heip *et al*., 1998). Among these indices are the Shannon–Wiener information function (Lloyd *et al*., 1968), the Simpson's dominance index (Hunter and Gaston, 1988), the Margalef species richness index (Meurant, 2012), and the Pielou evenness index (Pielou, 1966). The first two were used in the current study due to the linkage between a common family of diversity indices and nonadditive statistical mechanics (Keylock, 2005).

*The Shannon index.*

The main principle of this index is that the diversity of a community is the amount of data in a code. It is calculated as follows.

$$H = -\sum_{i=1}^{S} (p_i \times \ln p_i) = -\sum_{i=1}^{S} \left(\frac{n_i}{N} \times \ln \frac{n_i}{N}\right)$$

In this formula, S is the total number of species.
P = is the proportion (n/N) of individuals of one particular species found (n) divided by the total number of individuals found (N)
ni = number of individuals of species "i"
p = is the proportion
pi = relative abundance of species "I"
N = total number of individuals of all species
$\frac{ni}{N}$ = equivalent to pi, the probability of N finding the i-th species.
H = Shannon Diversity Index

*Simpson index*

Simpson's approach for assessing species diversity evaluates the dominance of a species relative to the number of species in a sample or

$$D = [\Sigma n_i (n_i - 1)] / N (N - 1)]$$

population (Hunter and Gaston, 1988). It is calculated as follows.
D is the Simpson diversity index, ni is the number of individuals belonging to i species, and N is the total number of individuals.

- *Density analysis*

One of the often-employed techniques is predictive vegetation modeling. It is described as "predicting the distribution of vegetation across a landscape based on the relationship between the spatial distribution of vegetation and certain environmental variables" (Franklin, 1995 & Guisan and Zimmermann, 2000). Concepts of spatial variations are obtained according to the following equations.

$$\gamma(k) = \frac{1}{2n\,(k)} \cdot \sum_{i=1}^{2(k)} [z_{(x_i)} - z_{(x_i+k)}]^2,$$

where n(*k*) is the number of pairs of observation, and Z(*xi*) is the feature property measured in point *x* and in point *x* +*k*.

$$Z \cdot (x_0) = \sum_{i=1}^{n} \lambda_i \cdot z\,(x_i)\,, \qquad \sum_{i=1}^{n} \lambda_i = 1.$$

where $Z \cdot (x0)$ is the interpolated value of

variable $Z$ at location, $x0$, $Z(xi)$ represents the values measured at location $xi$ , and $\lambda i$ is the weighed coefficient calculated based on the semi variogram when

There for, it is possible to obtain non-biased interpolated values; that is, the expected value $E[Z \cdot (x0) - Z(x0)] = 0$ and the estimated variance $Var.[Z \cdot (x0) - Z(x0)]$= minimum (Elhag and Bahrawi, 2016).

**3.Result**

A total of 190 plant specimen in the 8 stands were represented by 20 species belonging to 8 families; (Abundance 1) The families Fabaceae and Apocynaceae were the dominance by (34%), (25%) respectively, followed by Amaranthaceae (13%), Poaceae (12%) and Cucurbitaceae (5%); then tow families Apiaceae & Asteraceae were represented by (4%), while Solanaceae was represented by only (3%) of the vegetation (Fig 5 & Table2).

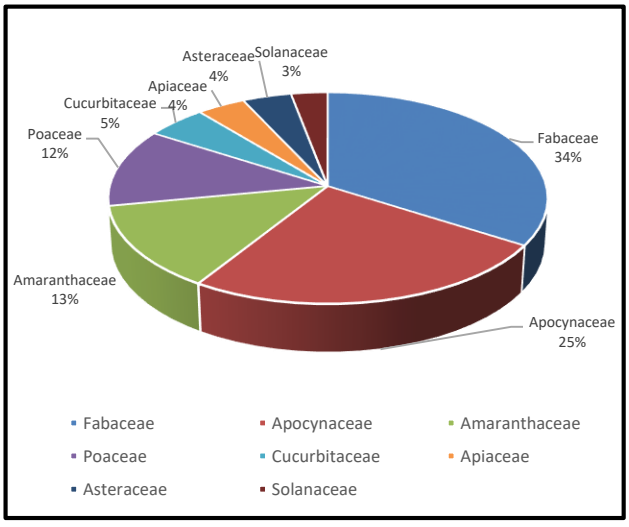



Figure 5. Families of the plant taxa in 8 represented stands around Makkah city.

Table 2. Plant Families among the study aera.

S

H

Shrubs dominated the vegetation growth of the study area by (54%), followed by trees, Grass, Herbs and small trees (17%, 13%, 8% and 8%, respectively) (Fig 6 & Table 3).

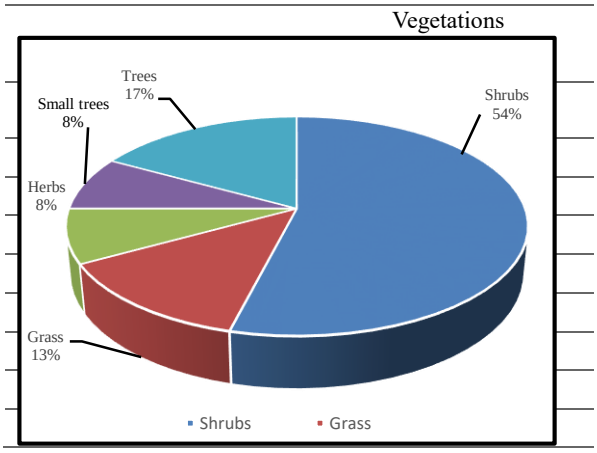



Figure 6. Plant growth form of plant taxa in 8 represented stands around Makkah city.

The life form of the recognized species follows Raunkiaer scale; Raunkiaerin's approach explains and helps in understanding the flora and structure of vegetation in relation to prevailing ecobiological conditions. As shown in (Fig 7 &Table 3), Phanerophytes (Ph) (8 species) by 40% is the dominance life form of the total species over the other life forms, followed by Therophytes (Th) and Chamaephytes (Ch) (5 species) (25%), while Hemicryptophytes (He) was the lowest value of life form (2 species) (10%).

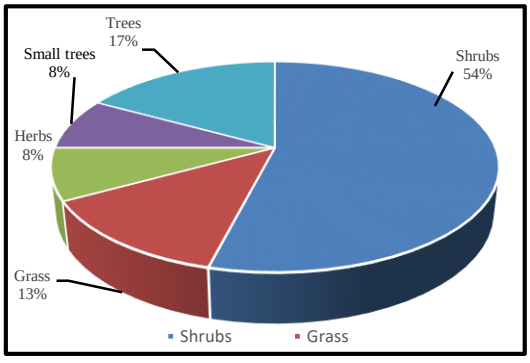
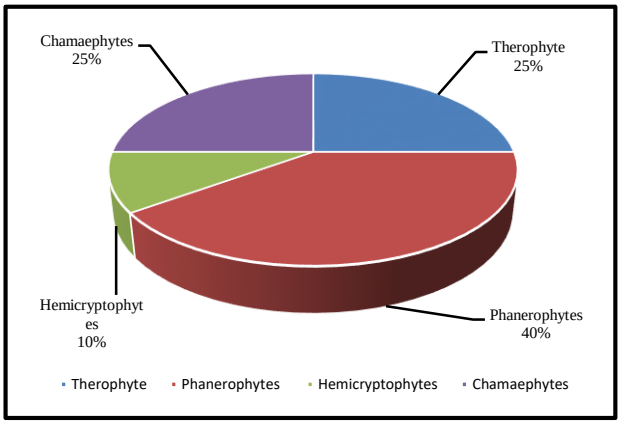



Figure 7. Plant growth form of plant taxa in 8 represented stands around Makkah city.

The Floristic categories Saharo-Arabian (SA) and Sudano-Zambezian (AZ) were the dominant by (38%), while Mediterranean (ME), Saharo-Sindian (SSI), Tropical (TR), Irano-Turanian (IT) were all represented by (6%) (Fig 8 & Table 3).

Figure 8. The life-form of plant taxa in 8 represented stands around Makkah city.

Figure (9) and Table (4) Showed that Rhazya stricta had the highest number of species in the




study area 33 species (17%), followed by Aerva javanica 25 species (13%) and Prosopis juliflora 18 species (9%), While Cenchrus biflorus, Leptadenia pyrotechnica, Lycium shawii, Panicum turgidum, Senegalia asak, Senna italica, Stipellula capensis, Vachellia flava and Vachellia tortilis were represented by only 3% over the stands.

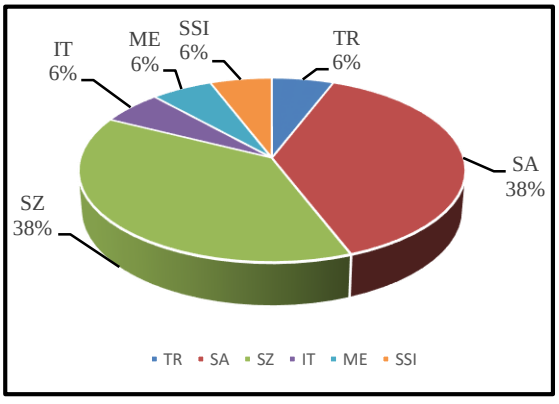



Figure 9. The Floristic categories of the plant taxa in 8 represented stands around Makkah city.

Categories: ME= Mediterranean, SA= Saharo-Arabian, SSi= Saharo-Sindian, TR= Tropical, SZ = Sudano-Zambezian, and IT = Irano-Turanian

Among all studied vegetations, The Shannon index was (2.036), while Simpson's index was (0.868). The values of Shannon index in the study area as follows: 1.2 (stand1), 1.7 (stand2), 0.6 (stand3), 1.2 (stand 4), 1.7 (stand 5), 1.8 (stand 6), 1.1 (stand 7) and 1.2 (stand 8). Which means that stand 6 was the highest in biodiversity while stand 3 was the lowest as shown in Figure 10 and Table 5.

Simpson's Results in the study area showed that the 0.250 (stand1), 0.071 (stand2), 0.333 (stand3), 0.372 (stand 4), 0.111 (stand 5), 0.083 (stand 6), 0 (stand 7) and 0.267 (stand 8). Which means that stands 4 is the highest in biodiversity while the lowest is stand 7 as shown in Figure 11 and Table 5.

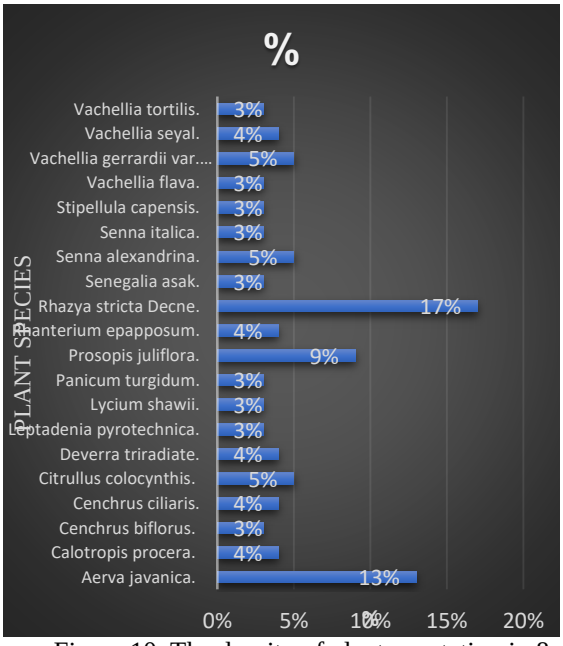



Figure 10. The density of plant vegetation in 8 represented stands around Makkah city.

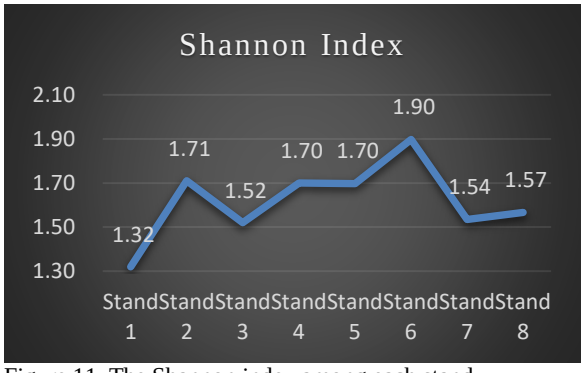



Figure 11. The Shannon index among each stand.

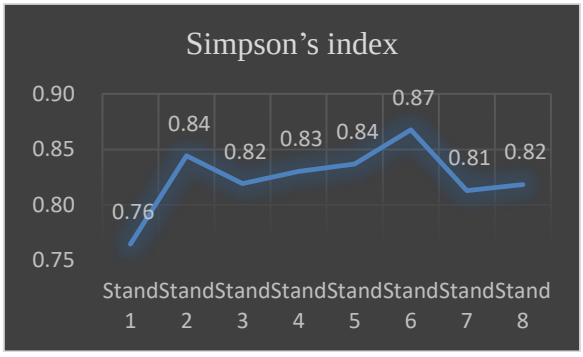



Figure 12. The Simpson's index among each stand.

Table 3. The list of plant species in 8 represented stands around Makkah city including life-form, growth and floristic categories.
Categories: ME= Mediterranean, SA= Saharo-Arabian, SSi= Saharo-Sindian, TR= Tropical, SZ = Sudano-Zambezian, and IT = Irano-Turanian

| | Plant species | Family | Life form | Growth | loristic categories |
|---|---|---|---|---|---|
| 1 | *Aerva javanica.* (Burm. fil.) Juss. | Aramanthaceae | Th | Herbs | TR |
| 2 | *Calotropis procera* (Aiton) W.T.Aiton | Apocynaceae | Ph | Shrubs | SA |
| 3 | *Cenchrus biflorus* Roxb. | Poaceae | Th | Grass | TR |
| 4 | *Cenchrus ciliaris* L. | Poaceae | He | Grass | SA+SZ |
| 5 | *Citrullus colocynthis* (L.) Schrader. | Cucurbitaceae | Th | Herbs | SZ+SA+IT+ME |
| 6 | *Deverra triradiata* Hochst. ex Boiss. | Apiaceae | Ch | Shrubs | SA |
| 7 | *Leptadenia pyrotechnica* (Forssk.) Decne. | Apocynaceae | Ph | Shrubs | SA+SZ |
| 8 | *Lycium shawii* Roem. & Schult. | Solanaceae | Ch | Shrubs | SA+SZ+IT |
| 9 | *Panicum turgidum* Forssk | Poaceae | He | Shrubs | SA+SZ |
| 10 | *Prosopis juliflora* (Sw.) DC. | Fabaceae | Ph | Shrubs or small trees | SA+ME+SZ |
| 11 | *Rhanterium epapposum* Oliv. | Asteraceae | Th | Shrubs | SA |
| 12 | *Rhazya stricta* Decne. | Apocynaceae | Ch | Shrubs or small trees | SA+SZ |
| 13 | *Senegalia asak* (Forssk.) Kyal. & Boatwr. | Fabaceae | Ph | Shrubs | SA+SZ |
| 14 | *Senna alexandrina* Mill. | Fabaceae | Ch | Shrubs | SSI+SZ |
| 15 | *Senna italica* Mill. | Fabaceae | Ch | Shrubs | SA+SZ |
| 16 | *Stipellula capensis* (Thunb.) Röser & Hamasha | Poaceae | Th | Geass | SA |

| | | | | | |
|---|---|---|---|---|---|
| 17 | *Vachellia flava (Forssk.) Kyal. & Boatwr.* | Fabaceae | Ph | Shrubs or trees | SZ |
| 18 | *Vachellia gerrardii* (Chaudhary) Ragup., Seigler, Ebinger & Maslin | Fabaceae | Ph | Shrubs or trees | SZ |
| 19 | *Vachellia seyal* (Delile) *P.J.H.Hurter* | Fabaceae | Ph | Trees | SA+SZ |
| 20 | *Vachellia tortilis* (Forssk.) Galasso & Banfi | Fabaceae | Ph | Trees | SSI+SZ |

Table 4. The density of plant taxa represented in 8 stands around Makkah city.

| Plant Species | Total N=190 | |
|---|---|---|
| | Density | % |
| *Aerva javanica* (Burm. fil.) Juss. | 25 | 13% |
| *Calotropis procera* (Aiton) W.T.Aiton | 8 | 4% |
| *Cenchrus biflorus* Roxb. | 5 | 3% |
| *Cenchrus ciliaris* L. | 7 | 4% |
| *Citrullus colocynthis* (L.) Schrader. | 10 | 5% |
| *Deverra triradiata* Hochst. ex Boiss. | 7 | 4% |
| *Leptadenia pyrotechnica* (Forssk.) Decne. | 6 | 3% |
| *Lycium shawii* Roem. & Schult. | 6 | 3% |
| *Panicum turgidum* Forssk | 5 | 3% |
| *Prosopis juliflora* (Sw.) DC. | 18 | 9% |
| *Rhanterium epapposum* Oliv. | 7 | 4% |
| *Rhazya stricta* Decne. | 33 | 17% |
| *Senegalia asak* (Forssk.) Kyal. & Boatwr. | 5 | 3% |
| *Senna alexandrina* Mill. | 10 | 5% |
| *Senna italica* Mill. | 5 | 3% |
| *Stipellula capensis* (Thunb.) Röser & Hamasha | 6 | 3% |
| *Vachellia flava* (Forssk.) Kyal. & Boatwr. | 5 | 3% |
| *Vachellia gerrardii* (Chaudhary) Ragup., Seigler, Ebinger & Maslin | 9 | 5% |
| *Vachellia seyal* (Delile) P.J.H.Hurter | 8 | 4% |
| *Vachellia tortilis* (Forssk.) Galasso & Banfi | 5 | 3% |

Table 5. Analysis of the plant taxa represented in each stand around Makkah city.

| Stand | Species | Density | % | Shannon | Shannon winner value | Simpson | Simpson value |
|---|---|---|---|---|---|---|---|
| 1 | *Rhazya stric*ta Decne. | 4 | 24% | -0.340451525 | 1.32 | 0.044117647 | 0.76 |
| | *Vachellia gerrardii*. | 2 | 12% | -0.25177249 | | 0.007352941 | |
| | *Senna alexandrina* Mill. | 6 | 35% | -0.367571956 | | 0.110294118 | |
| | *Senegalia asak* (Forssk.) Kyal. & Boatwr. | 5 | 29% | -0.35993395 | | 0.073529412 | |
| | Total | 17 | 100% | | | | |
| 2 | *Rhazya stricta* Decne. | 6 | 27% | -0.354349905 | 1.7 | 0.064935065 | 0.81 |
| | Vachellia seyal (Delile) P.J.H.Hurter | 2 | 9% | -0.217990479 | | 0.004329004 | |
| | Prosopis juliflora (Sw.) DC. | 4 | 18% | -0.309954199 | | 0.025974026 | |
| | *Vachellia tortilis* (Forssk.) Galasso& Banfi | 5 | 23% | -0.336728305 | | 0.043290043 | |

| Stand | Species | Density | % | Shannon | Shannon winner value | Simpson | Simpson value |
|---|---|---|---|---|---|---|---|
| | *Deverra triradiata* Hochst. ex Boiss. | 3 | 14% | -0.271695022 | | 0.012987013 | |
| | *Calotropis procera* (Aiton) W.T.Aiton | 2 | 9% | -0.217990479 | | 0.004329004 | |
| | Total | 22 | 100% | | | | |
| 3 | *Rhazya stricta*. Decne | 5 | 33% | -0.366204096 | 0.6 | 0.095238095 | 0.82 |
| | *Vachellia seyal* (Delile) P.J.H.Hurter | 4 | 27% | -0.352468224 | | 0.057142857 | |
| | *Prosopis juliflora* (Sw.) DC. | 2 | 13% | -0.268653736 | | 0.00952381 | |
| | *Stipellula capensis* (Thunb.) Röser & Hamasha | 2 | 13% | -0.268653736 | | 0.00952381 | |
| | *Panicum turgidum* Forssk | 2 | 13% | -0.268653736 | | 0.00952381 | |
| | Total | 15 | 100% | | | | |
| 4 | *Vachellia gerrardii* (Chaudhary) Ragup., Seigler, Ebinger & Maslin | 4 | 13% | -0.264218431 | 1.2 | 0.012903226 | 0.83 |
| | *Prosopis juliflora* (Sw.) DC. | 8 | 26% | -0.349560171 | | 0.060215054 | |
| | *Senna italica* Mill. | 5 | 16% | -0.294282144 | | 0.021505376 | |
| | *Aerva javanica* (Burm. fil.) Juss. | 8 | 26% | -0.349560171 | | 0.060215054 | |
| | *Citrullus colocynthis (L.) Schrader* | 2 | 6% | -0.176828389 | | 0.002150538 | |
| | *Stipellula capensis* (Thunb.) Röser & Hamasha | 4 | 13% | -0.264218431 | | 0.012903226 | |
| | Total | 31 | 100% | | | | |
| 5 | *Vachellia seyal* (Delile) P.J.H.Hurter | 2 | 8% | -0.202058292 | 1.7 | 0.003333333 | 0.84 |
| | *Prosopis juliflora* (Sw.) DC. | 2 | 8% | -0.202058292 | | 0.003333333 | |
| | *Deverra triradiata* Hochst. ex Boiss. | 4 | 16% | -0.293213034 | | 0.02 | |
| | *Rhazya stricta* Decne | 7 | 28% | -0.356430389 | | 0.07 | |
| | *Aerva javanica* (Burm. fil.) Juss. | 5 | 20% | -0.321887582 | | 0.03333333 | |
| | *Vachellia flava* (Forssk.) Kyal. & Boatwr. | 5 | 20% | -0.321887582 | | 0.03333333 | |
| | Total | 25 | 100% | | | | |
| 6 | *Rhazya stricta* Decne. | 7 | 18% | -0.311624528 | 1.8 | 0.029871977 | 0.087 |
| | *Vachellia gerrardii* (Chaudhary) Ragup., Seigler, Ebinger & Maslin | 3 | 8% | -0.200445306 | | 0.004267425 | |
| | *Prosopis juliflora* (Sw.) DC. | 6 | 16% | -0.29144632 | | 0.021337127 | |

| Stand | Species | Density | % | Shannon | Shannon winner value | Simpson | Simpson value |
|---|---|---|---|---|---|---|---|
| | *Aerva javanica* (Burm. fil.) Juss. | 6 | 16% | -0.29144632 | | 0.021337127 | |
| | *Citrullus colocynthis* (L.) Schrader | 3 | 8% | -0.200445306 | | 0.004267425 | |
| | *Lycium shawii* Roem. & Schult. | 6 | 16% | -0.29144632 | | 0.021337127 | |
| | *Cenchrus ciliaris* L. | 7 | 18% | -0.311624528 | | 0.029871977 | |
| | Total | 38 | 100% | | | | |
| 7 | *Aerva javanica* (Burm. fil.) Juss. | 2 | 11% | -0.236978084 | 1.1 | 0.005847953 | 0.81 |
| | *Leptadenia pyrotechnica* (Forssk.) Decne. | 6 | 32% | -0.364004056 | | 0.087719298 | |
| | *Cenchrus biflorus* Roxb. | 5 | 26% | -0.35131607 | | 0.058479532 | |
| | *Panicum turgidum* Forssk | 3 | 16% | -0.29144632 | | 0.01754386 | |
| | *Calotropis procera* (Aiton) W.T.Aiton | 3 | 16% | -0.29144632 | | 0.01754386 | |
| | Total | 19 | 100% | | | | |
| 8 | *Rhazya stricta* Decne. | 4 | 18% | -0.309954199 | 1.2 | 0.025974026 | 0.82 |
| | *Calotropis procera* (Aiton) W.T.Aiton | 3 | 14% | -0.271695022 | | 0.012987013 | |
| | *Senna alexandrina* Mill. | 4 | 18% | -0.309954199 | | 0.025974026 | |
| | Aerva javanica. (Burm. fil.) Juss. | 4 | 18% | -0.309954199 | | 0.025974026 | |
| | *Rhanterium epapposum* Oliv. | 7 | 32% | -0.364360279 | | 0.090909091 | |
| | Total | 22 | 100% | | | | |
| | Total number of all Species | | | 20 | | | |
| | Shannon index value | | | 2.035983198 | | | |
| | Simpson index value | | | 0.868175166 | | | |

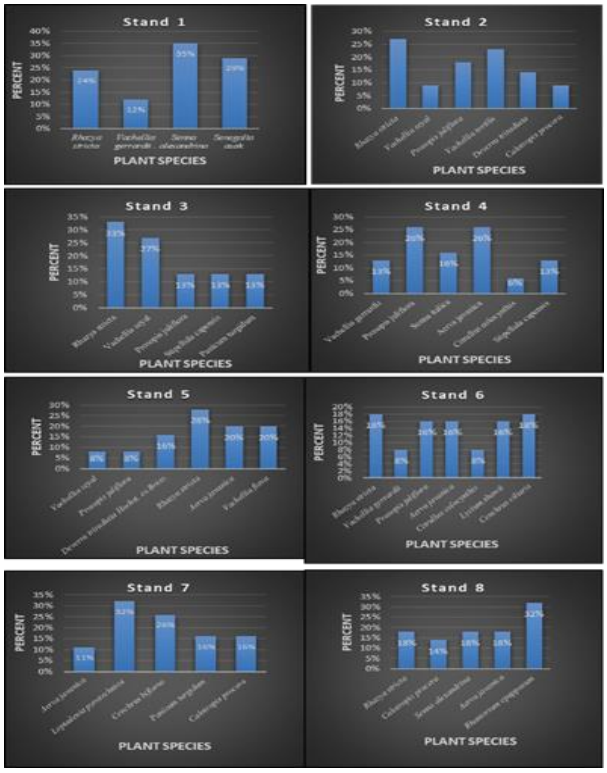



Figure 13. Proportions of plant species among each stand.

## 4. Discussion

The vegetation is the expression of the environment inside the specified locality within a specified period. It varies from year to year based on environmental conditions especially according to rainfall and temperature circumstances. During the study period in Makkah from December 2021 to February 2022, the precipitation was decreased according to National Center for Meteorology about (20.6 mm). Moreover, the characteristics of the vegetation cover of Makkah has low floristic diversity.

In terms of floristic and vegetation composition in the studied area, the families Fabaceae was represented by the highest number of species (34% which is agreed with Aati *et al*. (2019) who recorded the that Fabiaceae is the most dominating family in Saudi Arabia. Furthermore, this result coincides with Al-Eisawi & Al-Ruzayza (2015) who reported that the common families in the flora of Makkah in 2015 were Poaceae and Fabaceae by (16.94% and 13.11%, respetively); but in this study Fabeaceae was followed by Apocynaceae with 25% as the second dominant family instead of Poaceae as in Al-Eisawi and Al-Ruzazya result.

Moreover, it is well known that Fabaceae constitute the main bulk of plant species in Saudi Arabia as recorded and mentioned in many publications such as (Alfarhan *et al*., 1998; Collentte 1999; Mosallam, 2007; Al-Nafie, 2008 and El-Ghanim *et al*., 2010, Al-Namazi et al., 2022). Correspondingly, similar results were obtained in neighboring countries, such as Egypt (Abd EL-Ghani and Abd El-Khalik, 2006; Abd El-Ghani and El-Sawaf, 2004) and Jebel Marra of the Sudan (Wickens, 1976).

The dominance of Phanerophytes (Ph) life form by 40% was in dispute with the results of Al-Esawi and Al-Ruzazya (2015), this could be due to the changes of the ecological conditions through the years. The followed dominance life forms Therophytes (Th) and Chamaephytes (Ch) (5 species) (25%), are in accordance with Al-Esawin and Al-Ruzazya result. Moreover, it is also in accordance with Abdel Khlik *et al.* (2013).

The most prevalent chorotype was Saharo-Arbian like in most previous studies in Makkah region (Abduel-Khalik et al., 2013; Al-Esawi and Al-Ruzazya, 2015). While the Irano-Turanian was the second common in Al-Esawi and Al-Ruzazya, here it is the least frequent.

*Rhazya stricta* (Apocynaceae) was the richest species in the study area about 17%. *Rhazya stricta* is one of the most economically significant medicinal plants, found all over the Arabian Peninsula and dry South Asia, leaves are used in the traditional system of medicine to treat syphilis, chronic rheumatism, and body pain (Albeshri *et al*., 2021). *Calotropis procera* was the most dominant species in Makkah region in other studies (Abdel-Khalik et al., 2013). Even though, they are two different species but they belong to the same family Apocynaceae; this could explain why Apocynaceae is the second dominant family in this study.

## 5. Conclusions and Recommendation

Preservation of the native plant species conservation is important to maintain the

biodiversity-adapted area. Also, Native plants are the best adapted in the region because their characteristics such as less supplemental watering, aid in regulating precipitation runoff and preserve healthy soil because their deep root systems prevent the compaction of the soil. In Makkah, compared to previous studies the study showed there is a reduction in the number of species. This can be mainly due to the presence of various habitats each with features as regards the soil characteristics, rock type, water resources and grazing.

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# تقييم الغطاء النباتي الطبيعي في محيط مدينة مكة المكرمة، المملكة العربية السعودية

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*مستخلص*. مكة المكرمة – المملكة العربية السعودية، هي من أهم المدن التي واجهت انخفاضًا في الغطاء النباتي الطبيعي، بسبب مناخها الجفاف الحار، حيث تتراوح درجة الحرارة العظمى حوالي ٤٠–٤٩ درجة مئوية، وندرة هطول الأمطار، ويتراوح معدل هطول الأمطار بين ٥٠–٨٠ ملم/سنة. من المفترض أن يكون النبات طبيعيا من نباتات المنطقة، بمعنى أن ينمو النبات بشكل طبيعي في منطقة معينة أو نظام بيئي أو موطن معين دون تدخل بشري. الهدف من هذه الدراسة هو تقييم الحياة النباتية الطبيعية حول مدينة مكة المكرمة من خلال اختيار ثمانية مواقع من مناطق مختلفة. وكانت مساحة قطع الأرض حوالي ١٠ × ١٠ أمتار. وكشفت الدراسة أن المواقع الثمانية تمثلت بـ ٢٠ نوعا تنتمي إلى ٨ عائلات، هي الفصيلة البقولية Fabacese والفصيلة الدفلية Apocynaceae بنسبة (٣٤٪)، (٢٥٪) تليها الفصيلة القطيفية Amaranthaceae (١٣٪)،الفصيلة النجيلية Poaceae (١٢٪) ، فصيلة القرعيات Cucurbitaceae (٥٪). ثم تمثلت (الفصيلة الخيمية Apiaceae و الفصيلة النجمية Asteraceae) بنسبة (٤٪)، بينما تمثل الفصيلة الباذنجانية Solanaceae (٣٪) فقط من الغطاء النباتي. أما أشكال الحياة في النباتات المحلية فكانت النباتات البذرية (٤٠٪) هي السائدة بينما كانت النباتات النصف مستترة (He) هي الأقل قيمة في أشكال الحياة (١٠٪). واظهرت الدراسة أن الفئات الزهرية هي الصحراوية العربية (SA) والسودانية الزامبيزية (AZ) هي المهيمنة حيث تمثل (٣٨٪)، في حين كانت فئات البحر الأبيض المتوسط(ME) ، والصحراوية السندية(SSI) ، والاستوائية(TR) ، والإيرانية الطورانية (IT) هي الأقل قيمة وتمثل تقريباً (٦٪).

بالنسبة لأنواع النباتات فلقد ظهر أن نبات *Rhazya stricta* هو الأكثر عددا من الأنواع التي لوحظت في النباتات المحلية في منطقة الدراسة ويمثل (١٧٪)، في حين تم العثور على *Cenchrus biflorus* و *Leptadenia pyrotechnica* و*Lycium shawii* و*Panicum turgidum* و*Senegalia asak* و*Senna italica* و*Stipellula capensis* و*Vachellia frav* و*Vachellia tortilis*. الأدنى بنسبة (٣٪) في جميع المواقع. وأخيراً، فإن هناك نقص في أنواع النباتات في منطقة مكة.