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Survey and Identification of Toxic Plants in the Region of Osfan, Kingdom of Saudi Arabia

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Authors' contributions

This work was carried out in collaboration among all authors. Authors HMA and EAA designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors NA and MSA managed the analyses of the study. Authors MT and TME managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

Wild plants have many benefits for humans, animals, birds, and most of the creatures on earth. Because all organisms live in one environment, insects attack plants from time to time and the plant defends itself by mechanical or chemical methods by forming chemicals that kill insects or reduce insect attacks on them. Thus, these plants become toxic to insects and may be toxic to animals and humans as well. Hence, we find among wild plants a number of them that are toxic to animals and humans. Knowledge of these plants is extremely important, especially for those who graze camels and sheep in order to escape from their danger. What's more, it is very important for a person to

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recognize it and get away from her. In addition, naturally many of these poisonous plants are used in the manufacture of medicines for a large number of diseases and epidemics. The current study aims to identify poisonous plants in the Osfan region to educate people about their danger and to highlight them for use in the pharmaceutical industry. Thirty-four poisonous plants were registered in the area and toxic chemicals were observed in them, as well as their toxicity, location, and apparent description. In addition, by that, it will be the first step towards building a database for poisonous plants in the region.

Keywords: Calotropis; flora; medical; poisonous.

1. INTRODUCTION

Plants are primary producers; hence, they are consider the main food source for a broad amplitude of heterotrophic organisms. From the plants' point of view, they demand an efficient technique to evade the herbivory and to guard themselves versus pests like mollusks, nematodes, vertebrates and arthropods [1]. In that significant stretch, plants advanced a broad range of morphological, anatomical and chemical safeguard systems that can significantly reduce damage caused by attackers [2]. Plant defense techniques can be classified in two main groups, induced and constitutive [3]. Constitutive defenses are always present, independent on the absence or presence of an attack [4]. Many physical protections are constitutive as well as toxic compounds that are synthesized and stored in special plant tissues. In contrast, induced protections are stimulated only when needful, i.e., upon attack by an herbivore. Most all induced reactions belong to chemical-based protections. In this context, the plant has to realize the presence of the invader quickly and efficiently to induce signaling cascades to finally induce downstream responses.

The Kingdom of Saudi Arabia has vast areas and many wild plants with more than 2,300 plant species. These wild plants are characterized by high economic importance, some of which are benefited from the medical point of view and animal feed or coal production. Many previous floristic studies were done in different regions of the Kingdom of Saudi Arabia in general, such as Alsherif et al. [5] in Khulais, Mosallam [6] in Taif, Hosni and Hegazi [7] in the Asir Mountains, Al-Turki and Al-Olayan in Hail region [8] and Alatar et al. [9] in Al-Jufair Wadi. However, there are many poisonous plants, whether to human or animal, growing naturally amid the Saudi flora and many people do not know their danger. However, there are few previous studies on poisonous plants [10,11]. Despite this, plants in Osfan region is being used by locals for firewood, building material, medicine, food for humans or feed for domesticated animals.

It is notable that plants differ in toxicity by degree and many previous studies classified toxic plants as minimally toxic, moderately or extremely. However, it is not easy to classify plants according to their toxicity because this differ with the victim age in addition to many factors that affect levels of toxic principles in plants like plant growth stage, environment, and health condition of a person and the quantity of toxic part ate [12]. Abundant plants have medical uses but if it is used in an erroneous way with large quantities will have a toxic effect. Due to the vast use of plants by locals, it is imperative that knowledge about their toxicity be known and disseminated to lessen incidence of accidental poisoning. The value of the study is to educate people about their danger and to highlight them for use in the pharmaceutical industry. In addition, this will be a first step towards building a database for poisonous plants in the region upon which future research can be build.

2. MATERIALS AND METHODS

2.1 Study Area

The study region is located in piece of Hijaz district. 21°55' N 39°21' E. Soils texture ranges between coarse sandy to silty clay and the pH ranges between 7.8 to 8.1, while soil salinity ranges from 0.2 to 7.6 mM/cm [5]. The area has an arid climate, characterized by warm temperature in the winter (from December to February) and high in summer (from June to August). The annual average rainfall is 35.1 mm. The rainfall apart from its scantiness, is irregular and variable, it ranges between 0 to 90 mm. The sun-rays as in major parts of Saudi Arabia are intense and rarely diffused by clouds [13]. Extensive regular trips to the study are for toxic plant survey was done through the period February 2020.

2.2 Plant Collection and Identification

However, it was not possible to survey quantitatively the whole study area; even then, every effort was made to comprise the all representative, physiographic and topographic condition in the study area. Toxic plants were determined and collected according to previous studies [5,14]. Toxic plants were determined from previous publications about the Flora of the studied region and searching for its toxicity in literature, some of which were confirmed by the local population. Collected toxic plant specimens were collected in flowering and fruiting stage as possible (in the period from February to April). According Alsherif publications [5,14].

The collected plants were identified with the help of different Floras [15], Collenette, [16,17] Miller & Cope [18], Boulos [19] and Migahid, [20]. The voucher specimens were deposited in the Department of Biology, Faculty of Sciences and Arts/ University of Jeddah. No voucher specimens numbers were taken due to the discontinuation of the work due to the Corona Virus pandemic. The abundance of the plant was determined based on its presence in the studied areas, Very rare (less than 2%), rare (3-5%), modetrately common (6-30%), common (31-60), very common (more than 60%).

3. RESULTS AND DISCUSSION

3.1 Diversity

Thirty-four toxic plants species were recorded in this study, belonging to 16 families. One species belonging to Monocotyledons plants (*Aristida plumose* L.) and the residual recorded species are belonging to different Dicotyledons families. Information regarding their scientific name, family name, vernacular name, poisonous parts and their symptoms are indicated in the checklist (Table 1). Zygophyllaceae exhibited the greatest number of species (n=4), followed by Solanaceae (n=3) and Asclepediaceae (n=3). The Cucurbitaceae, Asteraceae and Boraginaceae were represented by two species each. Seven families had only one species each, while seven families were presented by only one species.

Habitats with sandy soil recorded tha maximum numbers of toxic plants (44%) followed by cultivated land (11%). The majority of plants registered have toxicity in all parts (53%), while 17% of plants registered have toxicity in latex and 11% have toxicity in their seeds and fruits.

The toxic constituents of the recorded species and their major symptoms were taken from previous literatures such as El-Kahtany and El-Masry [21], Kingsbury [22], Hardin and Arena [23], Hilal and Youngken, [24], Westbrooks and Preacher [25] and Westerfield and Wade [12]. The recorded toxic species represent about 14% of the total flora of for a region, Khulais, adjacent to the current study area [5].

3.2 Abundance and Habitat

Table 2 showed that two species are very common, *Calotropis procera* and *Tribulus longipetalus*, in the studied area, five are common, ten are moderately common, 4 species are rare and the majority are moderately rare. Only one species, *Calotropis procera*, was recorded in all habitats in the studied area. The majority of toxic plants recorded in the studied area prefer sandy soil (sand with medium size). Based on visual observations in the field, seven species were recorded in habitat with coarse sandy soil. Three species grow in rock crevices in mountains with different elevations. Previous study docoumented that *Calotropis procera* is adapt different environmental conditions [26,27]. It was stated that *Tribulus longipetalus* is widespread throughout the world from latitudes 35°S to 47°N [28].

3.3 Toxicity Categories

The toxic plants recorded in the current study contain most of the toxic substances that Douglas [29] has grouped into categories as follow; (1) Glycosides: chemical compounds produce single or more sugar (glycones) and single or more toxic glycones; they are generally crystalline solids, colorless and bitter. These substances were documented in *Calotropis procera, Citrullus colocynthis, Cucumis prophetarum* and *Pergularia tomentosa* (2) Alkaloids: Complex nitrogenous compounds, typically taste bitter, physiologically active and are normally insoluble in water. Found in *Andrachne aspera*, Solanum incanum and *Trichodesma africanum* and *Convolvulus arvensis* (3) Minerals: is associated with high levels of particular minerals in the soil or atmosphere and subsequently uptake by plants; levels of these minerals are cumulative in the plants such that they become poisonous; among the minerals often correlated with toxicity are copper, lead, and arsenic. The represented species of this group is *Chenopodium murale* (4) Photosensitizing compounds: are psoralens,

Table 1. List of the recorded toxic plants, their families, vernicular names, toxic part and their most toxic substances

Family name	Scientific Name	Vernacular name	Toxic plant parts	Toxicity	References
Aizoaceae	*Aizoon canariense* L.	Hadaq,	Fruits and flowers	Contains poisonous alkaloids. Relying on amount used, mucous membranes irritations, paralysis and cramps, inclusive respiratory paralysis may follow.	Kingsbury [22]
Acanthaceae	*Aerva javonica* (Burn.) Spreng.	Toorf	All plant	Contains cardiac glyciaides. If eaten pecially fruits cause irritation and stomach pain resulting in nausea vomiting and muscular weakness. Difficult intoxication results in quick irregular pulse, spasm and death because of heart failure.	Westbrooks and Preacher [25]
Asclepiadaceae	*Rhazya stricta* Decne	Harmal	All plant	Contains poisonous alkaloids (Quebrachamine, Rhazine, Rhazidine, Eburnaminie and flavonoids). Depending on amount used muscular cramps, abdominal pains and hard breathing may ensue.	El-Kahtany and El-Masry [21] Ali et al [31]
	Calotropis procera Ait	Ushar,	All plant especially the latex	Basic constituents are 4 glycosides, calotoxin, calotropin, usharidin and usharin. Its latex cause skin irritation, particularly eyes, causing inflammation and redness. The milky latex cause camels abortion which feed on its leaves and stems.	Hilal and Youngken [24], El-Kahtany and El-Masry, [21], Morsy et al. [32]
	Pergularia tomentosa L.	Omm el-laban	All plant especially the latex	Poisonous principles glycosides, vincetoxin and asclepin. The latex causes muscular weakness and stomach pain and severe toxicity results in rapid irregular pulse, convulsions and death according heart failure.	Hilal and Youngken, [24], El-Kahtany and El-Masry [21], Al Said et al [33]
	Solenostemma argel (Del.) Hayne.	Hargel,	All plant especially the latex	Its latex cause skin irritation, particular to eyes, causing inflammation and redness.	Hilal and Youngken [24]
Boraginaceae	Heliotropium ramosissimum (Lehm.) DC.	Ramram,	All plant	pyrrolizidine alkaloid is the main poisonous constitute. Causing digestive upset and liver damage.	Hilal and Youngken [24]
	Trichodesma africanum (L.) R.Br.	Himhim,	All plant	Its saponins and toxic alkaloids cause failure to liver of animals, in addition cause difficult breathing, muscular spasm, and partial muscular degeneration.	Hilal and Youngken [24]

Table (1): continued

Family name	Scientific name	Vernacular name	Toxic plant parts	Toxicity	References
Chenopodiaceae	*Chenopodium murale*	Fiss el-kelaab	All plant	Large amounts can cause interference with calcium metabolism in the body and may phototoxicity	Hilal and Youngken [24]
Cleomaceae	*Cleome amblyocarpa* Barr. et. Murb	Khunnayza,	All plant especially seeds	Causes rapid pulse, fever, dilation of pupils, hot and dry flushed skin, dry mouth, headache, difficulty of swallowing, hallucinations, burning of the throat, and convulsions.	Hilal and Youngken [24], Westerfield and Wade [12], El-Kahtany and El-Masry [21].
Compositae	*Conyza bonariensis* (L.) Cronquist	Qaysum,	All plant	If eaten in large amounts lead to low blood pressure, high temperature, nausea and dryness of the mouth.	Kingsbury [22]
Convolvulaceae	*Gymnarrhena micrantha* Desf.	Kaff Al-kalb	All plant	If large doses are ingested cause death for grazing animals through respiratory failure.	Kahtany and El-Masry [21].
	Convolvulus arvensis L.	Olleiq,	All plant	It contains resins alkaloids and coumarins. All plant parts cause abdominal pain and severe purgation.	Hilal and Youngken [24], Todd et al. [34], Rotini et al. [35]
Cucurbitaceae	*Citrullus colocynthis* (L.) Schard.	Hadaj, Hanzal	All plant, especially fruits	Main toxic substances are resins, as well as glycosides. The plant causes water stool and severe abdominal pains.	Hardin and Arena [23] Hilal and Youngken [24] Westerfield and Wade [12], El-Kahtany and El-Masry [21].
	Cucumis prophetarum L.	Hanadlaan	All plant, especially fruits	Main toxic substances are resins, as well as glycosides. The plant causes water stool and severe abdominal pains.	Hardin and Arena.[23], Hilal and Youngken [24], Westerfield and Wade [12], El-Kahtany and El-Masry [21].
Euphorbiaceae	*Euphorbia granulate* Forssk.	Abolabin,	All plant especially milky juice	Main toxic substances include glycosides, terpenes, triterpenoids and phenolics present in the latex. All parts of this plant or the latex exuded from it can cause an irritation or inflammation when contact with skin. If eaten by animals, the plant may cause severe purgation and vomiting.	Hilal and Youngken [24], Westerfield and Wade [21], El-Kahtany and El-Masry [21]

Table (1): continued

Family name	Scientific name	Vernacular name	Toxic plant parts	Toxicity	References
Euphorbiaceae	*Euphorbia peplus* L.	Shagaret-el-hanash,	All plant especially milky juice	Main toxic substances include glycosides, terpenes, triterpenoids and phenolics present in the latex. All parts of this plant or the latex exuded from it can cause an irritation or inflammation when contact with skin. If eaten by animals, the plant may cause severe purgation and vomiting.	Hilal and Youngken [24], Westerfield and Wade [12] El-Kahtany and El-Masry [12]
	Euphorbia retusa Forssk.	Nomaniya,	All plant especially milky juice	Main toxic substances include glycosides, terpenes, triterpenoids and phenolics present in the latex. All parts of this plant or the latex exuded from it can cause an irritation or inflammation when contact with skin. If eaten by animals, the plant may cause severe purgation and vomiting.	Hilal and Youngken [24], Westerfield and Wade [12], El-Kahtany and El-Masry [21],, Haba et al. [36]
	Chrozophora tinctoria (L.) A. Juss. ex. Spreng.	Qoddah,	Hairs and milky juice	Cause burning in thirst, throat, coughing and finally stomach pain, vomiting and nausea. May also cause an irritation or inflammation when contact with skin.	Hilal and Youngken [24]
	Andrachne aspera Spreng.	Iobein	All plant	Toxic principles are scyanogenic glycoside and alkaloids. If eaten in large amounts are cause vomiting and diarrhea.	El-Kahtany and El-Masry [21]
Gramineae	*Aristida plumose* L.	Sabat,	All plant	The plant causes headache, dizziness, difficult breathing, vomiting, cardiac arrhythmia, coma and convulsions.	El-Kahtany and El-Masry [21]
Leguminosa	*Senna italica* Mill	Ishriq,	All plant especially seeds and fruits	Cause remorse, diarrhea and dark brown urine. The plant juice produces animal's abortion.	Westerfield and Wade [12]
	Crotalaria senegalense (Pers.) DC.	--	All plant	Include pyrrolizidine alkaloid producing sheep toxicity.	Lee [37]
Rutaceae	*Haplophyllum tuberculatum* Forssk.) A. Juss.	Zifrah,	All plant	The plant produces camel's abortion.	Sheriha et al. [38]
Solanaceae	*Datura innoxia Mill*	Semm El-Faar	All plant especially seeds and fruits	Main toxic substances are hyoscyamine and traces of hyoscine and atropine. Symptoms include nausea, headache, extreme thirst, vertigo and death.	Hilal and Youngken [24], El-Kahtany and El-Masry [21]

Table (1): continued

Family name	Scientific name	Vernacular name	Toxic plant parts	Toxicity	References
Solanaceae	*Solanum nigrum* L.	Shajarat Al-balbul	All plant especially seeds and fruits	Irritation of the mouth and gastrointestinal lesions characterize the poisoned animal.	Hilal and Youngken [24]
	Withania somnifera (L.) Dun.	Sim elhalal	The fruit	It can cause dilatation for the pupils, rapid heartbeat, elevated temperature and dry flushed skin.	Hilal and Youngken [24], El-Kahtany and El-Masry [21], Abraham et al. [39]
	Solanum incanum L.		Unripe fruits	The fruits are used as an ingredient of fish poisons and arrow poisons contain quantities of spirosolane alkaloids. Cause also coughing and bloat and sheep.	Thaiyah et al. [40].
	Frosskalea tenacissima L.	Losseiq,	All plant	Its Stining hairs cause several rashes and skin irritation with itching sensation.	Hilal and Youngken [24], El-Kahtany and El-Masry [21].
Urticaceae	*Fagonia cretica* L.	Aqool	All plant	It contains poisonous saponins, alkaloids and triterpenoids. All parts of the plant are toxic causing vomiting due to irritant principles. The plant causes animals abortion.	Hilal and Youngken [24]
Zygophyllaceae	*Fagonia indica* Burm.	Hulaywah	All plant	It contains toxic saponins, alkaloids, and triterpenoids. All parts of the plant are poisonous causing nausea and vomiting owing to irritant substances; sometimes necrosis results.	Hilal and Youngken [24]
	Tribulus longipetalus Viv.	Katob	All plant	It contains alkaloid extraction norharmane and beta-carboline indoleamines harmane. Both compounds affect the central nervous system and cause limb paresis.	Kingsbury [22]
	Tribulus terrestris L.	Katob	All plant	It contains alkaloid extraction norharmane and beta-carboline indoleamines harmane. Both compounds affect the central nervous system and cause limb paresis.	Kingsbury [22], Aslani et al. [41], Bourke et al. [42]
	Zygophyllum coccineum L.	Tarteer	All plant	The basic constituents are saponins, zygophyllin bitter principle, harman and harmine alkaloids. Causing vomiting, nausea, later cardiac inhibition and depression. Lowering in blood pressure followed by coma and death.	Hilal and Youngken [24]

Table 2. Habitats and abundance of the recorded toxic plant species in Osfan region

	Plant species	Habitats	Abundance
1	*Aizoon canariense* L.	Slightly compact sandy soil	Moderately common
2	*Aerva javonica* (Burn.) Spreng.	Wadi bed	Moderately common
3	*Rhazya stricta* Decne	Sandy soil	Moderately rare
4	*Calotropis procera* Ait	Everywhere except rocky soil	Very common
5	*Pergularia tomentosa* L.	Soil with small gravels	Moderately rare
6	*Solenostemma argel* (Del.) Hayne.	Soil with small gravels	Moderately rare
7	Heliotropium ramosissimum (Lehm.) DC.	Soil with fine sandy particles	Moderately rare
8	*Trichodesma africanum* (L.) R.Br.	Mountains cracks	Moderately rare
9	*Chenopodium murale*	Cultivated lands	Moderately common
10	*Cleome amblyocarpa* Barr. et. Murb	Sandy soil	Moderately rare
11	*Conyza bonariensis* (L.) Cronquist	Sandy soil with abundant water	Moderately common
12	*Gymnarrhena micrantha* Desf.	Sandy soil	Rare
13	*Convolvulus arvensis* L.	Cultivated lands	Moderately common
14	*Citrullus colocynthis* (L.) Schard.	Sandy soil	Moderately common
15	*Cucumis prophetarum* L.	Rock crevices	Rare
16	*Euphorbia granulate* Forssk.	Sandy soil	Moderately common
17	*Euphorbia peplus* L.	Cultivated lands	Moderately rare
18	*Euphorbia retusa*	Cultivated lands	Moderately rare
19	*Chrozophora tinctoria* (L.) A. Juss. ex. Spreng.	Coarse sandy soil	Moderately common
20	*Andrachne aspera* Spreng.	Mountains cracks	Moderately rare
21	*Aristida plumose* L.	Shallow sandy soil and that layer covering the mountains	Moderately common
22	*Senna italica Mill*	Sandy soil	Common
23	*Crotalaria senegalense* (Pers.) DC.	Fine sandy soil	Moderately rare
24	*Haplophyllum tuberculatum* Forssk.) A. Juss.	Sandy soil	Rare
25	*Datura innoxia Mill*	Sandy soil	Rare
26	*Solanum nigrum* L.	Sandy soil	Moderately rare
27	*Withania somnifera* (L.) Dun.	Sandy soil	Moderately rare
28	*Solanum incanum* L.	Coarse sandy soil	Common
29	*Frosskalea tenacissima L.*	Coarse sandy soil	Common
30	*Fagonia cretica* L.	Sandy soil	Common
31	*Fagonia indica* Burm.	Sandy soil	Moderately common
32	*Tribulus longipetalus* Viv.	Sandy soil	Very common
33	*Tribulus terrestris* L.	Sandy soil	Moderately rare
34	*Zygophyllum coccineum* L.	Sandy soil	common

which lead to severe skin sensitivity to light sources, like sun, after exposure. These substances were detected in *Withania somnifera*. (5) Phytotoxins: Toxic protein molecules that are analogous to bacterial toxins in reaction and structure (6) Resins: Compounds chemically very different but which participate specific physical feature, these compounds burn easily or melt, are soluble in organic solvents, insoluble in water, and do not consist of nitrogen. Resines were detected in *Convolvulus arvensis* and *Citrullus colocynthis.* (7) Amines and Polypeptides: Nitrogenous compounds like tyramine and phenyl ethylamine. Found in

Tribulus longipetalus and *Tribulus terrestris*. The presence of most poisonous substances in the recorded species may be for the diversity of habitats, which provides conditions for the growth of many different poisonous plants. The studied area is distinguished by many ecosystems differing in levels of plant species diversity [30] comprising of important medicinal plants, genetic resources of crop and xerophytic vegetation.

4. CONCLUSIONS AND FUTURE DIRECTIONS

The co-evolution and interaction between plants and their normal enemies have led to the accumulation of excellent chemical defense mechanisms and toxins in the plant kingdom. This broad repertoire of bioactive compounds continues to present great opportunities for human health, as many therapeutically relevant compounds are of plant origin and originally evolved for plant defense. It is very important to understand the poisonous plants that grow naturally in the Osfan region. The current study highlights the poisonous plants present in the area to educate people, travelers, herders and citizens about these plants and their dangers. It also motivates specialists to study to use them in the pharmaceutical industry.

DISCLAIMER

The products used for this research are commonly and predominantly use products in our area of research and country. There is absolutely no conflict of interest between the authors and producers of the products because we do not intend to use these products as an avenue for any litigation but for the advancement of knowledge. Also, the research was not funded by the producing company rather it was funded by personal efforts of the authors.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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