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Journal of Agriculture & Forestry Research (JAFR)

Editorial message

Dear Readers, Authors, and Colleagues,

It is with great pleasure that we welcome you to the second volume and fifth issue of the Journal of Agriculture & Forestry Research.

We express our heartfelt gratitude to the authors who have contributed their valuable research to this issue. Your dedication to advancing knowledge in agriculture and forestry is commendable, and we are honored to feature your work in our journal. To our readers, we invite you to engage with the diverse perspectives presented in this volume and consider the implications of the research for your own work and practices. Your feedback and contributions are crucial in shaping the future discourse in these vital fields. As we navigate the complex challenges and opportunities in agriculture and forestry, let us remain united in our pursuit of sustainable, innovative, and impactful solutions. We hope you find inspiration and knowledge within the pages of this second volume and fifth issue of the Journal of Agriculture and Forestry Research.

Sincerely,

Editor-in-Chief
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Journal of Agriculture & Forestry Research (JAFR)

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Research Article

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Ethnobotanical Study of Village Darangal Kambat Tehsil Samarbagh, District Dir Lower, Khyber Pakhtunkhwa Pakistan

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ABSTRACT

A total of 50 species of plants belonging to 35 families were collected from the research area Darangal Dir Lower. Details about their local names, descriptions of plants, and ethno-medicinal uses were also recorded. These medicinal plants are used for different types of diseases such as respiratory disease, colds, diabetes, kidney disease, fever, pain, hair problems, anti-bacterial, anti-ulcer, cough, and skin disease. The results indicated that the medicinal plants in the study area a wide medicinal uses and important value as recorded by the local community. These plants have much importance and medicinal uses for local people and are a cheap source of cures because these are mostly used by the poor mass of the community. The composed plant's species were utilized as remedial plants pursued via vegetables along with food, 12 species were used for fuel and wood, 10 species were used for furniture, 4 species were used as thatching, 2 species were used as a hedge, 2 species were used for fruits and 6 species were used for ornamental purposes. The dominant families of the research area were Rosaceae have 10 species, Fabaceae and Poaceae each have 9 species. Lamiaceae and Solanaceae each have 8 species. Brassicaceae, Cucurbitaceae, Moraceae, Papilonaceae, Ranunculaceae and Rotaceae each have 5 species. Euphorbiaceae, Labiatae, Malvaceae and Rhamaceae each have 4 species. Leaves of the plant were mostly utilized in the preparation of therapeutic recipes. These medicinal recipes were used mostly orally in the form of decoction. Traditional methods of collection and poor post-harvest also decreased the quality of these medicinal plants. Deforestation, soil erosion as well as increase in inhabitants were also solemn intimidation to the valuable plants of the region. The current work is an initiation step toward the documentation of these valuable plants. The flora of the area requires proper conservation for the better future of Darangal.

1. INTRODUCTION

1.1 Introduction to study area:

District Dir Lower is located between 340-370 to 350-07 North Latitudes and 710-310 to 720-14 East longitudes, (Ullah et al., 2022). District Lower Dir is located in the north-western part of Khyber Pakhtunkhwa province and is spread over an area of 1583 square kilometers. This area is superficially hilly. This region is connected on the north with Upper Dir, and Swat on the east, in the South borders with Malakand District, while Afghanistan and Bajaur districts lie on the west side (Ullah et al., 2021). At the time of independence, Dir was a princely state ruled by Nawab Shah Jehan Khan. It was merged with Pakistan in 1969 and later declared a district in 1970. On 13 August 1996, Districts Dir was bifurcated into two separate states, i.e., District Upper Dir and District Lower Dir (Ullah et al., 2017). The district is divided into two main Subdivisions; Samar Bagh and Timergara. The district has seven Tehsils I.e., Balambat, Adenzai, Lal Qilla, Munda, Khall, Samar Bagh, and Timergara (Ullah et al., 2023.). District Dir Lower is further divided into 37 UCs and 1,023 villages (census report of District in, 1998). Peshawar is connected to Dir via Charsadda and Malakand. (Ahmad et al., 2023). Kambat is a union council of the Lower Dir District in the Khyber Pakhtunkhwa province of Pakistan. Lower Dir District has 37 union councils with a population of 797,852, according to the 1998 census report. The population growth rate of the Lower Dir District was 3.42% per annum between the 1981 and 1998 censuses (Ajaib *et* al., 2010). The major tribes are Yousafzai, Mashwani, Saddat, Tarran, Tajak, Atrafi, Khilji, Sahibzadgan, Mast Khel, Shinwari, Umer Khel, Swati, Mayar, Gujar, Sadat, Mashwani, Tajak, Wardag and Sultan Kheel etc (zaman et al., 2022). Ethnobotany is the study of the interaction between plants and people, with a particular emphasis on traditional tribal cultures. According to the World Health Organization (WHO) about 65-80% of the world's population in developing countries depends essentially on plants for their primary healthcare due to poverty and lack of access to modern medicine (Usma et al., 2022). Plants are significant sources of medicines that are used in the treatment of various categories of human diseases (Ahmad et al., 2023). Historically all medicinal preparations were derived from plants, whether in the simple form of plant parts or in the more complex form of crude extracts, mixtures, etc. Today a substantial number of drugs are developed from plants that are active against a number of diseases (Principe, et al, 2005) and the use of medicinal plants is well known among the indigenous people in rural areas of many developing countries. Plants, especially the higher ones have been described as the sleeping giants of drugs and these medicinal plants have been screened for their chemicals that are potentially potent (Bahadur et al. 2023). In 2002, herbal therapy was the leading CAM (complementary and alternative medicine) modality, consumed by 38 million U.S. adults. In 1997, 12.1% of the U.S. population used herbal medicine, whereas, by 2002, this figure increased to 18.6 % (Zaman et al., 2022). Moreover, sales of herbal medicines skyrocketed from $200 million in 1988 to $3.5 billion in 1997 and $4.4 billion in 2005. The naturopathic doctor Michael Murray has fittingly pointed to a "herbal renaissance" resulting from advances in pharmacological techniques, increased scientific knowledge of medicinal compounds, and enhanced public acceptance of natural, or complementary, therapies (Hameed et al., 2022). Using ethnobotanical medicines from various global traditions for the treatment of cancer as examples, this article examines the utilitarian and anthropocentric ethics surrounding therapeutic flora. While several key ethnobotanical species for cancer treatment will be foregrounded in this article, I recognize that the ethics of reciprocity relate to all therapeutic uses of medicinal plants (Ajayi and Moody, 2015). However, ethnobotanical species for cancer treatment offer salient examples of the need for reciprocity ethics; conventional medical practices prioritize the alleviation of human suffering, but marginalize the importance of giving back to plants, of returning the favor, in the spirit of reciprocity. The conservation of medicinal plants in the wild ensures an ongoing reservoir of therapeutic plant compounds in the future (Arshad, 2021). However, while we consume ethnobotanical plants and contribute to (or subtract from) the viability of their habitats, what do we return to the plants from which the medicines have been derived? In contrast to the utilitarian ethics of medicinal plants, the value of reciprocity foregrounds appropriate and sustained exchanges between people and flora that are not based on use-value or virtue-theoretic alone. Leslie Francis defines reciprocity as "the idea of actions-in-return that are not founded in voluntary agreements or contracts" and "doing one's part to produce a common good when especially because others are doing theirs (Ahmad, 2023).

2. MATERIALS AND METHODS:

The present study was carried out from April 2021 to April 2022. During this time the project area was visited once a month for the collection of data pertinent to the ethnobotany, conservation and plant diversity of the area. Each study trip was planned and executed effectively. The research project was completed in three phases. These include literature collection, field trips for data collection and documentation of the data obtained from Darangal Kambat Tehsil Samarbagh Dir Lower.

2.1. Field Work

Fieldwork was carried out in order to investigate the ethnobotany, plant diversity, and conservation status of the flora of Darangal Kambat Tehsil Samarbagh Dir Lower. The fieldwork included interviews, observations, and guided field walk/transect walks. Two methods were frequently used during the fieldwork.

2.2. Observations

This method was based on observations in the field conditions. These observations were made while visiting different villages. During this process, local methods of medicinal plant collection, storage, drying, harvesting time, processing, and utilization were observed and noted. In the meantime, all the plants during the flowering/fruiting stage, were collected, pressed, and preserved.

2.3 Botanical Identification

Plant samples collected throughout the fieldwork were taxonomically identified by using Flora of Pakistan and placed in the Herbarium of Govt Ghazi Umara Khan Degree College Samarbagh. The voucher specimens were kept after broad documents for future reference. From Medicinal Plants Names Services (mpns.kew.org/mpns) the correct name of plants was confirmed.

2.4. Interviews

During fieldwork, interviews were conducted with the local inhabitants, selected informants, the herbalists 'hakims' (local physicians of the eastern system of medicine), pansaries (medicinal plants sellers in the local markets). Questionnaires were being adopted during the surveys in order to get a qualitative and participatory approach about the plant resources and their utilization by the local people. Questions concerning the utility of different plants, quantity of plants used, rate of consumption, availability, economics/market value, and fuel wood /fodder head loads were asked.

2.5. Ethnobotany

The plants of ethnobotanical importance were collected and classified on the basis of their utility in the area. Local people including plant collectors and others on the basis of age group were interviewed for ethnobotanical information about the area. The timings for fieldwork were selected according to the growth and collection season of the plants. Population size and its distribution, languages, ethnic affiliation, history of settlement, major social groups or classes, productive activities, subsistence crops, migration trends etc. were also explored during the fieldwork.

3. RESULTS

A total of 50 species of plants belonging to 35 families were collected from the research area Darangal Dir Lower. Details about their local names, description of plant, and ethno medicinal uses were also recorded. The details description is given below.

Plant No: 1

Botanical Name: *Ajuba bracteosa* Wall. Ex Benth
English Name: Bugle
Local Name: Khwaga bootei, Gooti
Family: Lamiaceae
Habit: Shade-loving herb growing in crevices
Habitat: Dry Place
Flowering Season: February – June
Parts used: Whole plant
Medicinal uses:
The plant is used in internal colic, angina cough, and fever and for the treatment of achnaes. Decoction is useful for curing jaundice, hypertension, refrigerant and sore throat.

Plant No: 2

Habitat: Dry places
Flowering Season: March-April
Parts used: Leaves, shoots, and seeds
Local Name: Jaukay

Family: Asteraceae (Compositae)
English Name: Viagte wormwood
Habit: Herb
Botanical Name: *Artemisia scoparia* Linn
Medicinal uses: Respiratory stimulant, anthelmintic and purgative. Used as a cure for earache

Plant No: 3

Botanical Name*: Isodon rugosus* (Wall. ex Bth.) Codd
English Name: Ajwain
Local Name: Spairkay
Family: Lamiaceae
Habit: Herbs
Habitat: Dry place
Parts used: Leaves
Medicinal uses:
The filtrate is kept for the whole night in the open sky and is drank early in the morning before breakfast for sore throat. Some people extract juice from its leaves, mix it with water, shake it well, and give it to children for cough.

Plant No: 4

Botanical Name: *Mentha arvensis* L.
English Name: Corn Mint
Local Name: Pudina
Family: Lamiaceae
Habit: Herb
Habitat: Moist places
Flowering season: July-August
Parts used: Whole plant
Medicinal uses:
The green and dried leaves are used as antispasmodic, refrigerant, stimulant, diuretic, and aromatic. The decoction of the leaves and lemon grass prepared and used as febrifuge in fever. It is a honey- bee species.

Plant No: 5

Botanical Name: *Melia azedarach* L
English Name: Chain berry Tree
Local Name: Hindustanai Shandai (Toora Shandai)
Family: Meliaceae
Habit: A medium sized tree
Habitat: Dry soil
Flowering season: May-July
Parts used: Whole plant
Medicinal uses:
The bark used as cathartic, emetic and vermifuge. The fruit used as anthelmintic and sexual tonic. The decoction of leaves employed in hysteria and skin diseases. The leaves extract and fruit powders used for liver complaints, night blindness, vomiting in fever and worms.

Plant No: 6

Botanical Name: *Olea ferruginea* Royle
English Name: Indian olive
Local Name: Khona
Family: Oleaceae
Habit: Tall tree
Habitat: Dry places
Flowering Season: April – May
Parts used: Fruits, leaves and trunk
Medicinal uses:
The fruit is antidiabetic. The leaves are used for toothache and throats soar. The leaves and bark are bitter and used as an astringent, antiseptic, antiperiodic, diuretic and tonic.

Plant No: 7

Botanical Name: Monotheca buxifolia (Falc.) A. D
English Name: Sideroxylon
Local Name: Gorgowara
Family: Sapotaceae
Habit: Medium sized tree
Habitat: Dry, exposed, sunny places
Flowering season: April-June
Parts used: Whole plant
Medicinal uses:
Fruits are edible, used as an astringent, refrigerant and to improve digestion. The plant grazed by goats, is used as fuel wood and as a hedge plant. The plant is used as fodder and for fencing.

Plant No: 8

Botanical Name: Paeonia emodi Wall. Ex Royle
English Name:
Local Name: Mamaikh
Family: Paeoniaceae
Habit: A perennial herb
Habitat: Dry place
Flowering Season: April-May
Parts used: Rhizomes, roots and seeds
Medicinal uses:
Roots and rhizomes are used to cure backache, dropsy and epilepsy. It is also a tonic, emetic, cathartic, blood purifier and colic. The tubers are used medicinally in uterine and nervous Diseases. The seeds are used as purgative and emetic.

Plant No: 9

Botanical Name: *Tribulus terrestris* L.
English Name: Land caltrops
Local Name: Markondai
Family: Zygophylaceae
Habit: Herb
Habitat: Dry Place
Flowering period: April-August
Parts used: Fruits, roots
Medicinal uses:
The fruits and roots are given for urinary disorders and chronic cystitis. Its general use is an aphrodisiac. The fruits and seeds are mixed with honey and used for curing impotence.

Plant No: 10

Botanical Name: Verbascum thapsus L.
English Name: Kashmir Salvia
Local Name: Kharghwag
Family: Scrophulariaceae
Habit: An annual herb
Habitat: Dry Place
Flowering Season: May to August
Parts used: Leaves, flowers, seeds
Medicinal uses:
Leaves and flowers are used against cough and pulmonary diseases in the form of a paste. The seeds are narcotic and used as a fish poison. Medicinally the plant used as demulcent, emollient, stimulant and vermifuge.

Plant No: 11

Botanical Name: *Accacia nilotica* (L.) Delile
English Name: Gum Arabic
Local Name: Kikar
Family: Mimosaceae
Habit: Tree
Habitat: Dry places
Flowering Season: May to August
Parts used: Flower
Medicinal uses:
Flower along with sugar is used for cough. In traditional medicine, Acacia nilotica is widely used. This plant has anti-microbial, anti-plasmodial and antioxidant activity and used for treatment of human immunodeficiency virus, hepatitis C virus and cancer.

Plant No: 12

Botanical Name: *Acacia modesta* Wall
English Name: Senglia Modesta
Local Name: Palosa
Family: Mimosaceae
Habit: Tree
Habitat: Dry Places
Flowering Season: May to August
Parts used: Gum and wood
Medicinal uses:
Gum is used as a tonic. And used for cough. Traditionally, Acacia modesta Wall has been used to treat a number of ailments, such as leprosy, wound healing, dysentery, cough, venereal diseases, bacterial infection, and backache. In the present study, the work has been extended to examine the anti-diabetic, cytotoxic, and proliferative potential of this valuable plant.

Plant No: 13

Botanical Name: *Chenopodium batrys* L.
English Name: Goosefoot
Local Name: Kharawa Sarmay
Family: Chenopodiaceae
Habit: Herb
Habitat: Dry place
Flowering Season: April to August
Parts used: Whole plant
Medicinal uses:
Use for washings of utensils, fuel, cooling agent and for infection with water and used for blood purification. Chenopodium botrys has been used as an antispasmodic, anti-asthmatic, anthelmintic, and spice in traditional medicine.

Plant No: 14

Botanical Name: *Dodonea viscosa* (L.) Jacq
English Name: Hop bush
Local Name: Ghwarrasky
Family: Sapindaceae
Habit: Shrub
Habitat: Dry place
Flowering Season: April to August
Parts used: Whole plant
Medicinal uses:
Ash is used to treat burns and skin infections. Water extracts of leaves is used as antihelmentic.

Plant No: 15

Botanical Name*: Zanthoxylum armatum* DC
English Name: Winged prickly ash
Local Name: Dambara
Family: Rutaceae

Habit: Shrub
Habitat: Dry place
Parts used: Fruit
Flowering Season: April to August
Medicinal uses:
Fruit is used for treating stomach disorders. Zanthoxylum armatum used as a medicine from ancient time for cure of various diseases such as toothache and problems related to tooth, asthma, used for gum bleeding, fever, dyspepsia, and tonics.

Plant No: 16

Botanical Name: *Diospyros kaki* L
English Name: Japanese persimmon
Local Name: Amlook
Family: Ebenaceae
Habit: Tree
Habitat: Dry Place
Flowering Season: April to August
Parts used: Fruit
Medicinal uses:
Fruit is suitable for eating; Leaves are utilized as food and fuel. Leaves, known as Shi Ye (in Chinese), have a long history as a Chinese traditional medicine for the treatment of ischemia stroke, angina, internal hemorrhage, hypertension, atherosclerosis and some infectious diseases

Plant No: 17

Botanical Name: Eucalyptus lanceolatus L.
English Name: Eucalyptus
Local Name: Laachi
Family: Myrtaceae
Habit: Tree
Habitat: Dry place
Parts used: Seed and wood
Flowering Season: April to August
Medicinal uses:
The powdered seeds are used to suppress cough. Herbal remedies recommend using fresh leaves in a gargle to relieve a sore throat, sinusitis, and bronchitis. Also, eucalyptus oil vapor appears to act as a decongestant when inhaled. It is a popular home remedy for colds and bronchitis.

Plant No: 18

Botanical Name: *Morchella esculenta* L.
English Name: Morel
Local Name: Khosay
Family: Helvelaceae
Habit: Mashroom
Habitat: Dry Place
Flowering Season: April to August
Parts used: Whole body
Medicinal uses:
Used as body tonic and nutritive food and also edible. It may be used as a purgative, laxative, body tonic, emollient and also used for stomach problems, healing the wound and for general weakness. It can be poisonous if eaten raw and produces so many adverse reactions if not used properly.

Plant No: 19

Botanical Name*: Ricinus communis* L.
English Name: Castor been
Local Name: Herhanda
Family: Euphorbiaceae
Habit: Shrub
Habitat: Dry Place
Flowering Season: April to August
Parts used: Seed and leaves
Medicinal uses:
Seeds are used for stomachache and in bowels problems. Seed oil is specifically used therapeutic for constipation. Leaves are emetic, narcotic.

Plant No: 20

Botanical Name: Viola canscens Wall. Ex Roxb
English Name: Himalayan White Violet
Local Name: Benafsha
Family: Violaceae
Habit: Herb
Habitat: Dry Place
Flowering Season: April to August
Parts used: Whole plant
Medicinal uses:
Plants were used during cold, cough, asthma, headache and .and leaves are also mix in tea and used against chest disease.

Plant No: 21

Botanical Name: *Rose indica* L.
English Name: Rose
Local Name: Gulab
Family: Rosaceae
Habit: Shrub
Habitat: Found in most part of the country
Flowering Season: April to August
Parts used: Flower, leaf and stems
Medicinal uses:

It is useful in heart disease, eye problem and improves high blood pressure. Herbal tea prepared from rose petal is very suitable to control acidity. Rose petals are used for the formation of perfume.

Plant No: 22

Botanical Name*: Equisetum arvense* L.
English Name: Field Horsetail
Local Name: Bandakay
Family: Equisetaceae
Habit: Herbs
Habitat: Dry Place
Parts used: Shoots
Sporing Seasons: March to April
Medicinal uses:
The extracts of shoots are mixed with mustard oil and used as a hair tonic and against lice. It is used for cleaning and washing utensils.

Plant No: 23

Botanical Name: *Helianthus annuus* L.
English Name: Sun Flower
Local Name: Nwar parast
Family: Asteraceae
Habit: Shrubs
Habitat: Agricultural Field
Flowering Season: April to August
Parts used: Whole plant
Medicinal uses:
Oil is used for cooking. Plant is ornamental. use as a remedy for pulmonary affections, a preparation of the seeds has been widely used for cold and coughs, in the Caucasus the seeds have served as a substitute for quinine in the treatment of malaria

Plant No: 24

Botanical Name: *Hibiscus esculentus* (L.) Moench
English Name: Lady Finger
Local Name: Bandai
Family: Malvaceae
Habit: Herbs
Habitat: Agricultural Land
Flowering Season: April to August
Parts used: whole plant
Medicinal uses:
Used for wounds and boils. Leaves are diuretic, emollient. Fruit is edible. An infusion of the roots is used in the treatment of syphilis. The juice of the roots is used externally in Nepal to treat cuts, wounds and boils. The leaves furnish an emollient poultice. A decoction of the immature capsules is demulcent, diuretic and emollient.

Plant No: 25

Botanical Name: *Plantago lanceolata* L.
English Name: Ribwort plantain
Local Name: Ghawajabai
Family: Plantaginaceae
Habit: Herbs
Habitat: Dry Place
Flowering Season: April to August
Parts used: Leaves, fruits, seeds
Medicinal uses:
Extract of leaves is applied to sores, wounds and inflamed surfaces. The seeds are laxative and are used for dysentery and mouth diseases. The leaves slightly rubbed and used as antifungal in athlete's foot disease.

Plant No: 26

Botanical Name: *Zizyphus oxyphylla* Edgew
English Name: Pointed-Leaf jujube
Local Name: Elanai
Family: Rhamnaceae
Habit: Shrubs
Habitat: Dry Place
Flowering Season: April to August
Parts used: Roots, fruits
Medicinal uses:
The roots are used for curing jaundice. The fruits are edible and used for gas troubles. Also grown as hedge plant.

Plant No: 27

Botanical Name: *Solanum nigrum* L
English Name: European black nightshade
Local Name: Karmacho
Family: Solanaceae
Habit: Herbs
Habitat: Dry place
Flowering Season: April to August
Parts used: Vegetative parts
Medicinal uses:
Fodder of low quality. Drinking water after eating this plant may cause flatulence and prove fatal to cattle. It has been used traditionally for the treatment of bacterial infections, cough and indigestion. This plant has also been investigated for ant proliferative.

Plant No: 28

Botanical Name: Datura stramonium L.
English Name: Jimsonweed
Local Name: Batura
Family: Solanaceae
Habit: Herbs
Habitat: Dry place
Flowering Season: April to August
Parts used: Leaves, seeds
Medicinal uses:
Green leaves are used for softening the boils. Seeds are smoked for narcotic action. Seeds and leaves are used as anodyne. The juices of flowers are useful for earache.

Plant No: 29

Botanical Name: *Brassica campestris* L.
English Name: Mustard
Local Name: Sharrsham
Family: Brassicaceae
Habit: Herb
Habitat: Moist, dry and sandy places
Flowering Season: March - April
Parts used: Leaves, seeds and whole plant
Medicinal uses:
Used for headache, used for hair growth, used for hair thickness and used for muscular pain of the body. Oil is obtained from seeds and used for body massaging and hairs.

Plant No: 30

Botanical Name: *Solanum virginisnum* L.
English Name: Thorny Nightshade or Yellow Berried Nightshade
Local Name: Maraghony
Family: Solanaceae
Habit: Herb
Habitat: Dry place
Flowering Season: March – April
Parts used: Fruit extract
Medicinal uses:
Used for the treatment of teeth ache. Used for the opening of sneezing. Fruit is to be chewed and stayed in mouth. Fruit extract in put into nose for opening sneezing

Plant No: 31

Botanical Name: *Cyperus rotundus* L.
English Name: Coco Grass
Local Name: Drab
Family: Cyperaceae
Habit: Herb
Habitat: Dry place
Flowering Season: May to August
Parts used: Whole plant
Medicinal uses:
Use for fodder and fuel. *Cyperus rotundus* L. is a medicinal herb traditionally used to treat various clinical conditions at home such as diarrhea, diabetes, paresis, and inflammation, malaria, and stomach and bowel disorders.

Plant No: 32

Botanical Name: *Vigna unguiculata* L.
English Name: Cowpea
Local Name: Lobya
Family: Fabaceae
Habit: Shrub
Habitat: Cultivated Fields
Parts used: Seeds
Medicinal uses:
Used as food and for kidney stone. Used to treat epilepsy, bilharzia, chest pains and constipation.

Plant No: 33

Botanical Name: *Typha angustata* Bory & Chaub.
English Name: Typha Angustifolia
Local Name: Lokha
Family: Typhaceae
Habit: Herb
Habitat: Moist place
Parts used: Whole plant
Medicinal uses:
It is used as thatching material. Leaves are use as fodder. is an Ayurvedic herb used to treat bleeding disorders, difficulty to pass urine. It detoxifies breast milk, semen, ovum, menstrual blood and urine. It acts as diuretic and hemostatic.

Plant No: 34

Botanical Name: Oryza sativa L.
English Name: Rice
Local Name: Shoola
Family: Poaceae
Habit: Herb
Habitat: Moist place
Flowering Season: May to August
Parts used: Whole plant
Medicinal uses:

It is used for heart diseases, diabetes and also used for a food and fodder. Sticky rice often is used to treat heart-burn, stomach upsets and indigestion. Brown rice extracts had been utilized to treat warts, breast and stomach cancer and also many parasitic diseases.

Plant No: 35

Botanical Name: *Vitex negundo* L.
English Name: Chines chaste tree
Local Name: Marvandai
Family: Lamiaceae
Habit: Shrub
Habitat: Dry Place
Parts used: Whole plant
Medicinal uses:
Used as digestive problems and fuel. These bioactive compounds exhibit anti-inflammatory, antioxidant, and antidiabetic, anticancer, antimicrobial. Typically known for its role in the modulation of cellular events like apoptosis, cell cycle, and motility of sperms, polycystic ovary disease, and menstrual cycle.

Plant No: 36

Botanical Name: *Cestrum nocturnum* L.
English Name: Lady of the Night
Local Name: Rat ki rani
Family: Solanaceae
Habit: Shrub
Habitat: Dry Place
Parts used: Whole plant
Medicinal uses:
Used for decorative purposes. It is also used as a hedge plant and cultivated as a medicinal plant. The medicinal properties of night blooming jasmine include antioxidant, anti-hyperlipidemia, hepatoprotective, analgesic, antifungal, anti-convulsant, anti-HIV and larvicidal activities.

Plant No: 37

Botanical Name: Tagetes minuta L.
English Name: Tagetes
Local Name: Dambar Gully
Family: Asteraceae
Habit: Herb
Habitat: Moist Place
Flowering Seasons: June – July
Parts used: Whole plant
Medicinal uses:
Different plants can be safe from nematodes and use ornamentally. Remedy for colds, respiratory inflammations, stomach problem, anti-spasmodic, anti-parasitic, anti-septic, insecticide and sedative.

Plant No: 38

Botanical Name: *Parthenium hysterophorous* L.
English Name: Santa Maria fever few
Local Name: Zangley Tarkha
Family: Asteraceae
Habit: Herb
Habitat: Dry Place
Parts used: Whole plant
Medicinal uses:
Fodder and fuel. Remedy for skin inflammation, rheumatic pain, diarrhea, urinary tract infections, dysentery, malaria and neuralgia.

Plant No: 39

Botanical Name: Ficus carica L.
English Name: Fig
Local Name: Inzar
Family: Moraceae
Habit: Medium sized cultivated tree
Habitat: Dry Place
Flowering Season: Summer.
Parts used: Fruits, latex
Medicinal uses:
Fruits, both in dry or fresh form, are edible. It is laxative and demulcent, used in constipation, piles and urinary bladder problems. The latex is used against warts and to remove spines and thorns easy.

Plant No: 40

Botanical Name: Nasturtium officinale R. Br
English Name: watercress
Local Name: Tarmira
Family: Brassicaceae (Cruciferae)
Habit: A perennial herb of moist habitats
Habitat: Moist Place
Flowering Season: March-Aug.
Parts used: Vegetative portion
Medicinal uses:
A vegetable, salad and pot-herb. It is antiscorbic, appetizer, diuretic and used in chest infections and stomachache. Some people also used in heart and kidney troubles.

Plant No: 41

Botanical Name: *Narcissus poeticus* L
English Name: poet's daffodil
Local Name: Goli Nargas
Family: Amayrlidaceae
Habit: Herb
Habitat: Moist and Dry Place
Parts used: Flowers
Medicinal uses:
It is used for ornamental purposes. Indeed, powerful anticancer properties of Narcissus poeticus L. were already known to the Father of Medicine, Hippokrates, who recommended a pessary prepared from narcissus oil for the treatment of uterine tumors.

Plant No: 42

Botanical Name: Papaver somniferum L
English Name: bread seed poppy
Local Name: Apium or Opium
Family: Papaveraceae
Habit: Shrub
Habitat: Dry Place
Parts used: Leaves and fruit
Medicinal uses:
The capsule is cut with blade and removes "charse"" farm them. Relive pain, Hypnotic, Sedative, Headache, Diarrhea and Dysentery. Seed are nutritive and also used for cough.

Plant No: 43

Botanical Name: *Amaranthus virdis* L.
English Name: slender amaranth
Local Name: Chorlai
Family: Amaranthaceae
Habit: Herb
Habitat: Dry Place
Parts used: Leaves
Medicinal uses:
For Diuretic, lithasis, headache swelling and used food and fodder. Traditional Ayurvedic medicine as antipyretic agents, also for the treatment of inflammation, ulcer, diabetic, asthma and hyperlipidemia.

Plant No: 44

Botanical Name: *Fumaria indica* (Husskn.) H.N. Pugsley
English Name: Fumitory
Local Name: Shahtra
Family: Fumariaceae
Habit: Herb
Habitat: Dry Place
Parts used: Whole plant
Medicinal uses:
It is used as a fodder as well as fuel. Shoots are also used in diarrhea, blood purifier and fever. Fumeria indicia is used in aches and pains, diarrhea, fever, influenza, liver complaints, vomiting, constipation, dyspepsia, blood purification, leucoderma, anthelmintic, diuretic, diaphoretic and, in combination with black pepper, for jaundice.

Plant No: 45

Botanical Name: *Medicago denticulata* Willd
English Name: California bur clover
Local Name: Feshtary
Family: Fabaceae
Habit: Herb
Habitat: Moist Place
Parts used: Leaves
Medicinal uses:
Used as food and for sugar control. It is used in the treatment of heart disease, stroke, cancer, diabetes, indigestion, halitosis, constipation, and menopausal disorders in women.

Plant No: 46

Botanical Name: *Taraxicum officinale* (L.)
English Name: dandelion
Local Name: Ziar gully
Family: Asteraceae
Habit: Herb
Habitat: Dry Place
Parts used: Roots
Medicinal uses:
Roots are used in diabetes and for kidney problems. Fresh or dried dandelion herb is also used as a mild appetite stimulant, and to improve upset stomach. The root of the dandelion plant may act as a mild laxative and has been used to improve digestion. Preliminary research suggests that dandelion may help improve liver and gallbladder function.

Plant No: 47

Botanical Name: Pinus roxburghii Sargent
English Name: Chir pine or longleaf Indian pine
Local Name: Nakhtar

Family: Pinaceae
Habit: Tree
Habitat: Dry Place
Parts used: Whole tree
Medicinal uses:
The resin locally known, as "Jaula" is a stimulant used for ulcers, snakebites, scorpion stings and skin diseases. It is a blood purifier. Wood is an aromatic, antiseptic, deodorant, and diaphoretic, stimulant and is used in the burning the body, cough, fainting and ulceration. Wood is used as timber in construction, and makes a good fuel.

Plant No: 48

Botanical Name: *Euphorbia helioscopia* L
English Name: Sun spurge
Local Name: Mandarro
Family: Euphorbiaceae
Habit: Herb
Habitat: Moist and damp places
Parts used: Juice of leaves and root
Medicinal uses:
Leaves juice is used against scorpions and snack biting. Used for the removal of intestinal parasites. Help in the treatment of chronic coughing and dysentery. Seed are purgative. Latex is used for skin diseases and to extract spine from skin.

Plant No: 49

Botanical Name: Artimisia maritime L.
English Name: Sea wormwood
Local Name: Tarkha
Family: Asteraceae
Habit: Herbs
Habitat: Dry Place
Parts used: Whole plant
Medicinal uses:
Use as shelter, fuel, Cough, cold, and anemia. It is used mainly as a tonic to the digestive system, in treating intermittent fevers and as a vermifuge. The leaves and flowering shoots are anthelmintic, antiseptic, antispasmodic, carminative, cholagogue, emmenagogue, febrifuge, stimulant, stomachic, tonic and vermifuge

Plant No: 50

Botanical Name: Indigofera articulate gouan (L)
English Name: Indigo
Local Name: Ghwarega
Family: Papilonaceae.
Habit: Shrub
Habitat: Mountain Areas
Parts used: Whole plant
Medicinal uses:
Use as a fuel and shelter also used is fodder of cattle. Pain, respiratory diseases, diarrhea, wound healing. Is Indigofera a medicinal plant Indigofera species are widely employed in traditional medicine all around the world, against many ailments.

Table: 1 Plants used for Fuels

S.NO	Botanical Name	Local name	Family
1.	*Melia azedarach L*	Toora shandai	Meliaceae
2.	*Olea ferruginea* Royle	Khona	Oleaceae
3.	*Monotheca buxifolia*	Gorgowara	Sapotaceae
4.	*Verbascum thapsus* L	Kharghwag	Scrophulariaceae
5.	*Accacia nilotica*	Kikar	Mimosaceae
6.	*Acacia modesta* Wall	Palosa	Mimosaceae
7.	Chenopodium batrys L	Kharawa Sarmay	Chenopodiaceae
8.	*Zanthoxylum armatum* DC	Dambara	Rutaceae
9.	*Diospyros kaki*	Amlook	Ebenaceae
10.	*Eucalyptus lanceolatus* L	Laachi	Myrtaceae
11.	*Zizyphus oxyphylla* Edgew	Elanai	Rhamnaceae
12.	*Cyperus rotundus* L	Drab	Cyperaceae
13.	*Vitex negundo* L.	Marvandai	Lamiaceae
14.	*Parthenium hysterophorous* L.	Zangley Tarkha	Asteraceae
15.	*Amaranthus virdis* L	Chorlai	Amaranthaceae
16.	*Pinus roxburghii* Sargent	Nakhtar	Pinaceae
17.	*Artimisia maritime* L.	Tarkha	Asteraceae

18.	*Indigofera articulate* gouan (L	Ghwarega	Papilonaceae.
19.	Fumaria indica	Shahtra	Fumariaceae

Table: 2 Plants used for Furniture

S.NO	Botanical Name	Local name	Family
1.	*Melia azedarach* L	Toora shandai	Meliaceae
2.	*Pinus roxburghii* Sargent	Nakhtar	Pinaceae
3.	*Acacia modesta* Wall	Palosa	Mimosaceae
4.	*Olea ferruginea* Royle	Khona	Oleaceae
5.	*Monotheca buxifolia*	Gorgowara	Sapotaceae

Table: 3 Plants Used for Fodder

S.NO	Botanical Name	Local name	Family
1.	*Monotheca buxifolia*	Gorgowara	Sapotaceae
2.	*Solanum nigrum* L	Karmacho	Solanaceae
3.	*Cyperus rotundus* L.	Drab	Cyperaceae
4.	*Typha angustata* Bory & Chaub.	Lokha	Typhaceae
5.	*Oryza sativa* L	Shoola	Poaceae
6.	*Parthenium hysterophorous* L.	Zangley Tarkha	Asteraceae
7.	*Amaranthus virdis* L.	Chorlai	Amaranthaceae
8.	*Fumaria indica*	Shahtra	Fumariaceae

Table: 4 Plant used as Vegetable

S.NO	Botanical Name	Local name	Family
1.	*Mentha arvensis*	Pudina	Lamiaceae
2.	*Hibiscus esculentus* (L.) Moench	Banda	Malvaceiae
3.	*Brassica campestris* L	Sharrsham	Brassicaceae
4.	*Nasturtium officinale* R. Br	Tarmira	Brassicaceae
5.	*Amaranthus virdis* L.	Chorlai	Amaranthaceae

Table: 5 Plants used for Shelter

S.NO	Botanical Name	Local name	Family
1.	*Artimisia maritime* L.	Tarkha	Asteraceae
2.	*Indigofera articulate gouan*	Ghwarega	Papilonaceae
3.	*Melia azedarach* L	Toora shandai	Meliaceae
4.	*Olea ferruginea Royle*	Khona	Oleaceae
5.	*Monotheca buxifolia*	Gorgowara	Sapotaceae
6.	*Verbascum thapsus L*	Kharghwag	Scrophulariaceae
7.	*Accacia Nilotica* L.	Kikar	Mimosaceae
8.	*Acacia modesta Wall*	Palosa	Mimosaceae
9.	*Chenopodium batrys L*	Kharawa Sarmay	Chenopodiaceae
10.	*Melia azedarach* L	Toora shandai	Meliaceae

Table: 6 Plants used for Ornamentals

S.NO	Botanical Name	Local name	Family
1.	*Helianthus annuus* L.	Nwar parast	Asteraceae
2.	*Tagetes minuta* L	Dambar Gully	Asteraceae
3.	*Narcissus Poeticus* L	Goli Nargas	Amayrlidaceae

Table: 7 Plants Used for Food

S.NO	Botanical Name	Local name	Family
1.	*Mentha arvensis*	Pudina	Lamiaceae
2.	*Olea ferruginea* Royle	Khona	Oleaceae
3.	*Monotheca buxifolia*	Gorgowara	Sapotaceae
4.	*Zanthoxylum armatum* DC	Dambara	Rutaceae
5.	*Diospyros kaki* L	Amlook	Ebenaceae
6.	*Morchella esculenta* L.	Khosay	Helvelaceae
7.	*Hibiscus esculentus* (L.)	Banda	Malvaceiae
8.	*Solanum nigrum* L	Karmacho	Solanaceae
9.	*Brassica campestris* L.	Sharrsham	Brassicaceae
10.	*Vigna unguiculata* L	Lobya	Fabaceae
11.	*Oryza sativa* L	Shoola	Poaceae
12.	*Ficus carica* **L.**	Inzar	Moraceae
13.	*Nasturtium officinale*	Tarmira	Brassicaceae
14.	*Amaranthus virdis* L.	Chorlai	Amaranthaceae
15	*Medicago denticulata* Willd	Feshtary	Fabaceae

Table: 8 Plants used for Medicine

S.NO	Botanical Name	Local name	Family
1.	*Ajugba bracteosa* Wall. Ex Benth	Gooti	Lamiaceae
2.	*Artemisia scoparia* Linn	Jaukay	Asteraceae
3.	*Isodon rugosus*	Spairkay	Lamiaceae
4.	*Mentha arvensis*	Pudina	Lamiaceae
5.	*Melia azedarach* L	Toora Shandai	Meliaceae
6.	*Olea ferruginea* Royle	Khona	Oleaceae
7.	*Paeonia emodi* Wall. Ex Royle	Mamaikh	Paeoniaceae
8.	*Verbascum thapsus* L.	Kharghwag	Scrophulariaceae
9.	*Zanthoxylum armatum* DC	Dambara	Rutaceae
10.	*Eucalyptus lanceolatus* L	Laachi	Myrtaceae
11.	*Morchella esculenta* L.	Khosay	Helvelaceae
14	*Ricinus communis* L.	Herhanda	Euphorbiaceae
15	*Viola canscens* Wall. Ex Roxb	Benafsha	Violaceae
16	*Rose indica* L.	Gulab	Rosaceae
17	*Equisetum arvense L*.	Bandakay	Equisetaceae
18	*Plantago lanceolata* L.	Ghawajabai	Plantaginaceae
20	*Datura stramonium* L.	Batura	Solanaceae
21	*Brassica campestris* L.	Sharrsham	Brassicaceae
22	*Solanum virginisnum* L	Maraghony	Solanaceae
23	*Oryza sativa* L.	Shoola	Poaceae
24	*Vitex negundo* L	Marvandai	Lamiaceae
25	*Ficus carica* **L.**	Inzar	Moraceae
26	*Nasturtium officinale* R.Br	Tarmira	Brassicaceae
28	*Amaranthus virdis* L.	Chorlai	Amaranthaceae
30	*Medicago denticulata* Willd	Feshtary	Fabaceae
31	*Taraxicum officinale (L.)*	Ziar gully	Asteraceae
32	*Pinus roxburghii* Sargent	Nakhtar	Pinaceae
33	*Euphorbia helioscopia* L	Mandarro	Euphorbiaceae

Table: 9 Number of species and percentage

S. No	Family	Family Numbers	Percentage (%)
1	Lamiaceae	4	8
2	Asteraceae	6	12
3	Meliaceae	1	2
4	Oleaceae	1	2
5	Sapotaceae	1	2
6	Paeoniaceae	1	2
7	Zygophylaceae	1	2
9	Scrophulariaceae	1	2
10	Mimosaceae	2	4
11	Chenopodiaceae	1	2
12	Sapindaceae	1	2
13	Rutaceae	1	2
14	Ebenaceae	1	2
15	Myrtacea	1	2
16	Helvelaceae	1	2
17	Euphorbiaceae	2	4
18	Violaceae	1	2
19	Rosaceae	1	2
20	Equisetaceae	1	2
21	Malvaceiae	1	2
22	Plantaginaceae	1	2
23	Rhamnaceae	1	2
24	Solanaceae	4	8
25	Brassicaceae	2	4
26	Cyperaceae	1	2
27	Fabaceae	2	4
28	Typhaceae	1	2
29	Poaceae	1	2
30	Moraceae	1	2
31	Amayrlidaceae	1	2
32	Papaveraceae	1	2
33	Amaranthaceae	1	2
34	Fumariaceae	1	2
35	Papilonaceae.	1	2

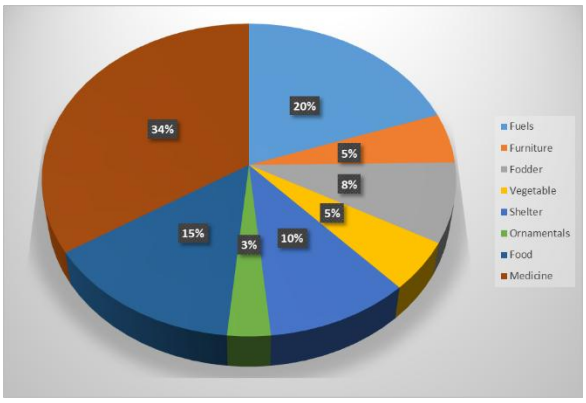

Figure 1: Representation of Plants used for, Fuels, Furniture, Fodder, Vegetable, Shelter, Ornamentals, Food and Medicine

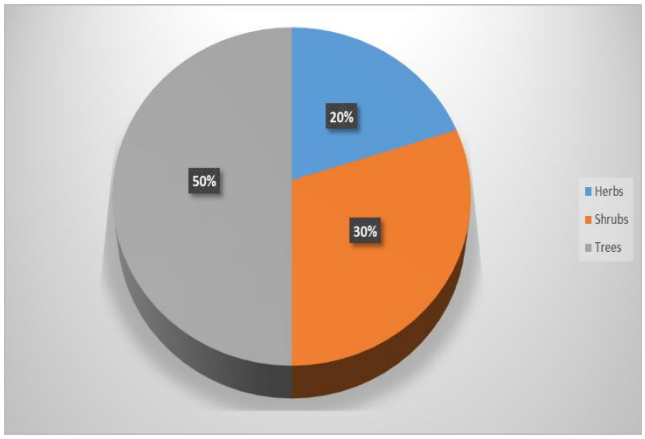

Figure 2: Representation of Herbs, Shrubs and Trees

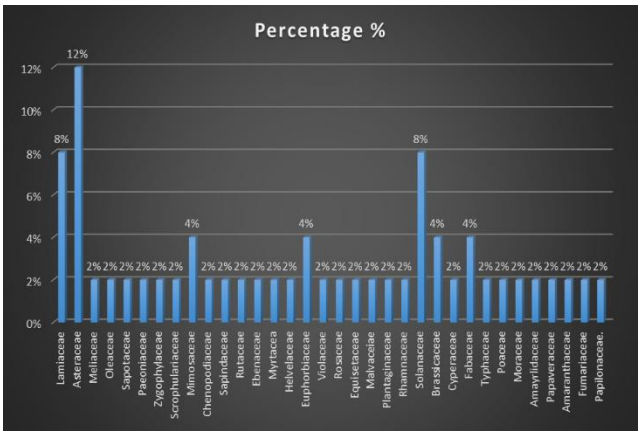

Figure 3: Representation of families and their percentage

4. DISCUSSION

In the present research study sum of 50 plant species belonging to 32 families was reported from the District Darangal Dir Lower. Different plant parts i.e., roots, rhizomes, tubers, leaves, stem, wood and fruits were used by the locals for various purposes in their daily life. Leaves were the most favored plant part used by an indigenous community comprised of 50 species (70.42%) followed by stems (47 species, 66.87%), whole plant (13 species, 20.52%), fruits (09 species, 14%) and roots (04 species, 5.71%). During the survey family Asteraceae was found to contribute the highest number of plant species (08) to the local usage. It was followed by the family Papilionaceae (06 species), Poaceae (05 species), Mimosaceae and Solanaceae (04 species each), Euphorbiaceae (03 species), Apocynaceae, Amaranthaceae, Brassicaceae, Capparaceae, Chenopodiaceae, Polygonaceae, Rhamnaceae, Malvaceae and

Myrtaceae shared 02 species each while family Arecaceae, Acanthaceae, Cactaceae, Asclepiadaceae, Boraginaceae, Convolvulaceae, Cucurbitaceae, Cyperaceae, Canabaceae, Caryophyllaceae, Fumariaceae, Lamiaceae, Liliaceae, Primulaceae, Oleaceae, Sapindaceae, Sapotaceae, Temaraceae, Oxalidaceae, Meliaceae, Moraceae, Solanaceae, Apiaceae and Zygophylaceae were represented by one species each. (Fatima et al. 2023) reported from Punjab a total of 48 plant species belonging to 23 families used for various purposes by the local community. (Jan et al. 2011) reported from lower Dir that the family Asteraceae was the most important family with regard to its ethnobotanical value. He documented 26 weed species belonging to 16 families. (Ijaz et al, 2017) reported a total of 172 medicinal taxa from Allai Valley, Pakistan used by the indigenous people for the treatment of various illnesses. Popularly used 31 medicinal plants by the indigenous were reported from Northern Ethiopia (Mesfin et al. 2013). In District Dir Lower the indigenous people mainly used wild herbs (44 spp., 61.11%), followed by wild trees (16 spp., 23.61%) and wild shrubs (11 spp., 15.06%). These plants were used for different purposes such as fodder, furniture, fuel, oil, edible fruits and vegetables. Most of the reported species 110were used for multipurpose. In the present study it was concluded that 45 species (63.5%) were used as fodder, 30 species (41.66%) for fuel, 10 species \(14.69%) for furniture, thatching species were 08 (11.95%), 07 species (9.58%) were used as vegetable, 04 species (7.04%) for hedge purpose, fruit species were 04 (6.04%), 03 species (4.10%) were grown for ornamental purposes and 01 species (1.36%) for each of the following purposes; coloring the clothes, oil for hairs, perfume, in surf industries and in making basket, ropes and hand fan. (Barkatullah and Ibrar, 2011) reported 31 plants species from Malakand agency that were used in the area for fuel, 14 plant species for making furniture, 15 species for house construction particularly for thatching purposes, 47 species were most frequently used for fodder/forage, 40 species (23.68%) were consumed as vegetable and fruit. There were 19 species grown around houses and crop fields as fences. (Hazrat et al., 2011) conducted survey in district Buner and reported 21 fuel plant species, 13 vegetables, 7 roof thatching species, 6 timber wood species and 40 species for medicinal purposes. 10% of plant species were used for fuel and furniture from district Mana Angetu (Lulekal et al., 2008). 16 plant species were used as fuel at Jandool Valley, Dir Lower (Nasrullah et al., 2012). In a similar study, (Ullah, 2021) reported 15 plant species used for furniture and 9 plant species used for ornamental purposes at Ushairy Valley, district Dir (Upper). Cones of gymnosperm were used for decoration at Poonch Valley Azad Kashmir Pakistan (Khan, 2008).04 bushy and spiny species were used as borders around the parks and houses. The oil of Eruca sativa as used a hair tonic while the oil of Pongamia pinnata is used for cooking purposes. The Osmium bacilicum is used in perfumes due to its fragrance. Aloe vera fleshy leaves are used in surf industries. The ash of Calotropis procera is used as a cloth coloring agent. Lack of proper education and poor economic condition of the area has led to the deforestation of natural vegetation, which is added by the unavailability of alternative fuel.

5. CONCLUSION

The current medicinal survey was carried out on medicinal plants of Village Darangal Tehsil Samar Bagh Khyber Pakhtunkhwa. A total of 50 plant species were collected from March to September along with their local name, botanical name, English name, family, habit, part use, method of use and medicinal use. Herbaceous cover was dominated with (40%) species followed by trees with (42%) species and then by shrubs with (18%) species. We concluded that the studied area is rich floristically with medicinal plants and is important medicinally and economically. But unfortunately, due to unawareness some medicinally and economically important plants like Pinus species have high market value which are cutting at an alarming rate. Because of over utilization, over collection, over-exploitation, habitat degradation, overharvesting, deforestation, population explosion, over grazing and deforestation the area is under high biotic pressure.

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Phytochemical Detection and Medicinal Studies of Selected Plants from War Effected Areas of Khyber Pakhtoonkhwa Pakistan

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ABSTRACT

In the present study qualitative investigation of methanolic, ethanolic and aqueous extracts of *Verbascum thapsus* and *Micromeria biflora* and Medicinal studied of Selected Plants was carried out. Phytochemical detection of *Verbascum thapsus* plant ethanolic extracts in leaves contained a dark colour which shows that Alkaloids are present. Where phenol was present in both methanolic, ethanolic and aqueous extracts. The saponins in aqueous show dark concentration comparison with ethanolic and methanolic extracts. The flavonoids were present in all three types of extract and Tannins were found in all types of extract in large amounts but in Aqueous found in small amounts. The alkaloids, glycosides and Phlobatannins are absent in aqueous extract. The Flavonoids were present in moderate amounts in both methanolic and ethanolic extract in leaves and they were present in low amounts in the aqueous extract. The Phlobatannins were present in moderate amounts in the methanolic extracts and low amounts in the ethanolic extracts of *Verbascum thapsus* and absent in the aqueous extracts. Tannins were present in the highest amount in ethanolic extracts followed by the methanolic extracts. The qualitative phytochemistry also shows that the Carbohydrate, Glycosides, were found in the highest amount in the plant extracts and the other phytochemicals such as Alkaloids, Flavonoids and Phenol were present in moderate amount. The Alkaloid, Carbohydrate, Glycosides, Phlobatannins, Saponins, Terpenoids. In the current study ethno-botanical importance plant of Munda Khazana district lower Dir an overall of 50 valuable plants assembled from the research region. These plants belong to different families. The dominant valuable plants and the bases of habit were herbs (22 species) followed by shrubs (8 species) and trees (10 plant species).

1. INTRODUCTION

Phytochemicals (from the Greek word Phyto, meaning plant) are biologically active, naturally occurring chemical compounds found in plants, which provide health benefits for humans further than those attributed to macronutrients and micronutrients (Hasler and Blumberg, 1999). They protect plants from disease and damage and contribute to the plant's color, aroma and flavor. In general, the plant chemicals that protect plant cells from environmental hazards such as pollution, stress, drought, UV exposure and pathogenic attack are called phytochemicals (Ullah et al. 2023). Recently, it is clearly known that they have roles in the protection of human health when their dietary intake is significant. More than 3,000 phytochemicals have been cataloged and classified by protective function, physical characteristics and chemical characteristics and About 150 phytochemicals have been studied in detail (Ullah et al., 2021). Wide-ranging dietary phytochemicals are found in fruits, vegetables, legumes, whole grains, nuts, seeds, fungi, herbs and spices. Broccoli, cabbage, carrots, onions, garlic, whole wheat bread, tomatoes, grapes, cherries, strawberries, raspberries, beans, legumes, and soy foods are common sources (Moorachian, 2000). Phytochemicals accumulate in different parts of the plants, such as in the roots, stems, leaves, flowers, fruits, or seeds7. Many phytochemicals, particularly pigment molecules, are often concentrated in the outer layers of the various plant tissues. Levels vary from plant to plant depending upon the variety, processing, cooking, and growing conditions (Ullah et al. 2019). Phytochemicals are also available in supplementary forms, but evidence is lacking that they provide the same health benefits as dietary phytochemicals (Harvey and Strategy, 2000). These compounds are known as secondary plant metabolites and have biological properties. Such as antioxidant activity, antimicrobial effect, modulation of detoxification enzymes, stimulation of the immune system, decrease of platelet aggregation, and modulation of hormone metabolism and anticancer properties. There are more than a thousand known and many unknown phytochemicals. It is well-known that plants produce these chemicals to protect themselves, but recent research demonstrates that many phytochemicals can also protect human against diseases (Rao, 2002).

Phytochemicals are not essential nutrients and are not required by the human body for sustaining life, but have important properties to prevent or to fight some common diseases. Many of these benefits suggest a possible role for phytochemicals in the prevention and treatment of disease, Because of this property; many researchers have been performed to reveal the beneficial health effects of phytochemicals. The purpose of the present review is to provide an overview of the extremely diverse phytochemicals present in Medicinal plants (Ahmad et al., 2023).

1.2 Plants Introduction

1.2.1 *Verbascum thapsus*

Common mullein, also known as Wooly Mullein (*Verbascum thapsus* L., Scrophulariaceae) has been used as a Medicinal herb since ancient times. The leaves and flowers are reported to have expectorant and demulcent features which are used to treat respiratory problems such as bronchitis, dry coughs, whooping cough, tuberculosis, asthma, and hoarseness. The plant is reported to be mildly diuretic to have a soothing and anti-inflammatory effect on the urinary tract, and to act as a mild sedative. It has also been used as a domestic remedy for pneumonia, fever, congestion, allergies, migraine, catarrhs, and colic (Hameed et al. 2022). During our routine field excursions, it was found that this plant is used to treat respiratory tract infections and external boils and abscesses. Also, it has also been as a traditional remedy to treat various ailments such as spasmodic, digestive disorders, and menstrual problems. Therefore, the aim was to determine V. Thapsus extracts that have been shown earlier to have biological activity against urinary tract pathogens (Turker et al. 2002).

1.2.2 *Micromeria biflora*

A perennial herb, found in rock crevices and gravel slopes of sub-tropical and temperate `zones: Stem ascending, slender, 10-25cm long, glabrous. Leaves simple, small, sessile, ovate, entire, thick, acute, 2-10 mm long and 2-5mm broad. The inflorescence is verticillaster, few-flowered. Flower zygomorphic,

pale pink, bract small, linear. Calyx ribbed with narrow lobes. Corolla 2-lipped, lower lip 2-lobed, upper lip flat. Fruit outlet, oblong, brown. Flowering and Fruiting: Medicinal Value: Locally used as an herbal tea for flu, and throat irritation and plant extract treats pneumonia, stomach disorders, headache and wounds. Essential oil is anti-inflammatory (Rajiv et al. 2016).

2. MATERIAL AND METHODS

2.1. Collection of plants and their parts

Rhizome and whole plants of *Verbascum thapsus* and *Micromeria biflora* were Collected in October 2020 from the District Lower Dir of Khyber Pakhtunkhwa.

2.2. Botanical Identification

Plant samples collected throughout the fieldwork were taxonomically identified by using Flora of Pakistan, and placed in the Herbarium of Ghazi Umara Khan Degree College Samarbagh Dir Lower. The voucher specimens were kept after broad documents for future reference. From Medicinal Plant Names Services (mpns.kew.org/mpns) the correct name of plant was confirmed.

2.2. Solvent system used

The solvents like methanol ethanol and water were used. For the preparation of crude extract of the *Verbascum thapsus* and *Micromeria biflora* plants.

2.3. Crude Extract Preparation

Plants and their parts were collected in the field and then transferred into the lab and cleaned with the help of tap water to take away the unwanted constituents and silicate material then were placed for 30 days for dryness purposes in shade at room temperature 20-20°C (Rajiv et al. 2016).

2.5. Crashing and filtration of the plants

After the dryness of the whole plants and their parts with the help of an electric grinder selected plant and their parts were ground. 10 g of plant powdered was taken then retained in a distinct conical flask and 90 ml of solvent i.e. (Methanol, Ethanol, and aqueous) was added to the plants powdered separately. Then with the help of an aluminum file, the Flask was covered and retained in a shaker for 72 hrs. for shaking purposes. After 72 hrs of shaking the extracts were filtered with the help of man filter paper and then through the filtration process plant husk was removed (Ullah et al. 2019).

2.6. Rotary evaporation of the solvents

The extract enclosed organic solvents such as Ethanol, Methanol, and water which were basically the filtrate of the particular plant and their parts. Beneath the control temperature 30°C-35°C They were evaporated with the help of a rotary evaporator (Ullah et al. 2019).

2.7. Crud Extract

After the process of rotary evaporation certain liquid leftovers were further dried at a regulator temperature of 20°C- 25°C through a water bath. Then the plant paste was obtained known as crude extract and then the extract was placed in air-tight bottles (Fatima et al. 2023).

2.7. Phytochemical Detection

The plants extract of *Verbascum thapsus* and *Micromeria biflora* were taken in different types of solvents i.e. Methanol, Ethanol and aqueous and then tasted for the absence or presence of phytochemical constituents like Alkaloids, Tannins, Phlobatannins, Flavonoids, Carbohydrates, Phenols, Saponin and Glycosides (Soni et al. 2011).

2.8. Carbohydrates

The 0.5 ml of filtrate of *Verbascum thapsus* and *Micromeria biflora* was treated with 0.5 ml of Benedict's regent and the solution was heated for 2 minutes in boiling water. Then the presence of carbohydrates was confirmed by the formation of a reddish-brown precipitate (Soni et al. 2011).

2.9. Flavonoids

The alkali substitute test was useful when the extract solution of the selected plants was treated with sodium hydroxide solution. The formation of red precipitation indicates the presence of flavonoids (Soni et al. 2011).

2.10. Phenols

2 ml of ferric chloride ($FeCl_2$) solution was added to 2 ml of *Verbascum thapsus* and *Micromeria biflora*

extracts solution in a test tube. Formations of deep bluish-green solution show the presence of phenol. (Soni et al. 2011).

2.11. Tannins

A ferric chloride test was done for the detection of tannins The Ferric chloride ($FeCl_2$) was assorted with an extract solution. The formation of blue-green coloration indicates the presence of tannins (Soni et al. 2011).

2.12. Saponins

In the test tube, five milliliters of *Verbascum thapsus* and *Micromeria biflora* plant extract were shaken dynamically. When the formation of froth occurred shown the existence of Saponins (Soni et al. 2011).

2.13. Phlobatannins

In the test tube, 0.5-gram powder of the plant extracts remained put after the addition of 2 ml water and shaken for a few minutes then the filtrate was taken and 1% aqueous HCl was added to the filtrate and then boiled in water both. The presence of Phlobatannins is indicated by the formation of a red color (Ullah et al. 2022).

2.15. Glycosides

The 5% Ferric chloride solutions and 1 ml glacial acetic acid were added to five milliliters of plant extract and then further addition of a few drops of concentered sulphuric acid. The presence of glycosides was confirmed through the formation of a greenish-blue color (Zaman et al. 2022).

2.16. Alkaloids

A few drops of Wagner's reagent (Potassium iodine) are added to the two grams of plant extracts. When the formation of a reddish-brown precipitate occurred, it showed the presence of alkaloids (Khandelwal et al. 2015).

2.17. Tests for terpenoids

1ml of *Verbascum thapsus* and *Micromeria biflora* plant extract was assorted with 2ml of chloroform and carefully added concentrated sulphuric acid along the sides of the tube for the formation of a layer. The formation of reddish-brown coloration indicates the presence of terpenoids (Dahiru et al. 2006).

3. RESULTS

3.1. Phytochemical analysis

A qualitative investigation of methanolic ethanolic and aqueous extracts of *Verbascum thapsus* and *Micromeria biflora* was carried out.

3.2. Qualitative Detection of Bioactive Compound Verbascum thapsus Leaves

Qualitative analysis of *Verbascum thapsus* and *Micromeria biflora* was carried out for the detection of Alkaloid, Flavonoids. Carbohydrate, Phlobatannins, Glycosides, Saponins, Phenol, Terpenoids, Tannins. Phytochemical detection of *Verbascum thapsus* plant ethanolic extracts contained a dark colour which shows that Alkaloids are present. Where phenol was present in both methanolic, ethanolic, and aqueous extracts. The saponins in aqueous show dark concentration comparison with ethanolic and methanolic extracts. The flavonoids were present in all three types of extract and Tannins were found in all types of extract in large amounts but in Aqueous found in small amounts. The alkaloids, glycosides, and Phlobatannins are absent in aqueous extract. The data is shown in Table 1. The highest amount of carbohydrates was present in the methanolic extract and low amounts were present in both ethanolic and aqueous extracts. In the ethanolic extracts, the glycosides were found in low amounts. In the methanolic extract, glycosides were present in the highest amount the glycosides were absent in the aqueous extract of the plant. The Flavonoids were present in moderate amounts in both methanolic and ethanolic extract and they were present in low amounts in the aqueous extract. The Phlobatannins were present in moderate amounts in the methanolic extracts low amounts in the ethanolic extracts and absent in the aqueous extracts. The Phenol was founding in all three types of plant extracts i.e. (ethanol, methanol, and Aqueous). The Saponins were present in low amounts in the methanolic, ethanolic, and Aqueous extracts. The highest amounts of Tannins were present in the ethanolic extracts and low amounts of Tannins were found in both ethanolic and aqueous. Moderate amounts of

Terpenoids were present in the methanolic extracts of the *Verbascum thapsus* plants and low amounts of Terpenoids were found both ethanolic and aqueous. The data is stated in the following Table 1.

Table 1: phytochemical detection of *Verbascum thapsus* leaves extracts

SL.NO	Phytochemical test	Methanol	Ethanol	Aqueous
1	Alkaloid	++	+	_
2	Flavonoids	++	+ +	+
2	Carbohydrate	+++	+	+
3	Phlobatannins	++	+	_
5	Glycosides s	+++	+	_
6	Saponins	+	+	+
7	Phenol	+	+ +	+
8	Terpenoids	++	+	+
9	Tannins	++	+++	+

Key: -; Not found, +: Low, ++: Moderate, +++: High

3.2. Qualitative Detection of Bioactive compound in the Verbascum Thapsus stems

Phytochemical detection of rhizome of Verbascum thapsus extract in all the three solvents i.e., ethanolic, methanolic, and aqueous are used which indicates the existence of bioactive compounds except glycosides are not present in aqueous extracts while the dark concentrations indicate the presence of saponins. The qualitative phytochemical detections of the selected plants show that the Carbohydrates, Glycosides, and Tannins were present in the highest amount in ethanolic extracts followed by the methanolic extracts. The qualitative phytochemistry also shows that the Carbohydrates and glycosides were found in the highest amount in the plant extracts and the other phytochemicals such as Alkaloids, Flavonoids, and Phenol were present in moderate amounts. The Alkaloid, Carbohydrate, Glycosides, Phlobatannins, Saponins, Terpenoids. The Alkaloids, Glycosides, and Phlobatannins were absent in Aqueous extracts. The concentration of alkaloids was highest in the methanolic extracts and present in low amounts in the ethanolic extracts and the alkaloids were absent in the Aqueous extracts. The flavonoids were present in all types of extracts i.e. (methanol, ethanol, and Aqueous). Glycosides and Phlobatannins were present in the highest amount in the methanolic extract and moderate amounts in the ethanolic extracts and these both are absent in the Aqueous extracts of the P*. ceritica* plants. The Phenol is present in moderate amounts in the methanolic extracts and the amounts in methanolic extracts and Aqueous extracts. The saponins were present in low quantities in the *P. ceritica* plant. The phytochemical Tannins were found in the highest amounts in the ethanolic extracts and moderate amounts in methanolic and Aqueous extracts. The Alkaloids, Terpenoids, Tannin, and Flavonoids are present in moderate amounts in the methanolic extracts. The data is stated in the following Table 2.

Table 2: Phytochemical detection of *Verbascum thapsus* stem

SL.NO.	Phytochemical test	Methanol	Ethanol	Aqueous
1	Alkaloid	++	+	_
2	Flavonoids	++	+ +	+
2	Carbohydrate	+++	+	+
3	Phlobatannins	++	+	_
5	Glycosides	+++	+	_
6	Saponins	+	+	+
7	Phenol	+	+ +	+
8	Terpenoids	++	+	+
9	Tannins	++	+++	+

Key: -; Not found, +; Low, ++; Moderate, +++; High

3.5. Qualitative Detection of Bioactive Compound Verbascum thapsus Roots

Phytochemical detection of roots of *Verbascum thapsus* in all three solvents i.e., ethanolic, methanolic, and aqueous are used which indicated the existence of bioactive compound except glycosides are not present in aqueous extracts while the dark concentrations indicate the presence of saponins. The qualitative phytochemical detections of the selected plants show that the Carbohydrates, Glycosides, and Tannins were present in the highest amount in ethanolic extracts followed by the methanolic extracts. The qualitative phytochemistry also shows that the Carbohydrates and glycosides, were found in the highest amount in the plant extracts and the other phytochemicals such as Alkaloids, Flavonoids, and Phenol were present in moderate amounts.

The Alkaloid, Carbohydrate, Glycosides, Phlobatannins, Saponins, Terpenoids. The Alkaloids, Glycosides, Phlobatannins, were absent in Aqueous extracts. The concentration of alkaloids was highest in the methanolic extracts and present in low amounts in the ethanolic extracts and the alkaloids were absent in the Aqueous extracts. Glycosides and Phlobatannins were present in the highest amount in the methanolic extract and moderate amounts in the ethanolic extracts and these both are absent in the Aqueous extracts of the Verbascum Thapsus plants. The Phenol is present in moderate amounts in the methanolic extracts and the amounts in methanolic extracts and Aqueous extracts. The saponins were present in low quantities in the Verbascum Thapsus plant. The phytochemical Tannins were found in the highest amounts in the ethanolic extracts and moderate amounts in methanolic and Aqueous extracts. The Alkaloids, Terpenoids, tannins, and Flavonoids are present in moderate amounts in the methanolic extracts. The data is stated in the following Table 3.

Table 3: Phytochemical Investigation of *Verbascum thapsus* Root Extracts

SL.NO	Phytochemical test	Methanol	Ethanol	Aqueous
1	Alkaloid	++	+	_
2	Flavonoids	++	+ +	+
2	Carbohydrate	+++	+	+
3	Phlobatannins	++	+	_
5	Glycosides s	+++	+	_
6	Saponins	+	+	+
7	Phenol	+	+ +	+
8	Terpenoids	++	+	+
9	Tannins	++	+++	+

Key: -; Not found, +; Low, ++; Moderate, +++; High

3.6. Qualitative Detection of Bioactive compound Micromeria biflora leaves

The highest amount of carbohydrates was present in the methanolic extract and low amounts were present in both ethanolic and aqueous extracts. In the ethanolic extracts, the glycosides were found in low amounts. In the methanolic extract, glycosides were present in the highest amount the glycosides were absent in the aqueous extract of the plant. The Flavonoids were present in moderate amounts both methanolic and ethanolic extract and they were present in low amounts in the aqueous extract. The Phlobatannins were present in moderate amounts in the methanolic extracts low amounts in the ethanolic extracts and absent in the aqueous extracts. The Phenol was found in all three types of plant extracts i.e. (ethanol, methanol, and Aqueous). The alkaloids, Glycosides, and Phlobatannins were absent in Aqueous extracts. The concentration of alkaloids was highest in the methanolic extracts and present in low amounts in the ethanolic extracts and the alkaloids were absent in the Aqueous extracts. Glycosides and Phlobatannins were present in the highest amounts in the methanolic extract and moderate amounts in the ethanolic extracts and these both are absent in the Aqueous extracts of the *Micromeria biflora* plants. The data are shown in Table 4.

3.7. *Qualitative Detection of Bioactive compound Micromeria biflora Stem*

The qualitative phytochemical detections of the selected plants shows that the Carbohydrate, Glycosides, Tannins were present in highest amount in ethanolic extracts and followed by the methanolic extracts. The qualitative phytochemistry also shows that the Carbohydrate, Glycosides, were found in highest amount in the plants extracts and the other phytochemical such as Alkaloid, Flavonoids and Phenol were present in moderate's amount. The Alkaloid, Carbohydrate, Glycosides, Phlobatannins, Saponins, Terpenoids. The Alkaloid, Glycosides, Phlobatannins, were absent in Aqueous extracts. The Saponins were present in low amounts in the methanolic, ethanolic, and Aqueous extracts. The highest amounts of Tannins were present in the ethanolic extracts and low amounts of Tannins were found in both ethanolic and aqueous. Moderate amounts of Terpenoids were present in the methanolic extracts of the *Micromeria biflora* plants and low amounts of Terpenoids were found both ethanolic and aqueous. The data are shown in Table 5.

Table 4: Phytochemical Investigation of *Micromeria biflora* Leaves Extracts

SL.NO	Phytochemical Test	Methanol	Ethanol	Aqueous
1	Alkaloid	++	+	_
2	Flavonoids	++	+ +	+
2	Carbohydrate	+++	+	+
3	Phlobatannins	++	+	_
5	Glycosides s	+++	+	_
6	Saponins	+	+	+
7	Phenol	+	+ +	+
8	Terpenoids	++	+	+
9	Tannins	++	+++	+

Key: -; Not found, +; Low, ++; Moderate, +++; High

Table 5: Phytochemical Investigation *Micromeria biflora* Stem Extracts

SL.NO	Phytochemical test	Methanol	Ethanol	Aqueous
1	Alkaloid	++	+	_
2	Flavonoids	++	+ +	+
2	Carbohydrate	+++	+	+
3	Phlobatannins	++	+	_
5	Glycosides s	+++	+	_
6	Saponins	+	+	+
7	Phenol	+	+ +	+
8	Terpenoids	++	+	+
9	Tannins	++	+++	+

Key: -; Not found, +; Low, ++; Moderate, +++; High

3.8. Qualitative Detection of Bioactive compound *Micromeria biflora* Roots

Phytochemical detection of *Micromeria biflora* plant ethanolic extracts contained dark colour which shows that Alkaloids are present. Where phenol was present in both methanolic, ethanolic and aqueous extracts. The saponins in aqueous show dark concentration comparison with ethanolic and methanolic extracts. Where the flavonoids were present in all three types of extract and Tannins were found in all types of extract in large amount but in Aqueous found in small amounts. The alkaloid, glycosides, and Phlobatannins are absent in aqueous extract. The flavonoids were present in all types of extracts i.e. (methanol, ethanol and Aqueous). Glycosides and Phlobatannins were present in highest amount in the methanolic extract and moderates amounts in the ethanolic extracts and these both are absent in the Aqueous extracts of the

Micromeria biflora plants. The Phenol is present in moderates amounts in the methanolic extracts and the amounts in methanolic extracts and Aqueous extracts. The data are shown in Table 6.

In the current study ethno-botanical importance plant of Munda Khazana District is lower Dir an overall of 50 valuable plants assembled from the research region. These plants belong to different families. The dominant valuable plants and the bases of habit were herbs (22 species) followed by shrubs (8 species) and trees (10 plant species,). Complete details of the plant, local name, botanical name, habit, family, components of plant use, and ethnobotanical utilizations are as follows.

Table 6: Phytochemical Investigation *Micromeria biflora* Roots Extracts

SL.NO	Phytochemical test	Methanol	Ethanol	Aqueous
1	Alkaloid	++	+	_
2	Flavonoids	++	+ +	+
2	Carbohydrate	+++	+	+
3	Phlobatannins	++	+	_
5	Glycosides	+++	+	_
6	Saponins	+	+	+
7	Phenol	+	+ +	+
8	Terpenoids	++	+	+
9	Tannins	++	+++	+

Key: -; Not found, +; Low, ++; Moderate, +++; High

Plant No: 1
Botanical name: *Ajuga parviflora* Benth
Family: Lamiaceae
Local name: Kauri Booti
Habit: Shrub
Part used: Leaves
Medicinal uses: Used in curing pimples, pimples, headache, stomach acidity and pimples.

Plant No: 2
Botanical name: *Amaranthus virdis* L.
Family: Amaranthaceae
Local name: Chorlai
Habit: Herb
Part used: Leaves
Medicinal uses: For Diuretic, lithasis, headache swelling, and used food and fooder.

Plant No: 3
Botanical name: Cannabis sativa L.
Family: Canabaceae
Local name: Bhang
Habit: Shrub
Part used: Seeds, leaves
Ethnobotanical uses: pleasant excitement and astringent.

Plant No: 4
Botanical name: *Sisymbrium irio* L.
Family: Brassicaceae
Local name: Genger
Habit: Shrub
Part used: Seeds
Medicinal uses: Seeds are used in dropsy.

Plant No: 5
Botanical name: Chenopodium album L.
Family: Chenopdiaceae
Local name: Sarmay
Habit: Shrub
Part used: Seeds, leaves and roots
Medicinal uses: Use as fodder, urinary problem, and worm killer.

Plant No: 6
Botanical name: *Convolvulus arvensis* L.
Family: Convolvulaceae
Local name: Perwathy.
Habit: Herb
Part used: Whole plant
Medicinal uses: For fuel young plants are grazed by the cattle and skin disorders.

Plant No: 7
Botanical name: *Fumaria indica* (Husskn.) H.N. Pugsley
Family: Fumariaceae
Local name: Shahtra
Habit: Herb

Part used: Whole plant
Medicinal uses: It is used as fodder as well as fuel. Shoots are also used in diarrhea, blood purifier, and fever.

Plant No: 8
Botanical name: *Morus alba* L.
Family: Moraceae
Local name: Spen Toot
Habit: Tree
Part used: Root, leaves
Medicinal uses: Fruits are edible and wood is used for furniture as well as for the treatment of throat infection.

Plant No: 9
Botanical name: *Ricinus communis* L.
Family: Euphorbiaceae
Local name: Arhanda
Habit: Tree
Part used: Whole plant
Medicinal uses: Leaves are purgative, poisonous and narcotic.

Plant No: 10
Botanical name: *Solanum nigrum* L.
Family: Solanaceae
Local name: Kaach Maacho
Habit: Shrub
Part used: Fruits and leaves
Medicinal uses: younger leaves as used for curing fever and flue cough. Dehydrated fruits are utilized for stomach ailments.

Plant No: 11
Botanical name: *Withania somnifera* (L.) Dunnel.
Family: Solanaceae
Local name: Kotilal
Habit: Shrub
Part used: Roots
Medicinal uses: Root paste is applied in painful swellings, bleeding wounds as well as ulcers and as well used for cure of asthma.

Plant No: 12
Botanical name: Phoenix dactylifera L.
Family: Arecaceae
Local name: Khajoor
Habit: Tree
Parts used: Fruit
Medicinal uses: It is used as an aphrodisiac and tonic.

Plant No: 13
Botanical name: *Calotropis procera* (Willd.) R. Br.
Family: Asclepiadaceae
Local name: Spulmay
Habit: Shrub
Parts used: Leaves, flowers, latex
Medicinal uses: Remove Intestinal pain, inflammation and respiratory disease.

Plant No: 14
Botanical name: *Brasica compestris* L.
Family: Brassicaceae
Local name: Sharrsham
Habit: Shrub
Parts used: Leaves,
Medicinal uses: Used as food and fodder. Beautification skin disease, Asthma and cough disease.

Plant No: 15
Botanical name: *Dalbergia sissoo* Roxb.
Family: Fabaceae
Local name: Shawa
Habit: Tree
Parts used: Whole plant
Medicinal uses: Use for fuel and fodder.

Plant No: 16
Botanical name: Melia azedirach L.
Family: Meliaceae.
Local name: Toora shandai
Habit: Tree
Parts used: Leave, fruit
Medicinal uses: Leaf extract is employed for antimicrobial agent,blood purification aswell as used for animal food.

Plant No: 17
Botanical name: *Acacia nilotica* (L.) Deliled.
Family: Mimosaceae
Local name: kikar
Habit: Tree
Parts used: Fruit and seeds
Medicinal uses: Used for fuel as well as fodder.

Plant No: 18
Botanical name: *Morus nigra* L.
Family: Moraceae
Local name: Toor Tooth
Habit: Tree
Parts used: Leaves, fruit
Medicinal uses: Used for cooling agent, astringent and cleaning throat.

Plant No: 19
Botanical name: *Eucalyptus camaldulensis* Dehnh.
Family: Myrtaceae
Local name: Lachi
Habit: Tree
Parts used: Leaves
Medicinal uses: Leaves are used to prepaire Joshanda to relieve flu. Leaves are used to cure Diarrhea.

Plant No: 20
Botanical name: *Psidium guajava* L.
Family: Myrtaceae
Local name: Amrood
Habit: Tree
Parts used: Leaves and fruit
Medicinal uses: Used as a tonic. It is also useful to expel abdominal worms.

Plant No: 21
Botanical name: *Cynodon dactylon* (L.) Pers.
Family: Poaceae
Local name: Kabal
Habit: Herb
Parts used: Root, leaves
Medicinal uses: Used for animal and also use for cough, dysentery and stones.

Plant No: 22
Botanical name: *Citrus sinensis* (L.) Osbeck
Family: Rotaceae
Local name: Malta
Habit: Tree
Parts used: Fruit
Medicinal uses: It is used for appetizer along with tonic and also given to the constipating patients.

Plant No: 23
Botanical name: *Datura alba* Nees
Family: Solanaceae
Local name: Dhatura
Habit: Shrub
Parts used: Whole plant,
Medicinal uses: Leaves are smoked to cure asthma.

Plant No: 24
Botanical name: *Vitis vinifera* L
Family: Vitaceae
Local name: Angoor
Habit: Shrub
Parts used: Fruit
Medicinal uses: Fruit is used like a common tonic and laxative.

Plant no.: 25
Botanical name: *Ocimum basilicum* L.
Family name: Lamiaceae
Local name: Kashmally
Habit: Herb
Part used: Leaves and flower
Medicinal uses: Used as a food, shelter and fodder, Antioxidant's skin and antipyretic disease.

Plant no: 26
Botanical name: *Nerium odurum* L.
Family name: Apocynaceae
Local name: Gandhery
Habit: Herb
Part used: Roots and bark
Medicinal uses: Use for fodder beatification, shelter Asthma and heart attack.

Plant no.: 27
Botanical name: *Plantago lanceolate* L.
Family name: Plantaginaceae
Local name: Ghwa jabbi
Habit: Herb
Part used: Whole plant
Medicinal uses: Respiratory, skin, insect and infection.

Plant no.: 28
Botanical name: *Debregeasia saneb* F.
Family: Urticaceae.
Local Name: Karwarra.
Habit: Shrub
Parts used: Fruits leaves.
Medicinal uses: Used as a fruit fodder, fuel and used for blood purification, and stomach.

Plant no.: 29
Botanical name: Sunchus aspera L
Family name: Asreraceae
Local name: Shoda pii
Habit: Herb
Part used: Whole plant
Medicinal uses: Used as food for farm animals.

Plant no.: 30
Botanical name: *Trifolium vesipinatum* L.
Family name: Fabaceae
Local name: Shaftal
Habit: Herb
Part used: Whole plant
Medicinal uses: It is used as food for farm animals. The seeds utilized for pimples.

Plant no.: 31
Botanical name: *Populus alba* L.
Family na33e: Salicaceae
Local name: Sufedad
Habit: Tree
Part used: Whole plant
Medicinal uses: Used like a fodder, timber, fuel and furniture.

Plant no.: 32
Botanical name: *Narcissus Poeticus* L.
Family name: Amayrlidaceae
Local name: Goli Nargas
Habit: Herb
Part used: Flowers
Medicinal uses: It is used for ornamental purposes.

Plant no.: 33
Botanical name: *Diospyros kaki* L.
Family name: Ebenaceae
Local name: Amlook
Habit: Tree
Part used: Fruit
Medicinal uses: Fruit is suitable for eating; Leaves are utilized as food and fuel.

Plant no.: 34
Botanical name: *Galium aparine* L.
Family: Rubiaceae
Local name: Jalakai
Habit: Herb
Part use: Whole plant.
Medicinal uses: Used as Antidiuretic.

Plant No: 35
Botanical Name: *Allium sativa* L
Family: Amaryllidaceae
Local Name: Ouaga
Habit: Herb
Parts used: Whole plant.
Medicinal Uses: Use as a food. Arteries, high blood pressure and heart diseases.

Plant no: 36
Botanical name: *Morus lavaegata* Wall. ex Brandis
Family name: Moraceae
Local name: Shah toot
Habit: Tree
Part used: Whole plant
Medicinal uses: Fruit is edible. Leaves are utilized as food for farm animals.

Plant no.: 37
Botanical name: *Ficus carica* L.
Family name: Moraceae
Local name: Inzar
Habit: Tree
Part used: Fruit and leaves
Medicinal uses: It is use as fuel and fodder for the shelter. Diabetic, migraine, diarrhea

Plant no.: 38
Botanical Name: *Verbascum thapsus* L.
Family: Scrophulariaceae.
Local Name: Khurdug.
Habit: Herb
Parts used: Flower leaves.
Medicinal Uses: Fruits, fuel, shelter. Tuberculosis, cough, asthma.

Plant no.: 39
Botanical name: *Mentha longifulia* (L.) L.
Family name: Labiateae
Local name: Enally
Habit: Herb
Part used: Leaves
Medicinal uses: It is used to relieve abdominal pain and reduce gastric acidity.

Plant no.: 40
Botanical name: Monotheca buxifolia (Falc.) A. DC.
Family name: Sapotaceae.
Local name: Gurgora
Habit: Tree
Part used: Whole plant
Medicinal uses: The plant is grazing through animals and the fruits are used human food. It is also used for curing Asthma and antipyretic.

Plant no.: 41
Botanical name: *Myrtus communis* L.
Family name: Moraceae
Local name: Manrro
Habit: Shrub
Part used: Fruit and leaves
Medicinal uses: It is used as fodders. It is also practices to cured animal respiratory and digestive disorder.

Plant no.: 42
Botanical Name: *Xanthium strumarium* L.
Family: Asteraceae.
Local Name: Geeshy.
Habit: Herb

Parts used: Whole Plant.
Medicinal Uses: Used as fodder, tonic, fuel and in digestive problems.

Plant no: 43
Botanical Name: *Zizyphus Jujube* Mill.
Family: Rhamaceae
Local Name: Berra
Habit: Tree
Parts used: Whole plant
Medicinal Uses: It is used as food, fuel, Shelter and also for skin disease.

Plant no: 44
Botanical name: *Cedrus deodara* (Roxb. ex D.Don) G.Don
Family name: Pinaceae
Local name: Diyar
Habit: Tree
Part used: Whole plant
Medicinal uses: It is used as a food as well as for the treatment of Dysentery, Diarrhea and Urinary problems.

Plant no: 45
Botanical Name: *Coriandrium sativum* L.
Family: Apiaceae
Local Name: Dania
Habit: Herb
Parts used: Leaves, Fruit.
Medicinal Uses: Used as food and fodder and Skin disease, Asthma, blood purifier, cardiac and respiratory disease.

Plant No: 46
Botanical Name: *Deutura innoxia* Mill.
Family: Solanaceae
Local Name: Batura
Habit: Herb
Parts used: Whole plant.
Medicinal Uses: Fuel and shelter, Tonic, Dysentery and diabetic disease.

Plant no: 47
Botanical Name: *Papaver somniferum* L.
Family: Papaveraceae.
Local Name: Doda, kash.
Habit: Shrub
Parts used: Seeds, latex.
Medicinal Uses: Used as fodder, and fuel and also utilized for Dysentery and diarrhea.

Plant no: 48
Botanical name: Medacago denticulate Willd.
Family name: Fabaceae
Local name: Feshtary
Habit: Herb
Part used: Leaves
Medicinal uses: Used as food and for sugar control.

Plant no: 49
Botanical name: Malva neglacta Wallr
Family name: Malvaceae
Local name: Panerak
Habit: Herb
Part used: Leaves
Medicinal uses: Food and pain.

Plant no: 50
Botanical name: *Teraxicum officinale* (L.)
Family name: Asteraceae
Local name: Zyarr guly
Habit: Herb
Part used: Roots
Medicinal uses: Roots are used in diabetes and for kidney problems.

3. DISCUSSION

In the present study qualitative investigation of methanolic ethanolic and aqueous extracts of *Verbascum thapsus* and *Micromeria biflora* was carried out. Phytochemical detection of *Verbascum thapsus* plant ethanolic extracts in leaves contained a dark colour which shows that Alkaloids are present. Where phenol was present in both methanolic, ethanolic, and aqueous extracts. The saponins in aqueous show dark concentration comparison with ethanolic and methanolic extracts. The flavonoids were present in all three types of extract and Tannins were found in all types of extract in large amounts but in aqueous found in small amounts. The alkaloids, glycosides, and Phlobatannins are absent in aqueous extract. The Flavonoids were present in moderate amounts in both methanolic and ethanolic extract in leaves and they were present in low amounts in the aqueous extract. The Phlobatannins were present in moderate amounts in the methanolic extracts low amounts in the ethanolic extracts of *Verbascum thapsus* and absent in the aqueous extracts. Tannins were present in the highest amount in ethanolic extracts followed by the methanolic extracts. The qualitative phytochemistry also shows that the Carbohydrates and glycosides, were found in the highest amount in the plant extracts and the

other phytochemicals such as Alkaloids, Flavonoids, and Phenol were present in moderate amount. The Alkaloid, Carbohydrate, Glycosides, Phlobatannins, Saponins, Terpenoids. The Alkaloid, Glycosides, Phlobatannins, were absent in the Aqueous extracts of *Verbascum thapsus*. The concentration of alkaloid was highest in the methanolic extracts and present in low amounts in the ethanolic extracts and the alkaloid were absent in the Aqueous extracts. Qualitative detection of bioactive compound *Verbascum thapsus* Roots in all the three solvents i.e., ethanolic, methanolic and aqueous are used which indicates the existence of bioactive compounds except glycosides are not present in aqueous extracts while the dark concentrations indicate the presence of saponins. The highest amount of carbohydrates was present in the methanolic extract of *Micromeria biflora* leaves and a low amount was present in both ethanolic and aqueous extracts of roots and stem of *Micromeria biflora*. In the ethanolic extracts, the glycosides were found in low amounts. In the methanolic extract, glycosides were present in the highest amount the glycosides were absent in the aqueous extract of the plant. The Flavonoids were present in moderate amounts in both methanolic and ethanolic extract and they were present in low amounts in the aqueous extract. The Phlobatannins were present in moderate amounts in the methanolic extracts low amounts in the ethanolic extracts and absent in the aqueous extracts.

A wide variety of pharmacological activities are shown by different phytochemicals, which may help in protection against chronic diseases. Tannins, flavonoids, saponins, glycosides, and amino acids have anti-inflammatory and hypoglycemic activities. Steroids and terpenoids show central nervous system (CNS) activities and analgesic properties. Because of their antimicrobial activity saponins are involved in plant defense systems (Ayoola et al. 2008). These phytochemicals showed antimicrobial activity through different mechanisms. With proline-rich proteins, tannins have been found to form irreversible complexes (Shimada, 2006) resulting in the inhibition of cell protein synthesis. (Parekh and Chanda, 2007) reported that tannins are known to react with proteins to deliver the typical tanning effect which is essential for the treatment of ulcerated or inflamed tissues. Herbs that have tannins as their key components are astringent in nature and are used for treating intestinal disorders such as dysentery and diarrhea (Dharmananda, 2002). Tannins and their derivatives are phenolic compounds considered to be primary antioxidants or free radical scavengers (Khan et al. 2018). These observations therefore support the use of *Verbascum thapsus* and *Micromeria biflora* in herbal cure remedies, thus suggesting that *Verbascum thapsus* and *Micromeria biflora* has potential as a source of important bioactive molecules for the treatment and prevention of cancer. The presence of tannins in *Verbascum thapsus* and *Micromeria biflora* supports the traditional Medicinal use of this plant in the treatment of different ailments. Alkaloid was another phytochemical constituent observed in the extract of *Verbascum thapsus* and *Micromeria biflora*. One of the most common biological properties of alkaloids is their toxicity against cells of foreign organisms. These activities have been widely studied for their potential use in the reduction and elimination of human cancer cell lines (Nobori, et al. 1993). One of the largest groups of phytochemicals is alkaloids in plants which have amazing effects on humans and this has led to the development of powerful pain killer medications (Kam and Liew, 2002). Shown the inhibitory effect of saponins on inflamed cells. Saponin was found to be present in *Verbascum thapsus* and *Micromeria biflora* extracts and has supported the usefulness of this plant in managing inflammation. Flavonoids, other phytochemicals show a varied range of biological activities like anti-inflammatory, antimicrobial, analgesic, anti-angionic, cytostatic, antioxidant, and anti-allergic properties (Hodek et al. 2002).

4. CONCLUSION

The local area (Dir Lower) is rich in medicinal plants and can be used for curing different diseases instead of using imported medicines. The extraction of different chemicals from the local plants can also be done to support Pakistan's health issues and economy. Indigenous knowledge regarding medicinal plant collection and its proper mode of administration should be collected from the local people and preserved properly. It is suggested here that this could be done through different stockholders i.e., government, research organizations NGOs, etc. The phytochemical analysis of medicinal plants is also important and has a commercial interest in both pharmaceutical companies and research institutes for the formation of new medicines for the treatment of several diseases. Thus, we hope that the important phytochemical properties identified by our study in the local plant of

War affected area of Bajaur agency, Pakistan will be helpful in the copping different diseases of this particular region.

Founding Source

There is no funding source for the students to do it by themselves.

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Flora Diversity, Phytosociology and Distribution Pattern of the Woody Vegetation and Its Relation to Soil Types, in Kalogi District, Nuba Mountains, Sudan

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ABSTRACT

The work is documents the findings of ecological parameters, which have been carried out in the low rainfall woodland savanna of the Nuba Mountains, Sudan. Filling the information gap on the woody vegetation along different habitats in Kalogi district. The vegetation sampling and data analysis were done following standard procedures. Fourty five plant species belonging to 29 genera and 14 families have been documented. The most common plant species based on the importance value index are Dichrostachys cinerea (IVI-98), Vachellia seyal (IVI-28) and Balanites aegyptiaca (IVI-25) respectively in dark cracking clay soil habitat. On the other hand the most common species on GARDOUD soil habitats are Hyphaene thebaica (IVI-37), followed by Balanites aegyptiaca (IVI-35), Combretum hartmannianum (IVI-23), Vachellia oerfota (IVI-20) and Albizia amara (IVI-16) respectively. Fabaceae is found to be the most dominant family. The distribution pattern revealed that 95.6% of species showed contiguous distribution, while 4.4% were randomly distributed. GARDOUD habitats showed the highest values of species richness and diversity indices as flow: richness of 39 species, Shannon-Wiener's (H') (2.77), Pielou index (E) (.076), Simpson index (D) (0.9), Margalef index (M) (5.9).

INTRODUCTION

Nuba Mountains describes a mountainous region approximately 10° to 12° N, and 29° to 31° E, surrounded by plains. It is also a region that, for the most part, lies in the federal state of South Kordofan (Ille, 2015). Nuba Mountains can be classified as one of the richest and most diversified regions in terms of vegetation cover components, beside Jebel Merra in Darfur, Jebel ElDair in North Kordofan, Ingassana Hills in the Blue Nile, and Red sea hills in the Red Sea.

Kalogi district is where is study is conducted and is located in Gadeer locality which is one of the 16 localities of South Kordofan State.

The study of plant communities and their classification is termed phytosociology (Mishra et al. 2012; Ahmad and Shaukat, 2012). Phytosociology is useful to describe the population dynamics of each plant species occurring in a particular community and to understand how they relate to the other species in the same community (Mishra et al. 2012).

The Convention on Biological Diversity (1992) defined Biodiversity as "the variability among living organisms from all sources including inter alia, terrestrial, marine and other aquatic ecosystems, and the ecological complexes of which they are part; this

includes diversity within species, between species, and of ecosystems.

Species richness refers to the number of species in a particular area, whereas species diversity refers to a combination of richness and relative abundance (Newton, 2007). A comprehensive review of the methods used for estimating both of these variables is provided by Magurran (2004).

Lack of information on both taxonomical and ecological regarding the woody vegetation of the Kalogi district, besides the climatic changes during the last decades, which may change the floristic composition, encouraged to conduct of this study. The area is considered one of the most important sources of diversified timber and non-timber forest products to the Sudanese markets.

This study aimed to fill the information gap on the woody vegetation along different habitats in the Kalogi district. Furthermore, we expect to have more Comprehensive and detailed information about these native woody vegetation regarding floristic and ecological aspects.

MATERIAL AND METHODS

Study area

The study area is located in the Gadeer locality of Nuba Mountains, South Kordofan. the study area extends from Umdiheileeb village (11° 2'41.56"N, 30°59'7.03" E) in the north to Morong village (10°33'29.60"N, 31° 5'36.12" E) in South and from Tosi village (10°51'50.22" N, 30°49'48.10" E) in the western direction to Gadeer village (10°49'40.02" N, 31° 7'51.11" E) in the east. The vegetation of the area of this study was classified according to (Harrison and Jackson, 1958) as special areas of low rainfall woodland savanna.

Data collection

Systematic sampling has been carried out with 56 circular plots of 01 ha. covering different sites during the period from Nov.-Dec. 2019. In each plot, all woody plants and individual numbers of each have been recorded. According to soil types, the vegetation of the study area was divided into two vegetation communities are: vegetation of dark cracking clay soil and vegetation of GARDOUD soil.

Data analysis

Phytosociology analysis

Phytosociological analysis was conducted for the woody vegetation of the Kalogi district. The density, frequency, and abundance of each species were measured and values were converted to their relative values to obtain the Importance value index (IVI) (Curtis, 1959).

The distribution pattern of the woody species was calculated as abundance/frequency ratio (A/F) as suggested by Whitford (1949) as a measure of contiguousness. The ratio indicates regular (< 0.025), random (0.025 – 0.05), and contiguous (> 0.05) distributions (Curtis and Cottam, 1956).

Diversity indices

Species diversity, equitability and concentration of dominance was computed by using Shannon-Weaver (1949), (Pielou, 1966) and Simpson indices (1949), respectively. Species richness was obtained as a number of species an calculating Margalef's Index (1968). Similarity between habitats was obtained by using the Jaccard index (Jaccard, 1912).

Past 3 packages have been used for data analysis to obtain alpha diversity indices and the Biodiversity pro 2 package used for calculating the Jaccard index and past 3 packages have been used for data analysis.

RESULTS AND DISCUSSION

Floristic composition

In this study, a total of 45 woody species belonging to 29 genera and 14 families were sampled. The most represented family was Fabaceae with 15 species followed by Malvaceae 6 and Anacardiaceae, Combretaceae with 5 species for each. Fabaceae is considered as one the dominant and most important families in Sudan (Table 1), it is also recorded as a dominant family in different studies (Ismail and ElSheikh, 2016; Ismail, 2020a; Ismail, 2020b).

Phytosociology analysis

Density and frequency

A total of 38 tree species were sampled in gardoud soil habitats. The absolute density of total woody

plant species in GARDOUD habitats was 248.1 stem/ha. The highest relative density was recorded by *Hyphaene thebaica* (19%) which is frequent in 30% of sampled plots and *Balanites aegyptiaca* (19%) which is frequent in 53.8% of sampled plots followed by *Combretum hartmannianum* (11%) which frequent in 46.2% of sampled plots (Table 1).

A total of 30 tree species were recorded from habitats of dark-cracking clay soil. The absolute density of total woody plant species in dark-cracking clay soil habitats was 510.1 stem/ha.

The highest relative density was recorded by *Dichrostachys cinerea* (56%) which frequent in 75% of sampled plots followed by *Vachellia seyal* (11%) which frequent in 46% of sampled plots and Balanites aegyptiaca (7.9%) which frequent in 64% of sampled plots (Table 1).

Dominance

The most dominant species in dark cracking clay soil habitat was Dichrostachys cinerea with IVI (98), followed by Vachellia seyal (28), Balanites aegyptiaca (25), *Senegalia senegal* (22) and *Combretum hartmannianum* (16) (Figure 2). While the dominant species in GARDOUD soil habitat was *Hyphaene thebaica* with IVI (37), followed by *Balanites aegyptiaca* (35), *Combretum hartmannianum* (23), *Vachellia oerfota* (20) and *Albizia amara* (16) (Figure 3).

It's clear that *Dichrostachys cinerea* dominated species with the highest value of IVI; this may be due to the suitability of dark cracking clay soil habitat to the requirements of this species, in addition to the fruits and leaves of this species is considered as one of the most important source of fodder for animals during the dry season. This area where species is dominant is considered one of the most important routes of seasonal migration of animals that feed by its fruits, and therefore animals play an important role in spreading their seeds all over the area.

From the results we found that *Balanites aegyptiaca* and *Combretum hartmannianum* listed with dominant species of both habitats, this assures its ability to live in diversified habitats.

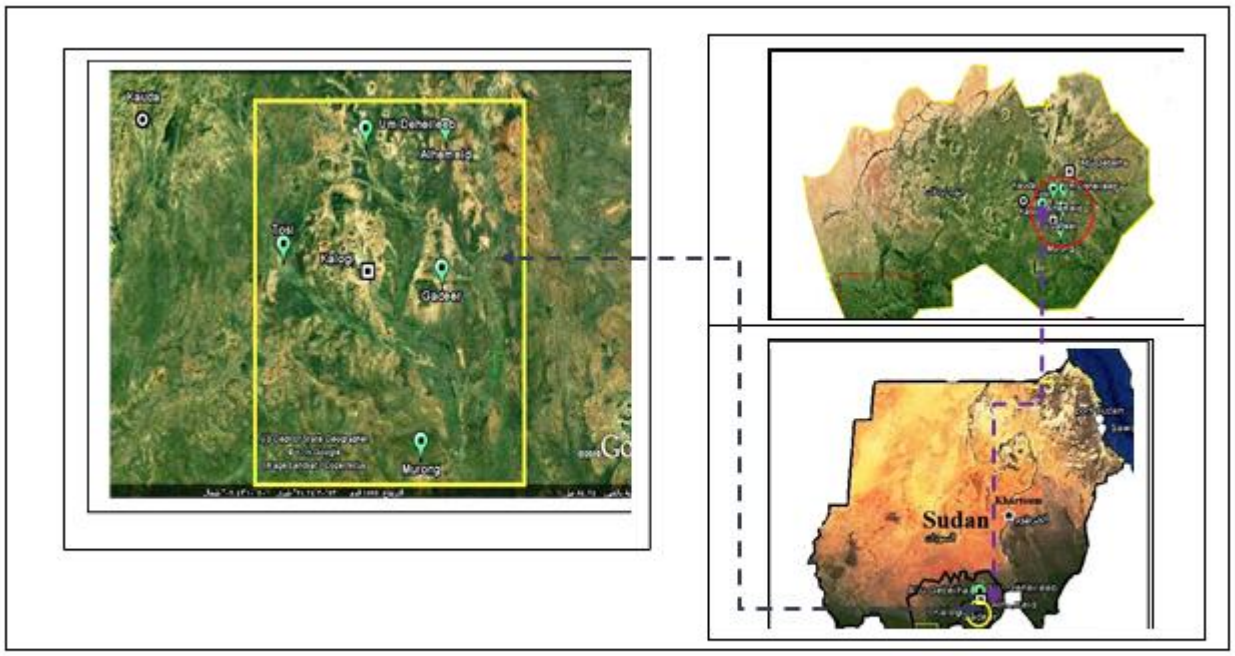

Figure 1. Map of the study area.

***Source**: Google earth 2010.*

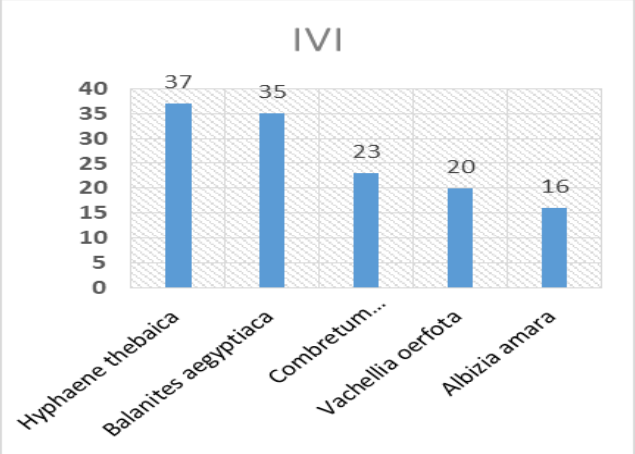

Figure 2: Dominant woody species of GARDOUD soil.

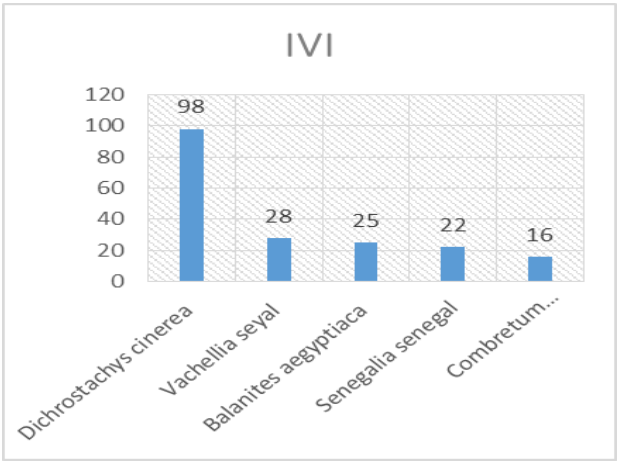

Figure 3: Dominant woody species of soil dark cracking clay habitats

Distribution pattern

Among the studied habitats, distribution pattern of all woody species was contiguous (95.6%) except *Terminalia leiocarpa* and *Combretum aculeatum* were random (4.4%) and no species showed a regular pattern. 15 (34.0%) of the species of contiguous pattern were distributed only in the GARDOUD soil habitat and 5 species (11.6%) were distributed only in dark cracking clay soil habitat, while 23 species (53.5%) of contiguous pattern and the two species of random pattern were distributed in both the two habitats (Table 1).

From the results, it's clear that a contiguous distribution pattern was recorded for the majority of species followed by only two species that showed a random pattern. There was no record of a regular distribution pattern, this may attributed to the absence of severe competition among species; this agreed with the fact that stated by Odum (1971) contiguous pattern of distribution is common in nature, random distribution is found only in very uniform environment and regular distribution occurs where severe competition exists between individuals.

Diversity Analysis

In the study area, species richness and diversity was found higher in GARDOUD soil habitat as compared to Dark cracking clay soil habitat of study area. GARDOUD soil habitat showed higher values in all diversity indices as follow, Shannon-Wiener's (H') (2.77), Pielou index (E) (.076), Simpson index (D) (0.9), Margalef index (M) (5.9) and richness of 39 species (Figure 2); while habitat of Dark cracking clay soil

showed lower values in all diversity indices as follow, Shannon-Wiener's (H') (1.76), Pielou index (E) (.0.52), Simpson index (D) (0.66), Margalef index (M) (3.99) and richness of 30 species (Figure 4). The lowest values of diversity indices may be attributed to intensive human activities such as the continuous expansion of mechanized and shifting agricultural activities in high fertile and productive dark-cracking clay soil; whereas GARDOUD soil rarely be cultivated by seasonal crops. The values of diversity indices in dark cracking soil habitat were relatively low due to the dominance of Dichrostachys cinerea with the largest value of IVI, exceeding the values of all species studied, a similar case was stated by Ismail and Alawad (2017). The low evenness value indicates the dominance of the environment by a few species (Van Breugel et al. 2007).

Similarity

The similarity of species between the two studied habitats is illustrated in Figure 5. revealed that 53.3% of the woody species were shared between the two habitats. This may due to the suitability of the habitats to the requirements of these species. *Balanities aegyptiaca* and *Combretum hartmannianum* can be considered as the most important species in the study area; especially they showed dominance in both habitats.

Table 1: phytosociological parameters and distribution pattern of the studied species

Species	Ver. name	On Gardoud							On clay							Distribution pattern
		D	F	A	D%	F%	A%	IVI	D	F%	A	D%	F%	A%	IVI	
Anacardiaceae																
Lannea fruticosa (Hochst. ex A. Rich.) Engl.	Layoun	2.3	19.2	1.2	2.4	3.2	1	6.6	1.1	4	3	0.2	0.7	2.2	3	Contiguous
Lannea humilis (Oliv.) Engl.	Layoun	0.4	3.85	1	0.2	0.6	0.9	1.6	0	0	0	0	0	0	0	Contiguous
Lannea schimperi (Hochst. ex. A. Rich.) Engl.	Amzak	0.4	3.85	1	0.2	0.6	0.9	1.6	0	0	0	0	0	0	0	Contiguous
Lannea schweinfurthii (Engl.) Engl.	Rutrut	1.5	7.69	2	0.6	1.3	1.7	3.6	3.2	14	2.3	0.6	2.7	1.7	5	Contiguous
Sclerocarya birrea (A. Rich.) Hochst.	Humeid	5.8	38.5	1.5	2.3	6.3	1.3	9.9	1.4	11	1.3	0.3	2	1	3	Contiguous
Arecaceae																
Hyphaene thebaica (Linn.) Mart.	Dom	46	30.8	15	19	5.1	13	37	8.9	11	8.3	1.7	2	6.2	10	Contiguous
Bignonaceae																
Steriospermum kunthianum	Kashkash Abyad	0.4	3.85	1	0.2	0.6	0.9	1.6	0.7	7	1	0.1	1.4	0.7	2	Contiguous
Burseraceae																
Boswellia papyrifera (Del.) Hochst.	Tarak trak	10	11.5	8.7	4	1.9	7.4	13	0.4	4	1	0.1	0.7	0.7	1	Contiguous
Commiphora africana (A. Rich) Engl.	Gafal	0.4	3.85	1	0.2	0.6	0.9	1.6	0	0	0	0	0	0	0	Contiguous
Capparaceae																
Boscia angustifolia A. Rich.	Sareh	1.2	11.5	1	0.5	1.9	0.9	3.2	0.7	4	2	0.1	0.7	1.5	2	Contiguous
Capparis deciduas (Forsk.) Edgew.	Tandub	0.4	3.85	1	0.2	0.6	0.9	1.6	0	0	0	0	0	0	0	Contiguous
Celastraceae																
Maytenus senegalensis (Lam.) Exdl.	Youi	0.4	3.85	1	0.2	0.6	0.9	1.6	0	0	0	0	0	0	0	Contiguous
Combretaceae																
Combretum aculeatum Vent.	Shuheit	3.5	15.4	2.3	1.4	2.5	1.9	5.9	4.6	25	1.9	0.9	4.7	1.4	7	Random
Combretum hartmannianum Schwein f. Beitr.	Habeel	26	46.2	5.7	11	7.6	4.8	23	10	11	9.3	2	6.9	6.9	16	Contiguous
Combretum molle R.Br. ex G. Don.	Habeel Kharsha	1.5	7.69	2	0.6	1.3	1.7	3.6	0	0	0	0	0	0	0	Contiguous
Guiera senegalensis J. F. Gmel.	Gubeish	3.1	11.5	2.7	1.2	1.9	2.3	5.4	0	0	0	0	0	0	0	Contiguous
Terminalia leiocarpa Baill.	Sealak/Sahab	9.2	50	1.8	3.7	8.2	1.6	14	4.6	21	2.2	0.9	4.1	1.6	7	Random
Fabaceae																

Senegalia laeta (R.Br. ex Benth.) Seigler & Ebinger	Shubahi	0	0	0	0	0	0	0	0.4	4	1	0.1	0.7	0.7	1	Contiguous
Senegalia mellifera (Benth.) Seigler & Ebinger	Kitir	4.6	15.4	3	1.9	2.5	2.6	7	5	14	3.5	1	2.7	2.6	6	Contiguous
Senegalia polyacantha subsp. *campylacantha* (Hochst. ex A. Rich.) Kyal. & Boatwr.	Um Sinena	0	0	0	0	0	0	0	13	36	3.5	2.4	6.8	2.6	12	Contiguous
Senegalia senegal (L.) Britton	Hashab	13	26.9	4.7	5.1	4.4	4	**14**	38	43	8.8	7.4	8.1	6.5	22	Contiguous
Vachellia gerrardii (Benth.) P.J.H.Hurter	Salgam	0.8	7.69	1	0.3	1.3	0.9	2.4	0.4	4	1	0.1	0.7	0.7	1	Contiguous
Vachellia oerfota (Forssk.) Kyal. & Boatwr.	Laout	16	11.5	14	6.4	1.9	12	20	4.3	7	6	0.8	1.4	4.4	7	Contiguous
Vachellia sieberiana (DC.) Kyal. & Boatwr.	Kouk	0	0	0	0	0	0	0	0.4	4	1	0.1	0.7	0.7	1	Contiguous
Vachellia seyal var. seyal	Talih	0	0	0	0	0	0	0	55	46	12	11	8.8	8.8	28	Contiguous
Albizia amara (Roxb.) Boiv.	Arad	15	46.2	3.2	5.9	7.6	2.7	16	7.1	21	3.3	1.4	4.1	2.5	8	Contiguous
Bauhinia reticulata DC.	Kadawdaw	3.8	7.69	5	1.6	1.3	4.3	7.1	1.8	4	5	0.3	0.7	3.7	5	Contiguous
Dalbergia melanoxylon Guill. & Perr.	Abanous	4.6	26.9	1.7	1.9	4.4	1.5	7.8	0.7	7	1	0.1	1.4	0.7	2	Contiguous
Dichrostachys cinerea (L.)White & Arn.	Kadad	8.8	23.1	3.8	3.6	3.8	3.3	11	284	75	38	56	14	28	98	Contiguous
Lonchocarpus laxiflorus Guill. & Perr.	Khaskhash azrag	0.4	3.85	1	0.2	0.6	0.9	1.6	0.4	4	1	0.1	0.7	0.7	1	Contiguous
Prosopis africana (Guill. & Perr.) Taub.	Abu Srouj	0.4	3.85	1	0.2	0.6	0.9	1.6	0	0	0	0	0	0	0	Contiguous
Tamarindus indica L.	Aradeib	0.8	7.69	1	0.3	1.3	0.9	2.4	0.4	4	1	0.1	0.7	0.7	1	Contiguous
Loganiaceae																
Strychnos innocua Del.	Abugawi gawi	1.5	3.85	4	0.6	0.6	3.4	4.7	0	0	0	0	0	0	0	Contiguous
Malvaceae																
Adansonia digitata Linn.	Tabaldi	2.3	11.5	2	0.9	1.9	1.7	4.5	0	0	0	0	0	0	0	Contiguous
Grewia flavescens Juss.	Khleikhsan	2.3	11.5	2	0.9	1.9	1.7	4.5	0	0	0	0	0	0	0	Contiguous
Grewia mollis Juss.	Basham	0.4	3.85	1	0.2	0.6	0.9	1.6	0	0	0	0	0	0	0	Contiguous
Grewia tenax (Forsk.) Fiori.	Gideim	6.9	23.1	3	2.8	3.8	2.6	9.2	2.1	14	1.5	0.4	2.7	1.1	4	Contiguous
Grewia villosa Willd.	Tuka	2.3	7.69	3	0.9	1.3	2.6	4.8	5.4	14	3.8	1	2.7	2.8	7	Contiguous
Adansonia digitata Linn.	Tartar	0.8	7.69	1	0.3	1.3	0.9	2.4	0	0	0	0	0	0	0	Contiguous
Rubiaceae																

Catunaregam nilotica (Stapf.) Tirveng.	Shajart almarfaeen	1.2	11.5	1	0.5	1.9	0.9	**3**	0	0	0	0	0	0	0	Contiguous
Gardenia ternifolia var. *jovis-tonantis* (Welw.) Verdc.	Abungawi	0	0	0	0	0	0	0	0.7	7	1	0.1	1.4	0.7	2	Contiguous
Meyna tetraphylla (Schweinf. ex Hiern) Robyns.	Simeim	0.4	3.85	1	0.2	0.6	0.9	1.6	0	0	0	0	0	0	0	Contiguous
Rhamnaceae																
Ziziphus spina-christi (L.) Desf.	Sidir	2.3	15.4	1.5	0.9	2.5	1.3	4.7	15	43	3.6	3	8.1	2.7	14	Contiguous
Ulmaceae																
Celtis toka (Frossk.) Hepper &Wood	Muhagria	0	0	0	0	0	0	0	0.4	4	1	0.7	0.7	0.7	2	Contiguous
Zygophyllaceae																
Balanites aegyptiaca (L.) Delile	Higleig	47	53.8	8.6	19	8.9	7.4	**35**	40	64	6.3	7.9	12	4.7	25	Contiguous
		248.1							510.1							

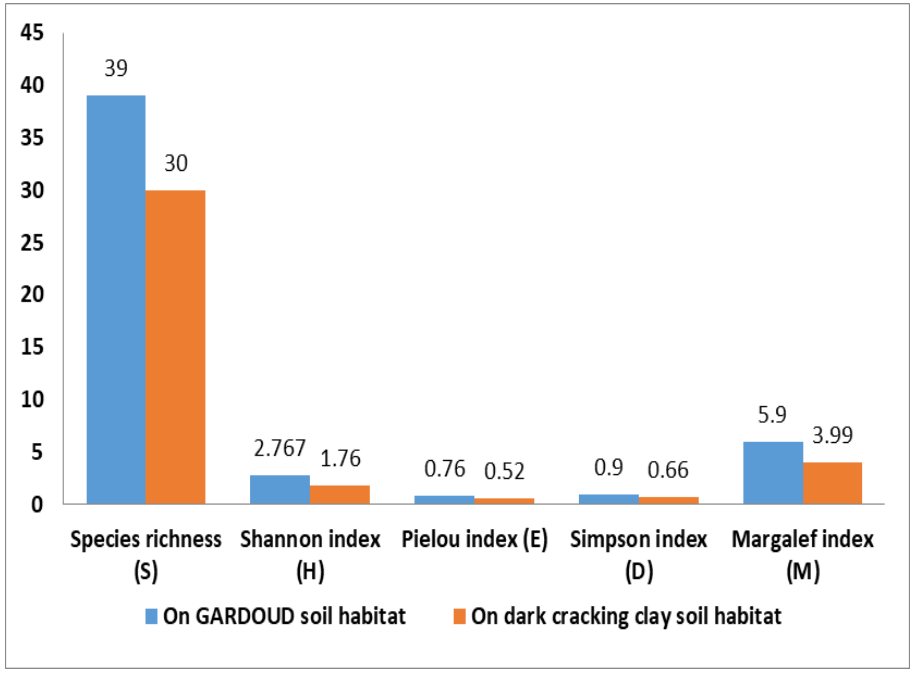

Figure 4: Richness and diversity indices of the two studied habitats

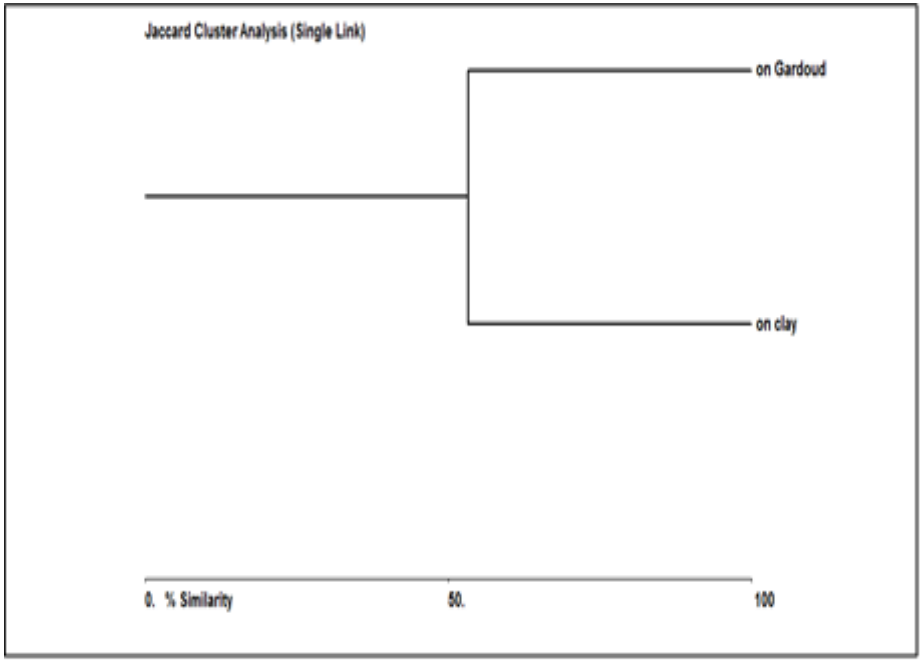

Figure 5: Dendrogram showing the percent of similarity between studied habitats.

CONCLUSION

The woody plants cover a diversity of the studied area and were represented by 45 plant species belonging to 29 genera under 14 families. While the dominant family Fabaceae is represented with 15 species, 7 families are monotypic. *Dichrostachys cinerea* showed the maximum IVI values at habitats of dark-cracking clay soil and the whole study area. The habitats of GARDOUD soil the more diverse than those of dark-cracking clay soil.

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Tagetes officinalis Oil Production under Photobiology Treatments

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ABSTRACT

Tagetes plant was grown widely as an herbaceous ornamental plant belonging to the family of Asteraceae. It is an economic plant species utilized in processed forms in modern medicinal processes. The main constituents of Marigolds are Phenolic compounds, carbohydrates, lipids, steroids, tocopherols, terpenoids, vitamin C, and carotenoids. From the results, it could be concluded that with the high exposure time (40 minutes two types of laser recorded the highest values in oil content compared with control and other laser treatments. The results of phenolic and flavonoid contents for essential oil from Tagetes treated with blue and red laser revealed a significant ($P \leq 0.05$) increase after laser treatment especially in red laser treatment which recorded (17.08 mg GAE/g) after 15 mins compared to control (13.25 mg GAE/g) and blue laser (16.49 mg GAE/g) at the same time. A similar observation was noticed in total flavonoid content, which increases with increasing exposure time to both types of laser. Twenty-nine volatile compounds were identified which comprise about 99.6%, 99.13%, 99.66%, 99.58%, and 99.27% in control and blue as well as red laser after 10 and 15 mins. respectively. The data revealed that the main volatile constituents were terpenes either mono or sesquiterpenes and oxygenated sesquiterpenes. Dihydro-Tagetone was considered the major volatile compound in all samples under investigation with a concentration of control (26.31%) and exhibited a pronounced increase in treated samples with concentrations of 28.56% and 27.91% after 15 mins. treatment with red and blue laser respectively.

INTRODUCTION

Tagetes plant (*Calendula officinalis*), (Marigold) is grown widely as an herbaceous ornamental plant belonging to the family of Asteraceae. It is an economic plant species utilized in processed forms in modern medicinal processes. The main constituents of Marigold are Phenolic compounds, carbohydrates, lipids, steroids, tocopherols, terpenoids, vitamin C, and carotenoids. In addition to the edible uses (i.e. coloring and flavoring agents of food). The main constituents of *Calendula officinalisare* include phenolic compounds, carbohydrates, lipids, steroids, tocopherols, terpenoids, vitamin C, carotenoids, and quinines Shahrbabakiet al (2017). Carotenoids extracted from dry petals are used for poultry feeds to improve the egg yolk color of the boiler's skin. Singh (2014). It has medical importance as a blood refiner, anti-inflammatory, skin antifungal, blood sugar reduction, and antiviral properties. Baranidharan et al (2020). Laser rays have attained much attention in different parts of the world for improving the growth and quality of plants. In this concern, Laser treatments can modify important components of

plant cells and have been reported to affect differentially, the morphology, anatomy, biochemistry, and physiology of plants depending on the source and time of laser exposure. Sami et al. (2013) and *Celosia argenta* and Sami et al. (2014) Caster bean reported that significant increase in plant growth. Also, they reported that laser rays could be useful to induce variation in plant improvement. Previous studies showed that laser influenced plant growth and metabolism. Whereas, oil contents in the tagetes seedling flowers were enhanced after using laser irradiation (Govilet al. 1991; Cai et al. 2000).

The extracted oil from tagetes has several applications in food products with antimicrobial activity and is used as flavoring and fragrance in perfumes. Also, the oil had medicinal properties such as anticancer, hypotensive, and ant inflammatory effects (Rajesh et al. 2012; Oliveira et al.2015). The essential oil of tagetes has been shown to be an effective free radical scavenger, and the ethanol extract is reportedly effective against parakeratosis (Khan and Evans, 1996; Gutierrez et al. 2006). Nowadays, there is increased attention to environmentally safe potential strategies for aromatic and medicinal plants to improve the morphological, physicochemical, and genetic agronomical traits. Among the physical elicitors UV as well as gamma irradiation and laser treatments have been applied in various studies to enhance seed germination, and improve the growth parameters and metabolite production (Thoratet al.2021; Saadet al. 2021). The current investigation has been undertaken to isolate the essential oil of tagetes after treatment with two types of laser (red and blue)at different times and evaluate its effect on phytochemicals, antioxidant as well and volatile oil composition. Therefore, the aim of this study was to investigate the effect of two types of laser on the chemical composition of oil contents in the Tagetes officinalis plant.

MATERIALS AND METHODS

The study was carried out at the greenhouse of the National Research Centre, Dokki, and Cairo, Egypt during seasons 2019-2020, to investigate the response chemical parameters of oil contents on Tagetes plants under irradiation conditions of helium cadmium (He-Cd and He-Cd) laser. For cultivation, pots 30 cm in diameter and 30 in depth were filled with loamy sandy soil (2:1 by volume) the physical and chemical characteristics of the soil are shown in Table (1). Nitrogen and potassium fertilizers were added to the soil according to the recommended dose of the Ministry of Agriculture after three months from planting. The experiment consisted of four for each kind of laser treatment including the control. Helium cadmium laser was used for exposing seedlings (10 cm length) at the wavelength of a blue laser (460) and red laser (650 nm) and output power 60 and 103 Mw/cm2. Seedlings plantation was in two seasons in February 2020 and 2021 after being treated with helium cadmium and helium-neon laser, whereas the exposure times were (0, 20, 30, and 40 min.) for two types of laser. After four months from planting, a representative plant sample was taken from three replicates randomly. Flowers samples were collected in the two seasons and weighted to extract the essential, oil (100 gm) fresh weight from flowers were weighted and hydro-distilled for 3 hours using Cleveger-type apparatus methods Cleveger (1928).

Table 1: Physical and chemical parameters of soil samples

Analyses type		Soluble Kations /ppm				Soluble Inions /ppm			
PH	EC	Ca	Mg	Na	K	CO_3	HCO_3	Cl	SO_4
7.64	0.93	3.5	1.5	3.6	0.8	-	0.9	4.8	3.7

Preparation of Essential oil

The volatile oil was obtained by passing over anhydrous Na2SO4 to strip it of any water, while the oils were kept in sealed glass bottles covered with aluminium foil at 20°C until required.

Determination of total phenolic content

The total phenolic content of essential oil methanolic extract was estimated by the Folin–Ciocalteu colorimetric method, based on the procedure of Singleton and Rossi (1965), using gallic acid as a standard phenolic compound. Briefly, 50 ul (three replicates) of the filtered extracts were mixed

with 450 ul of distilled water and 2.5 ml of 0.2 N Folin–Ciocalteu reagent. After 5 min, 2 ml of saturated sodium carbonate (75 g/l) was added. The absorbance of the resulting blue-colored solution was measured at 765 nm after incubation at 30 oC for 1.5 h with intermittent shaking. Quantitative measurements were performed, based on a standard calibration curve of six points: 20, 100, 200, 300, 400, and 500 mg/L of gallic acid in 80% methanol. The total phenolic content was expressed as gallic acid equivalents (GAE) in milligrams per gram of oil.

Total flavonoids

The total flavonoid content of the prepared extracts was determined by the method of Davis et al. (1980). The extract (100 µL) was placed in a test tube before adding 1 mL of diethylene glycol reagent and 100 µL of 1 N NaOH. The mixture was shaken vigorously and incubated at 37 ^{o}C for 1 hr before measuring the absorbance at 420 nm. A standard curve was prepared using rutin. The total flavonoid content was expressed as rutin equivalents (RE) in milligrams per gram of oil.

Determination of total antioxidant activity
ABST assay

The antioxidant capacity assay of essential oil methanolic extract was carried out using the improved ABTS+ method, as described by Re et al. (1999). Briefly, ABTS+ radical cation is generated by reacting 7 mM ABTS+ and 2.45 mM potassium persulfate via incubation at room temperature (23 oC) in the dark for 12–16 h. The ABTS+ solution was diluted with 80% HPLC-grade ethanol to an absorbance of 0.700 ± 0.040 at 734 nm and equilibrated at 30 ^{o}C. Plant extracts were diluted with distilled water or 80% methanol, such that after the introduction of a 30 µL aliquot of each dilution into the assay, it produced from 20% to 80% inhibition of the blank absorbance. To 3.0 ml of diluted ABTS+, 30ul of each plant extract solution was added and mixed thoroughly. The reactive mixture was allowed to stand at room temperature for 6.0 min and the absorbance was recorded immediately at 734 nm.BHT and ascorbic acid were used as a positive control. The results are expressed as IC50 values (ug/ml), the concentration required to cause a 50% ABST+ inhibition (Re et al. 1999).

-Carotene bleaching assay

The carotene bleaching method is based on the loss of the yellow colour of -carotene due to its reaction with radicals formed by linoleic acid oxidation in an emulsion. The rate of -carotene bleaching can be slowed down in the presence of antioxidants (Kulisicet al.2004). -Carotene (2.0 mg) was dissolved in 20 ml chloroform and to 4.0 ml of this solution, linoleic acid (40 mg) and Tween 40 (400 mg) were added. Chloroform was evaporated under a vacuum at 40 oC and 100 ml of oxygenated ultra-pure water was added, then the emulsion was vigorously shaken. Reference compounds (BHT and ascorbic acid) and essential oils were prepared in methanol. The emulsion (3 ml) was added to a tube containing 0.2 ml of different concentrations of essential oils (1, 3, 5 and 7 mg/ml) and extract (1, 10, 100 and 200 ug/ml). The absorbance was immediately measured at 470 nm and the test emulsion was incubated in a water bath at 50 oC for 120 min, when the absorbance was measured again. BHT and ascorbic acid were used as positive control. In the negative control, the essential oil extracts were substituted with an equal volume of methanol. The antioxidant activity (%) of the essential oils was evaluated in terms of the bleaching of the -carotene using the following formula:

% Inhibition = [(At -Ct)/C0-Ct)] X100

where At and Ct are the absorbance values measured for the test sample and control, respectively, after incubation for 120 min, and C0 is the absorbance values for the control measured at zero time during the incubation. The results are expressed as IC50 values (ug/ml), the concentration required to cause a 50% -carotene bleaching inhibition. Tests were carried out in triplicate.

Gas chromatography–flame ionization detector (GC–FID) analysis

The essential oil analyses were carried out using Agilent 7890 GC equipped with a flame ionization detector, an electronic pressure control injector and a capillary column (HP-5 Innowax: 30 m X 0.25 mm; 0.25 um film thickness); carrier gas, He at 1.0 ml/min; split ratio, 1:20. The oven temperature was programmed from 60 to 250ºC at the rate of 5ºC/min. and finally, the temperature of 250ºC was kept constant for 10 minutes. Subsequent GC working conditions were as follows: carrier gas was He with a constant flow rate of 1.0 mL/min.

Ionization voltage was kept at 70 eV. MS working conditions were as follows: the temperature of the ion source and the interface were 200 and 250ºC, respectively, and the mass range was scanned from 43 to 456 m/z. The injector and detector temperatures were 250 and 300ºC, respectively.

Gas chromatography-mass spectrometry (GC–MS) analysis

GC/MS analysis was performed on Agilent 7890 GC coupled to a 5977 MS detector with electron impact ionization (70 eV). An HP-5-MS capillary column (30 m X 0.25 mm coated with 5% phenyl methyl silicone, 95% dimethylpolysiloxane, 0.25 um film thickness) was used. Oven temperature was programmed to rise from 60 to 250 oC at a rate of 5 oC/min; the transfer line temperature was 250 °C. The carrier gas was He with a flow rate of 1.0 ml/min and a split ratio of 60:1. Scan time and mass range were 1 s and 40–300 m/z, respectively.

Identification of the volatile constituents

The identification of constituents was performed on the basis of retention indices (RI) determined by co-injection with reference to a homologous series of n-alkanes, under identical experimental conditions. Further identification was performed by comparison of their mass spectra with those from NIST (NIST, 2011) and the homemade MS library built up from pure substances and components of known essential oils, as well as by comparison of their retention indices with literature (Adams, 2007).

RESULTS AND DISCUSSION

We can conclude from Table (2) in general, all exposure times of laser treatments (0, 20, 30, and 40 min.) recorded increments in oil content compared with zero min (control). Laser exposure time. Treated plants with 40 min. exposure time for the two laser types recorded the highest values, followed by 30 min. the laser exposure time of two laser types. The oil content of tagetes flowers was increased by laser treatment and surpassed the control plants. This may be due to the formation of GA and the main biological activity of growth hormones and enzyme activity enhancing under laser effect, Sami et al (2014) on *Ricinus communis* plant.

Table 2: Effect of laser type and exposure time on oil flower content of Tagetes plant (Means of two seasons)

		Helium neon laser (red)			Cadmium neon laser (blue)		
Treatments	**0 min.**	**20 min.**	**30 min.**	**40 min.**	**20 min.**	**30 min.**	**40 min.**
Oil content (ml)	**1.7**	**1.9**	**2.5**	**3**	**2**	**3**	**3.5**

The phenoglic and flavonoid contents of essential oil from Tagetes treated with blue and red laser are given in(Table 3).The obtained results revealed that there is a significant (P≤0.05) increase in the determined phytochemicals after laser treatment especially in red laser treatment which recorded (17.08 mg GAE/g) after 40 mins compared to control (13.25 mg GAE/g) and blue laser (16.49 mg GAE/g) at the same time (Table 3). A similar observation was noticed in total flavonoid content which increases with increasing exposure time to both types of laser. The maximum value was found in the red laser after 40 mins (5.91 mg RE/g) compared to control and blue laser at the same time which had (4.96 and 5.31 mg RE/g) respectively (Table X).The obtained results are in good agreement with Katarzyna et al. (2020)who mentioned that the increase of phytochemicals such as phenolic and carotenoid content of T. wittm depend on the time of irradiation for seeds.Also, our results were confirmed byMahmood et al. (2021)who mentioned that laser light could improve the yield of plant metabolic pathways and enhance the production of biomass in a species as well as the dose-specific manner in sunflowers.The studied phytochemicals either phenolics or flavonoids are considered the most abundant antioxidants responsible for the plant defense mechanisms.In the literature, the effect of laser on phytochemicals and metabolites depends on the source of light and time of treatment (Etxeberriaet al. 2016; Cui and Lei, 2019).

The data in (Table 3) shows the effect of Tagetes essential oil antioxidant activity after red and blue laser treatments on assays of ABST+ and -carotene. The assay results expressed as IC50 in comparison with BHT and ascorbic acid. The data in (Table 3) showed that as the time of laser treatment

increased an increase in antioxidant activity occurred at all studied times. Generally, the red laser treatments were stronger than the blue laser. In comparing ions with standard antioxidants the investigated samples were lower than BHT, but higher than ascorbic acid. A similar observation was reported by Chen and Han (2014) who found an increase in antioxidant activity after laser light treatment of wheat. Based on the results reported by Ohnishi et al. (1994) the antioxidant activity of tagetes may be correlated with the phenolic compounds such as chlorogenic and caffeicacids which possess peroxyl radical antioxidant activity higher than ascorbic acid and tocopherols. All the studied doses and types of laser antioxidant activity could be therefore attributed to the proton donor ability and direct scavenging of the bioactive constituents (Brand-Williams et al. 1995). Therefore, it is important to extend our study to shade the light of the phenolic composition of the selected doses and type of laser using HPLC-MS analysis.

Table (3) Effect of laser type and exposure time on phytochemicals and antioxidant activity of Tagetes

Treatment	Control	Blue laser			Red laser		
		20	30	40	20	30	40
Total phenolics(GAE mg/g)	13.25±0.08	15.37±0.02[a]	16.43±0.13[b]	16.49±0.05	15.98±0.11[a]	16.92±0.21[b]	17.08±0.17[b]
Total flavonoids (RE mg/g)	4.96±0.12	5.09±0.14	5.28±0.15[a]	5.31±0.07[a]	5.76±0.09[b]	5.83±0.16[b]	5.91±0.12[b]
Antioxidant activity(IC_{50})							
ABST	25.34±0.17	19.35±0.08	17.36±0.04	15.73±0.05	14.32±0.06	12.85±0.07	9.67±0.08
-Carotene	46.82±0.14	31.94±0.02	28.47±0.12	21.76±0.09	24.37±0.16	19.45±0.09	15.24±0.03
BHT	8.13±.02						
Ascorbic acid	54.16±0.03						

Values are given as mean ± SD (n= 3); Values with the same letters within the same column are not significant

Volatile compounds analysis

The variations in tagetes essential oil composition after treatment with red and blue laser for different times were subjected to analysis by GC and GC-MS and the identified constituents with their relative concentrations are given in Table 4. A total of twenty-nine were identified which comprise about 99.6%, 99.13%, 99.66%, 99.58% and 99.27% in control and red as well as blue laser after 30 and 40 mins respectively. The data revealed that the main volatile constituents were terpenes either mono or sesquiterpenes and oxygenated sesquiterpenes. Dihydro-Tagetone was considered the major volatile compound in all samples under investigation with the concentration of control (26.31%) and exhibited a pronounced increase in the treated sample with concentrations of 28.56% and 27.91% after 40 mins. treatment with red and blue laser respectively (Table 4).Recently, studies referred to the improvement of essential oil yield and its precursors in anise after laser treatment as mentioned by Okla et al. (2021) which supported our data.

The obtained results are in good agreement with Craveiro et al. (1988) who mentioned that the Brazilian T. minuta rich in dihydrotagetone. Piperitenone and piperitone were the most dominant monoterpenoids with concentrations of 16.34% and 13.28% in control sample and exhibited pronounced increase after laser treatment especially red laser after 40 mins which recorded concentration of 19.25% and 16.72% of piperitenone and piperitone respectively (Table 4). Our results confirmed by Laosinwattana et al. (2018) who found that monoterpenes are the major volatile compounds in the aerial parts of T. erecta which represent about 46.3%-97.3%.In the present study,sesquiterpenoids such as caryophyllene was found with low concentration varied from 0.89% after treatment with blue laser for 30 mins and 0.24% after 40 mins compared to control sample which showed 0.59% (Table 4)and completely disappeared after blue laser treatment. The obtained data are in contrast to those reported by Resmi et al. (2018) who found that sesquiter

penoids like caryophyllene were considered the second major volatile compounds in tagetes. The variation in the volatile composition may be due to the species, aerial parts, and method of isolation as well as environmental conditions.

Table 4: Effect of laser type and exposure time on volatile oil composition of Tagetes

Volatile compounds	LRI [a]	Control	Red		Blue	
			30	40	30	40
α-Pinene	938	0.52	1.02	1.08	1.95	1.98
Sabinene	971	0.68	0.78	0.85	0.62	0.81
Myrcene	992	0.28	0.34	0.18	0.03	1.24
α-Phellandrene	1005	0.05	n.d	0.02	0.17	0.65
O-Cymene	1026	n,.d	n.d	0.16	0.92	n.d
Limonene	1027	6.13	7.16	8.17	7.56	7.85
Sylvestrene	1029	3.19	2.08	1.06	1.82	0.46
(Z)-β-Ocimene	1031	0.82	0.12	n.d	n.d	0.09
(E)-β-Ocimene	1045	0.65	0.37	0.13	0.28	0.12
Dihydro-Tagetone	1048	26.31	27.18	28.56	27.84	27.91
Linalool	1092	1.04	0.62	0.34	1.62	0.29
(E)-Tagetone	1138	1.93	0.35	0.18	0.58	0.16
(E)-Myroxide	1142	4.12	1.29	0.72	0.67	0.54
(Z)-Tagetone	1152	6.52	8.16	9.13	7.28	8.63
Borneol	1167	0.31	0.18	0.01	0.16	0.05
Terpinen-4-ol	1176	0.95	0.52	n.d	1.41	0.73
(E)-Isocitral	1178	0.42	0.49	0.38	n.d	1.04
p-Cymen-8-ol	1183	7.85	9.14	9.57	9.54	9.83
α-Terpineol	1186	2.39	1.34	0.59	1.78	0.25
Verbenone	1195	0.54	0.27	0.13	0.05	1.14
(E)-Ocimenone	1227	1.85	0.34	0.54	0.91	0.59
Piperitone	1248	13.28	15.26	16.72	15.67	16.02
Piperitenone	1341	16.34	18.36	19.25	18.52	18.74
Geranyl acetate	1380	0.25	0.17	0.38	n.d	0.07
β-Elemene	1388	n.d	0.05	0.61	0.01	0.05
(Z)-Jasmone	1393	2.17	1.63	n.d	0.03	n.d
β-caryophyllene	1416	0.59	0.89	0.24	n.d	n.d
α-Humulene	1457	0.28	0.64	0.19	0.02	0.01
Germacrene D	1482	0.14	0.38	0.47	0.14	0.02
Total		**99.6**	**99.13**	**99.66**	**99.58**	**99.27**

a: LRI: Linear retention indices; b: Values are expressed as relative area percentage; n.d: not detected

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Intensity of Livelihood Diversification on Food Security among Small-Scale Arable Farming Households in Benue State, Nigeria

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ABSTRACT

The study analyzed the intensity of livelihood diversification and food security among arable crop small-scale farming households in Benue State, Nigeria. The study adopted a survey research design that made use of primary data. The data collected were analyzed using frequency, percentages, means, and food security index. The results on socio-economic characteristics showed that most arable farmers are in their productive age (40 years), about 61.7% of males are majorly involved in farming and 89.4% are married. Arable farmers in the area spent at least 10 years in school had a household size of at least 7 members, and an average farm size of 5.55 hectares with an average annual income of N 461, 785.53. The result of livelihood strategies engaged in and income realized showed that most (23.3 %) of respondents were more diversified in cultivation of cassava with average income earned of N 82,688.89, 22.2 % diversified into yam cultivation with average income earned of N166,257.14, 18.3% diversified into rice cultivation and earned N139,757.58, 8.3 % into soybeans with average income earned of N129,130.; 6.7 % into guinea corn and earned N143,750.00, 6.1 % into maize and earned N 89,444.44, 5.0 % into cowpea (beans) and earned N101,428.57, 3.9 % into groundnuts and earned N 67,533.33, 1.1 % into sesame (beniseed) and earned N 107,500.00, and 0.6% into bambaranut and earned N 70,000.00. The results of Simpson index showed the mean diversification index of 0.7059 which falls between the index of 0.61 and 0.90 indicating that, small scale farming households are highly diversified in various diversification activities. The results on the constraints to diversifying livelihoods of respondents in the study area showed that inadequate access to credit (99.4 %), insufficient market price of commodity (80.0 %), and unstable electricity (78.3 %) were the most constraints. The study concludes that livelihood diversification strategies are healthy for income realization during off-season when farmers who depend on rain are no more in the cropping season. Agricultural policies should be targeted towards livelihood diversification strategies that ensure the food security status of small-scale farmers.

1. INTRODUCTION

In Nigeria, agriculture is the source of food for the populace as well as raw materials for the agro-industries and contributes about 33 % to the Gross Domestic Product of the nation (Bureau of African Affairs, 2010). The sector employs about one-third of the total labor force and provides a livelihood for the bulk of the rural populace (Federal Ministry of Agriculture and Rural Development, FMARD, 2006). Nigeria is an agrarian society with about 70 % of its population (approximately 140 million) small-scale farmers majorly participating in agricultural production to provide food for the teeming population and raw materials for industrial production (NBS, 2020).

The Nigerian agricultural landscape is basically dominated by small-scale farmers who form about 90 % of the farming population most of which are arable crop farmers. In most developing countries, the importance of non-agricultural activities is increasing and it is estimated to account for 30-50 % of rural incomes (Omofonwan, 2018). Several international organizations like the Oversea Development Institute (ODI), Department for Foreign and International Organizational Development (DFID), and many others promote and argue that livelihood diversification acts as a safety net for poor rural households.

Development economics literature has identified two main factors that drive diversification among arable crop farming households in developing countries like Nigeria. These factors are broadly classified into pull factors and push factors. Farm households can be pulled into the off-farm sector so as to earn high returns to labour or capita and the less risky nature of investment in the off-farm (Kilic *et al*. 2019). The push factors that may drive off-farm income diversification include; the need to increase family income when farm income alone cannot provide sufficient livelihood, the desire to manage agricultural production and markets risks in the face of a mission insurance market, the need to earn income to finance farm investment in the absence of a functioning credit market (Babatunde and Quim, 2013).

Many studies (Yared, 2012; Degefa, 2015) have shown the need and importance of diversification for households survival and secured livelihood. A household, which depends on few livelihood strategies, is very vulnerable. Diversification means there could be other sources of livelihood for the household to fall back on. Rural people in Africa and Nigeria, in particular, have diversified their economic activities to encompass a range of productive areas that include farm and non-farm income-generating activities (Idowu, 2014).

The main driving forces of diversification are: to increase income when the resources needed for the main activities are too limited to provide a sufficient means of livelihood (Nghiem, 2010), to reduce income risks in the face of the mission insurance market (Dilruba and Roy, 2012), to exploit strategic complementarities and positive interactions between different activities and to earn cash income and finance investment in the face of credit failures (Nghiem, 2010).

The problem of food security in Nigeria has not been adequately and critically analyzed despite various approaches to addressing the challenges. The government has introduced several projects and programmes including livelihood activities to improve agriculture status of small-scale farmers and boost food production in the country. However, the empirical records of many of these programmes and projects are not impressive enough to bring about the expected transformation of the small-scale farming households (Ihimodu, 2014). Today, the problem continues to exist at an increasing pace as more than 900 million people around the world are still food insecure (FAO, 2010). According to Adebiyi (2012), Nigeria remains a net importing nation, spending about N1.3 billion on importing basic food items annually. The food security

problem in Nigeria is pathetic as more than 70 percent of the populace live in households too poor to have regular access to the food that they need for healthy and productive living with an increasing high level of poverty (Babatunde et al. 2017).

There exist studies on diversification strategies and food security in Nigeria. Baharu (2016) studies the effect of livelihood diversification on household income; Abu and Soom (2016) focused on factors affecting food security in rural and urban farming households in Benue State; Ahungwa (2013) studied economic analysis of household food insecurity and coping strategies in Osun state, Nigeria. However, there are perhaps no known studies on livelihood diversification and food security among small-scale arable farming households in Benue State, Nigeria. Motivated by the above gaps, empirical evidence that will be generated by this study will help to fill the knowledge gap in the literature. Using Benue State, Nigeria as a typical ecological region, this study will focus on the analysis of livelihood diversification and food security among small-scale arable farming households in Benue State, Nigeria.

2.0 METHODOLOGY

2.1 Study Area

The study was conducted in Benue State, Nigeria. The State capital is Makurdi. Benue State lies within the lower river Benue trough in the middle belt region of Nigeria. Its geographic coordinates are longitude 7° 47' and 10° 0' East. Latitude 6° 25' and 8° 8' North; and shares boundaries with five other states namely: Nasarawa State to the north, Taraba State to the east, Cross-River State to the south, Enugu State to the south-west and Kogi State to the west. The state also shares a common boundary with the Nord-Ouest Province, claimed by both Ambazonia and the Republic of Cameroon on the south-east. Benue occupies a landmass of 34,059 square kilometers. Benué State consists of twenty-three (23) Local Government Areas.

The state is populated by several ethnic groups such as; Tiv, Idoma, Igede, Etulo, Abakpa, Juku, Hausa, Igbo, Akweya and Nyifon. Most of the people are farmers while the inhabitants of the river areas engage in fishing as their primary or important secondary occupation. The people of the state are famous for their cheerful and hospitable disposition as well as rich cultural heritage. The State is a major producer of food and cash crops like yam, cassava, rice, groundnuts and maize. Others include sweet potatoes, millet, sorghum, sesame and a wide range of others like soyabeans, sugarcane, oil palm, mango, citrus and banana. Irrigation farming along the bank of Rivers Benue and Katsina-Ala is a common feature.

2.2 Sample and Sampling Techniques

The population of this study consisted of arable crop small scale farmers in Benue State. Multi-stage random sampling technique was used to select respondents for the study. In the first stage random sampling technique was used whereby, one (1) Local Government was randomly selected from each of the three (3) agricultural zones in Benue State (Zone, A, B, and C) which include Vandeikya, Tarka and Otukpo Local Government Area respectively. A total of 90,071 small scale arable crop farmers were involved in production of arable crops in the selected Local Governments according to BNARDA, (2020). In the second stage a proportionate sampling technique was used whereby, a total of 180 respondents was selected using a proportionate distribution of 0.2%. The distribution of sample in the three (3) selected Local Government is presented in Table 1.

2.3 Methods of Data Collection and Analytic Technique

Primary data was used for this study. The data was collected through direct personal interview with structured questionnaire. Trained enumerators who understand and speak the native languages perfectly were employed in the collection of primary data, while the illiterate households were asked questions in the questionnaire and answers filled by the enumerators.

Data for the study was analysed using descriptive statistics such as frequency, percentages, mean and standard deviation and

inferential statistics such as food security index (FSI).

Table 1: Sample Size Selection Plan

Agricultural Zones	LGAs selected	No. of arable farmers in the LGAs	Sample size (0.2%)
A	VANDEIKYA	29,877	60
B	TARKA	30,518	61
C	OTUKPO	29,676	59
TOTAL		**90,071**	**180**

2.4 Model Specification

2.4.1 Food Security Index (FSI)

Food Security Index was used to ascertain the food security status of respondents in the study. Food security index is given as below

$$fi = \frac{per\ capita\ food\ expenditure\ for\ the\ Ith\ household}{\frac{2}{3} mean\ per\ capita\ food\ expenditure\ of\ all\ households}$$

Where:

$fi = Food\ Security\ Index$

$fi = 1$ (indicate food security)

$fi \geq 1$ *it implies that the Ith household is food secured*

$fi < 1$ *it implies the Ith household is food insecured*

3.0 RESULTS AND DISCUSSION

3.1 Socioeconomic Characteristics of Respondents

The socioeconomic variables of the respondents examined include: age, sex, marital status, years spent in school, household size, farm size, farming experience, extension contact and annual income.

Age (years)

The result in Table 2 showed that most (57.2%) of the respondents were between the age bracket of 21-40 years, 33.3 % were between 41-60 years, 6.7 % were more than 60 years and 2.8 % were less than 20 years of age. The mean age of respondents was 39.73 years. This implies that most members of small-scale arable farming households are economically active and energetic to engage in agricultural production which is an important factor that positively influence their involvement into varied diversification activities. This is in line with the findings of Tashikalma *et al*. (2015) and Afodu *et al*. (2020) that small scale farmers in Benue State, Nigeria are still in their youthful age of 31 to 40 years. The findings was also agreed by Bayero *et al.* (2019) who pointed out that most small scale farmers in Nigeria are between 30 to 40 years of age.

Sex

Table 2 also shows the distribution of respondents according to sex which indicates that majority (61.7 %) were males while 38.3 % were females. This implies that most of the small scale arable farmers in the study area are males. This is in line with the findings of Kuwornu *et al*. (2013) who reported that most farmers in Benue State, Nigeria are males. Also coincide with the findings of Gani *et al*. (2019) and Okpokiri *et al*. (2017) who reported that a larger population of arable crop farmers in Benue State, Nigeria were males.

Marital status

The findings on marital status revealed that, a larger proportion (89.4 %) of respondents were married while just 10.6 % of the respondents were single. This shows that a larger proportion of the small scale arable crop farming households in the study area were married. The implication is that most farmers who are married tend to try other sources of income and thus diversify into other option so as to obtain income to provide household needs. This is in agreement with the findings of Matthew-Njoku and Nwaogwugwu (2014) who found out that most farmers were married. Also Mohammed and Fentahun (2020) and Babatunde and Quim (2009) agreed that most arable crop farmers were married.

Years Spent in school

The analysis in Table 2 on the years spent in school by respondents revealed that most (57.2%) respondents spent between 7 and 12 years in school,

24.7 % spent between 1and 6years in school, 17.4 % spent more than 13years in school and 1.7 % spent less than 1year in school. The average years spent in school was 10.35years. This implies that, the respondents were literate and attained at least secondary education. This is in line with the findings of Gani *et al*. (2019) who posited that farmers in Nigeria were literate. Also in agreement with the findings of Haddabi *et al*. (2019) that farmers attained at least secondary level of education.

Household Size

The result on household size of respondents showed that most, (55.0 %) of respondents have a household size of between 5and 10 members, 28.3 % have less than 5 members, 11.1 % have between 11and15members and 5.6 % have more than 16 members in their households. The mean household size of respondents was 8 members. This implies that, the respondents have a large household size to support family labour and thus engage in diversification. This finding disagrees with Amurtiya et al. (2016) who reported that the average household size of farmers was between 10and 15 persons. Also not in line with Sowamin (2018) who was of the view that the average household size of arable farmers was between 5 and 6persons per household. But in line with the findings of Audu (2017) who reported that cassava farmers in Benue State, Nigeria have a household size of between 5 and 10 persons.

Farm Size

The findings in Table 2 on farm size showed that most (55.6 %) own more than 3.01hectares of farm size, 22.8 % own between 1.01and 2.00 hectares, 12.2 % own between 2.01 and 3.00 hectares of farm size and 9.4 % own less than 1.0 hectares of farm size. The respondents own a mean farm size of 5.55 hectares for the production of arable crops. This implies that respondents were medium-scale farmers who cultivate small portions of land which are often fragmented. Cumulatively, they have a reasonable farm size which will encourage their income earning and be involved in diversification since they will use the fragmented lands to grow different crops. This disagrees with the findings of Sowami (2018) who reported that farming households in Ogun state hold between 2-3hectares of farm size. Also disagrees with Haddabi *et al*. (2019) who reported an average of 2.95 hectares of farm size for rural farming households in Adamawa State, Nigeria.

Farming Experience

Analysis on farming experience showed that a larger proportion (60.1 %) of respondents have less than 10years of farming experience, 25.0 % have between 11 and 20 years of farming experience, 8.9 % have between 21 and 30 years and 5.0 % have more than 30 years farming experience. The mean farming experience of respondent was 13.16 years. This implies that, respondents in the study area are experienced farmers since they have spent many years in farming. This is in contrast with Abiodun *et al*. (2019) who reported that arable crop farmers have more than 10 years farming experience. Also in contrast with the view of Sowami (2018) that, farmers had between 10-20 years farming experience in cassava farming.

Extension Contact

The result in Table 2 showed that majority (92.8 %) of respondents made less than 3 times contact with extension agents and 7.2 % made more than 4 times contact with extension agents. The average extension contact of farmers was 1.09 times. This implies that, farmers do not often meet with extension agents. This may also be because of their diverse involvement with their farm enterprises since they will not be eager to wait and meet with extension agents. This is in line with the findings of Etuk *et al*. (2018) who reported less than one-time meetings with extension agents. Also agrees with Umeh *et al.* (2013) who reported a mean contact of 2 times with extension agents.

Annual Income

The results of annual income as presented in Table 2 showed that 49.4% of respondents earned between ₦100,001.00 and ₦300,000.00 annually, 37.8% earned less than ₦100,000.00 annually, 8.3% earned ₦300,001 and ₦500,000 annually and 4.4% earned ₦500,001 annually. The average annual income of respondents was ₦461,785.53 annually. This implies that respondents are low income earning farmers who are classified as operating under small scale since they make less than N 500,000.00 annually from their farming. This is line with Amurtiya *et al*. (2016) who reported that small scale farmers earn less than ₦500,000.00 per annum. Also in line with Sowami (2018) who reported that cassava farmers earn less than ₦500,000.00 annually as income from farming.

Table 2: Socioeconomic Characteristics of Respondents n = 180

Socioeconomic Variables	Frequency (F)	Percentage (%)	Mean ($\bar{x}$)
Age (years)			
<20	5	2.8	39.73
21-40	103	57.2	
41-60	60	33.3	
>60	12	6.7	
Sex			
Female	69	38.3	
Male	111	61.7	
Marital Status			
Single	19	10.6	
Married	161	89.4	
Years Spent in School (years)			
<1	3	1.7	10.35
1-6	44	24.7	
7-12	102	57.2	
>13	31	17.4	
Household size (persons)			
<5	51	28.3	8.0
5-10	99	55.0	
11-15	20	11.1	
>16	10	5.6	
Farm Size (hectares)			
<1.0	17	9.4	5.55
1.01-2.00	41	22.8	
2.01-3.00	22	12.2	
>3.01	100	55.6	
Farming Experience (years)			
<10	110	60.1	13.16
11-20	45	25.0	
21-30	16	8.9	
>30	9	5.0	
Extension Contact (times)			
<3	167	92.8	1.09
>4	13	7.2	
Annual Income (naira)			
<N100,000	68	37.8	461,785.53
N100,001 – N300,000	89	49.4	
N300,001 – N500,000	15	8.3	
>N500,001	8	4.4	

Source: Field Survey, 2021

3.2 The Livelihood Strategies Engaged in and Income Realized from them

The result on livelihood strategies engaged in and income realized from them as presented in Table 3 showed that majority (23.3 %) of respondents were more diversified in cultivation of cassava with average income earned to be N82,688.89, 22.2 % cultivated yam with average income of N166,257.14, 18.3 % cultivated rice and earned income of N139,757.58, 8.3 % cultivated soybeans with average income earned of N129,130.; 6.7% cultivated guinea corn and earned income of N143,750.00, 6.1 % cultivated maize and earned N89,444.44, 5.0 %

cultivated cowpea (beans) and earned N101,428.57, 3.9 % cultivated groundnuts and earned N67,533.33, 1.1 % cultivated sesame (beniseed) and earned N107,500.00, and 0.6% cultivated bambaranut and earned N70,000.00. This implies that most of the respondents were involved in diversification by participating in more than one farm activity thereby cultivating several crops. This is in line with Yusuf (2013) who reported that most farming households diversify their farming into cultivating other crops other than one type of crop.

Table 3: Livelihood strategies engaged in and income realized from them

Livelihood Diversification Strategies	Frequency (F)	Percentage (%)	Average Income (₦)	Standard Deviation
Beans	9	5.0	101,428.57	75537.755
Rice	33	18.3	139,757.58	90,421.247
Cassava	42	23.3	82,688.89	69,297.062
Potatoes	8	4.4	23,500.00	23,334.524
Guinea corn	12	6.7	143,750.00	142,722.258
Maize	11	6.1	89,444.44	38,907.297
Soybeans	15	8.3	129,130.43	90,574.080
Groundnuts	7	3.9	67,533.33	34,983.397
Yam	40	22.2	166,257.14	173,600.343
Beniseed (Sesame)	2	1.1	107,500.00	102,530.483
Bambaranut	1	0.6	70,000.00	0.000000
Mean			**101,908.22**	

Source: Field Survey, 2021

3.3 Food Security Status of Farming Households

Table 5 presents the result on food security status of farming households. A mean per capita annual food expenditure of N 97,494.44 was used to classify the households either as food secure or food insecure. The result showed that, majority (60.0 %) of respondents were found to be food secure while 40.0 % were found to be food insecure. This implies that most households were food secure, but also attaining food security is still a challenge in the study area since households (40%) experience chronic food insecurity problems annually. The result disagrees with the findings of Biam and Tavershima (2020) who found that 43.1% of the households were food secure, and 56.9 % were food insecure in their study on the food security status of rural farming households in Benue State, Nigeria.

3.4 Constraints to diversifying livelihoods

Multiple responses were used to determine the constraints toward farmer's diversification into other enterprises. It was found that; inadequate access to credit, unstable market price of commodity, unstable electricity, poor access to market, inadequate infrastructure, appreciation of tax rate, inadequate skill labour supply and high cost of rent for business premises all stand as bottle necks for farmers achieving diversification.

Inadequate access to credit

The result shows that inadequate access to credit (99.4 %) was the most identified constraints hindering farmers from diversifying to other enterprises. Most farmers are willing to get engaged into other enterprises so as not to be entangles to only one enterprise but they are handicap due to inadequate and unavailability of credit support from government and other financial institutions. This implies that, farmers who are poor and are not supported with credit facilities will tend to stick to cultivation of a particular cash crop. This is in line with the findings of Saha and Bahal (2014) and Degefa (2015) who found that farmers inability to obtain credit facilities restrict their potentials to harness opportunities from other crop enterprises.

Table 4: Food security status of farming households

Food Security Status	Proportion of households	Percentage (%)
Food insecure	72	40.0
Food secure	108	60.0
Total	180	100.0

Source: Field Survey, 2021

Unstable market price for commodities

The result shows that about 80.0% of respondents were of the view that instability of market price for commodities is one of the problems hindering farmers from achieving diversification. Unstable market prices makes farmers lose tract of appreciable prices of commodities. This discourages farmers from diversifying since they thought, they might lose their initial capital if invested into some crop enterprises. This is supported by Ellis and Freeman (2017) who found that, continuous reduction in prices of commodities discourage farmers intentions of investing in such enterprises. Also Dereje (2016) reported that price instability of agricultural products especially when prices are on the decrease prevents farmers from cultivating crops whose prices are low but tend to cultivate crops whose prices tend to increase.

Unstable electricity

The result also reveals that 78.3 % of respondents identified unstable electricity as another constraint towards attaining diversification. Most of the farmers who indulge in the processing of products to add value so as to receive appreciable prices are hindered due to incessant electricity power supply. Electricity power supply lowers the processing cost and when unstable, it makes farmers who carryout processing activities spend more money in processing agro-products. According to Omonfonwam (2018) unstable electricity prevents most farmers from diversifying to crops which needs value addition for appreciable prices. The findings are also supported by Martins and Lorenzen (2016) who pointed out that poor electricity supply prevents most farmers willing to invest in other crop enterprises from doing so considering the hike in prices of alternative sources of power.

Poor access to market

About 60.8% of respondents indicated that poor access to market also is a constraints hindering farmers from achieving livelihood diversification strategies. Some market structures prevents most farmers entry and this makes it difficult for most farmers who do not want to only stop at cultivation but also to explore the market opportunities not to participate in some livelihood diversification strategies. This is in accordance with the findings of Onunka and Olumba (2017) who pointed out that, most farmers refuse entry into other crop enterprise since they cannot participate in market activities which are most a times profitable than just cultivation of the crop.

Inadequate infrastructure

About 40.0% of respondents gave their responses amounting to acceptance that inadequate infrastructure is also a constraint towards farmers getting involved in other livelihood diversification strategies. This problem of infrastructure prevented farmers from enjoying economies of scale which could be provided by infrastructure facilities such as electricity, water supply, processing plants, warehousing, etc. This makes many farmers not explore other areas of investments and thus restricts their diversification abilities. This is in line with the findings of Sowami (2018) who suggested that a lack of infrastructure prevents farmers from being involved in the processing and packaging of products. Also in tandem with the findings of Tshikalma *et al*. (2015) who opined that poor infrastructures activities prevents farmers from indulging into other production activities which are profitable.

Appreciation in tax rate

The study found that, about 24.4% of respondents agreed to appreciation of tax as a constraints towards livelihood diversification by farmers. This is so because, rural farmers are mostly involve in the production of crops and where there is high tax charges, the farmers tend to avoid this and thus preventing them from getting involved into other livelihood strategies. For instance, if there are high taxes for transporting agro produce, farmer will tend

to sell their produce at the farm gate to avoid further expenses on transportation since they are poor farmers. These findings coincide with that of Ihimodu (2014) who found that high market taxes prevent farmers from diversifying into marketing of products in the agricultural markets. Haddabi *et al*. (2019) also contributed that, most farmers do not get involved in the processing of agricultural produce due to the high cost of processing.

Inadequate skilled labour supply

The results revealed that, about 22.8 % of respondents were of the view that inadequate skilled labour supply prevents them from diversifying into strategies. Most farmers are unskilled and thus only produce their products and get them sold at the farm gate. They are not learned and thus lack marketing skills, communication skills, processing skills and much more. This by implication makes these farmers to become limited in selling their produce only at the farm gate. This is in tandem with the findings of Kuwornu et al. (2013) who found out those farmers who are unskilled findings if difficult to diversify into other areas of crop enterprises since they lack knowledge of some crop enterprises. Similarly, Kyeremeh (2014) reported that most unskilled farmers tend not to adopt innovations and thus finds it challenging to indulge in other livelihood activities with ease.

High cost of rent for business premises

The result also shows that 5.0% of respondents agreed on high cost of rent for business premises as other constraints preventing most farmers from getting involved into livelihood diversification strategies. This shows that, the cost of rent for warehouses, storage rooms, shops is high and most farmers could hardly afford to pay. By implication, the cost of rent prevents farmers from diversifying into some livelihood diversification strategies. This is in line with the findings of Kassie (2016) who found that farmers who wish to diversify their productions process into marketing and distribution become handicap due to high cost of rent for land. These findings also coincide with that of Kyeremeh (2014) who reported that high cost of rent for assembling produce in the urban areas prevents most farmers from diversifying into transportation and marketing of agricultural produces which limits them to sale their produce at farm gate.

Table 5: Multiple Responses on the Constraints to diversifying livelihoods

Constraints	Frequency (F)	Percentage (%)	Rank
Inadequate access to credit	179	99.4	1
Poor access to market	109	60.8	4
Inadequate skilled labour supply	41	22.8	7
High cost of business premises	9	5.0	8
Unstable market price of commodity	144	80.0	2
Appreciation in tax rate	44	24.4	6
Inadequate infrastructure	72	40.0	5
Unstable electricity	141	78.3	3

*Multiple responses

Source: Field Survey, 2021

4. CONCLUSION AND RECOMMENDATIONS

The study concludes that a larger proportion of arable crop farmers are involved in livelihood diversification activities for improve income generations so as to take care of their households needs. This suggests that, there is need for arable crop farmers to get involved more into livelihood diversification activities so as to provide food for the household, increase their income earnings and in turn boost agricultural and nonagricultural activities for a developed economy. Based on the findings of this study, it is therefore recommended that:

i. Government should provide access to credit facilities so as to encourage farmer's easy swing into

livelihood diversification activities with benefits from economy of scale.

ii. Government should formulate policies and provide infrastructure facilities to help farmers improve their income

iii. Agricultural policies should be targeted towards livelihood diversification strategies that ensure food security status of small scale farmers.

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Maturation Period and Nitrogen Fixing Capacity of Some Cowpea (*Vigna unguiculata* L Walp) Varieties in Okigwe, Southeastern Nigeria

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ABSTRACT

The field experiment was carried out at Umulolo via National Horticultural Research Institute, Mbato, Okigwe Imo state, Nigeria in 2020 and 2021 to assess the maturation period and nitrogen-fixing capacities of some cowpea varieties in the rainforest ecology of southeastern Nigeria. The experiment was laid out in a randomized complete block design. The treatments were assigned in three replications. The treatments were seven cowpea varieties; IT98K-506-1, IT86D-719, IT89KD-391, IAR-48, IT90K-277-2, IT89KD-288 and Ife-brown. IT98K-506-1, IT98KD-391 and IT89KD-288 and attain early to 50% flowering between 42.23 - 44.71 days in 2020, and between 43.61 - 43.93 days in 2021. The most delayed to 50 % flowering, above 90 days in both cropping seasons, were recorded in Ife brown and IT86-D-719. The number of days to 50 % maturity as influenced by cowpea varieties differed significantly among the cowpea varieties, IT98-506-1 attained 50% maturation at 72.27 and 71.55 days in both cropping seasons followed by 88.92 and 91.33 days, respectively, recorded in IT89KD-391. Ife brown took the longest days to attain 50% maturity; 125.90 and 124.65 days in 2020 and 2021, respectively. IT89KD-391 had the significant grain yield of 1961.53kg/ha and 1904.17 kg/ha in both cropping seasons while the least grain yield; 963.41kg/ha and 965.72kg/ha was recorded from IT98K-506-1. IT90KD-288 had a significantly higher number of root nodules per plant; 85.01 and 86.34 in both cropping seasons, followed by 75.16 and 74.34 recorded in IT86KD-719. The least number of root nodules per plant; 37.33 and 39.60 was recorded in IT90K-277-2. IT90KD-288 had significant biomass accumulation of 1051.34 and 1047.11kg/ha in the 2020 and 2021 cropping seasons, respectively, followed by 1023.34 and 1030.13 kg/ha respectively, recorded in IT89KD-391. The least

biomass; 550.45 and 562.91 kg/ha in both cropping seasons, respectively was recorded in IT90K-277-2.

INTRODUCTION

Cowpea (*Vigna unguiculata* (L.) Walp) is an annual self-pollinated plant. It has been ranked as the most economically important indigenous African legume crop (Moussa et al. 2011; Horn et al. 2022). is one of the most important versatile and nutritive legumes that is being consumed along with starchy food menus such as yam, processed maize products, sweet potato, etc., Production of this crop is so much cherished nowadays as FAO (2022) reported that the global production of primary crop commodities reached 9.5 billion tonnes in 2021, increasing by 54 percent since 2000 and 2 percent since 2020. Cowpeas of different varieties are cultivated all over agro-ecological zones of West Africa based on local preferences for yield, resistance to pests and diseases, maturation period, grain size, grain colour, storability and taste (MOFA, 2011; Ikeh et al. 2017). It contains 23-30% protein content, 50-67% carbohydrate, 1.9% fat, 6.35% fibre and a small percentage of the B vitamins such as folic acid, thiamine, riboflavin as well as some micronutrients (Iron, Phosphorus, Zinc and Calcium) which improve human nutrition, health status and income generation (Udoh and Ndon, 2016).

More than 7.4 million tons of dried cowpeas are produced worldwide, with Africa producing nearly 7.1 million. Nigeria, the largest producer and consumer, accounts for 48% of production in Africa and 46% worldwide (IITA, 2023). The grains contain 25% protein and several vitamins and minerals. The plant tolerates drought, performs well in a wide variety of soils, and being a legume replenishes low-fertility soils when the roots are left to decay. It is grown mainly by small-scale farmers in developing regions where it is often cultivated with other crops as it tolerates shade. It also grows and covers the ground quickly, preventing erosion (IITA, 2023). IITA scientists have developed high-yielding varieties that are early or medium maturing and have consumer-preferred traits such as large seeds, seed coat texture, and color. A number of the varieties have resistance to some of the major diseases, pests, nematodes, and parasitic weeds. They are also well-adapted to sole or intercropping (IITA, 2023).

According to Boukar et al (2018), cowpea is grown predominantly in the dry savannahs to the Sahel in the fringes of the Sahara Desert, where the annual rainfall is around 300 mm or less annually. It can grow under harsh environmental conditions where other major crops fail to grow (Pereira et al. 2020).

It provides an important source of food nutrients such as protein, carbohydrates fat/oils, minerals and vitamins for human beings and livestock. The distinctive feature of grain legumes such as cowpea is their ability to utilize atmospheric nitrogen as a nutrient source (Gogoi et al. 2018). Nitrogen is an essential element that plants require in large quantities for growth, development, and production. It is an abundant gas in the atmosphere but plants cannot utilize them as a form of nitrogen. Legumes must reduce atmospheric into ammonia, in a process called fixation (Gogoi et al. 2018). Nitrogen fixation is a biological process, performed by specific species of bacteria. Legume crops such as groundnut, cowpea and soybean do not need application of nitrogen fertilizer due to their ability to fix N in the soil. The grain legumes help in solubilizing insoluble phosphorus (P) in soil, improving the soil's chemical properties, and increasing soil microbial activity. Cowpeas and other legumes have a special significant effect in modern agriculture as the optimization of nitrogen fertilizer, Addition of organic matter to the soil, maintenance and restoration of soil organic carbon (SOC) and minimizing soil pollution through inorganic application of nitrogen fertilizer (Gogoi et al. 2018). For the sake of nitrogen-fixing ability, legumes like cowpeas can support their own growth, development and yield in soil with low fertility status. As legume like cowpea grows, they accumulate a high amount of foliage biomass through the biological process known as photosynthetic carbon (C) fixation. The accumulated biomass finally enriches the soil with carbon by net exudation. This helps in maintaining soil organic carbon.

Considering the numeral beneficial effect of cowpea legume, differences may exist within cowpea varieties in terms of yield and nitrogen fixative capacity. The significant importance of cowpea's ability to fix atmospheric nitrogen in marginal soils where farmers have no access to agricultural inputs such as fertilizers or manure (Bolarinwa et al. 2021) needs to be explored on a variety basis. Akinbile et al. (2021) suggested that N2 fixation will increase in high-yielding environments since the nitrogenase, located in the nodules, will adjust its activity to the demand of the legume (Akinbile et al. 2021). Also, for Nigeria and West African nations to achieve food security, sufficiency and poverty reduction among poor households and smallholder farmers, there is a need to envisage an in deep strategic research of cowpea, especially for the selection of promising cultivars that would thrive and produce an appreciable yield in high humid ecology of southern Nigeria. Considering that variations exist among cowpea varieties, which vary in terms of plant growing habit, seed type, and cropping system, the maturity period is extremely diverse from one agroecological zone to another. Therefore, this study was carried out to identify the promising cowpea varieties with high grain yield and to ascertain the cowpea variety with high nitrogen fixative capacity in the rainforest ecology of Nigeria.

MATERIALS AND METHOD

The study was conducted at Umulolo via the National Horticultural Research Institute, Okigwe Sub-Station during the late planting season of 2019 and 2020. Okigwe is located between latitudes 5°49' 45" N, and longitudes 7° 21' 2" E. It has a mean annual range of rainfall of 80 to 375 mm, mean relative humidity of 79%, and mean temperature of 22.7 to 34°C. The area lies within Nigeria's humid tropical rainforest zone and has two seasons. The seasons are wet and dry season. The wet season starts between March and April and lasts till October, with a brief break in August traditionally referred to as the "August Break." The dry season begins in November and extends to February and late March.

The experiment was carried out on a continuously cultivated land by subsistence farmers and prior to the experiment, egusi melon, okra, and maize were harvested on the experimental plot in July 2019 while cassava, maize, and okra were harvested from the plot used in the second trial.

The experiment was laid out in a Randomized Complete Block Design (RCBD). The treatments were assigned to three replicates. The treatments were eight cowpea varieties; IT81D-95, IT86D-719, IT89KD-391, IAR-48, IT89KD-288, IT90K-277-2, IT98K-506-1 and Ife-Brown. Planting was done in the first week of September 2020 and 2021. Three seeds were planted per plot on a spacing of 75 cm x 30 cm and later thinned down to two stands two weeks after planting (WAP). Hoe weeding was carried out at 3 WAP with the aid of weeding hoes while hand pulling was carried out at 7 WAP.

The following data were assessed from ten tagged plants; emergence percentage was taken at 6 days after planting by counting all the emerged stands of cowpeas in a plot and dividing by the total number of stands planted per plot and multiplying by 100. The number of leaves per plant was determined by counting all the functional leaves from the tagged cowpea plants in a net plot. Leaf area was determined on cowpea leaves using length, and width and multiplying by 2.325 a factor, (Osei et al. 1983). Plant height was determined by measuring the vine length from the base to the terminal bud with measuring tape. The number of days to 50 % flowering was determined when half of the cowpea plants in the plot flowered. The number of days to 50 % podding was determined when half of the cowpea plants in the plot were podded.

The number of days to 50 % maturity was determined when half of the green cowpea pods in the plot dried and turned light yellow or brown. The number of pods per plant was counted according to the treatments. Number of seeds per pods was obtained by counting the number of seeds in each pod. Plant biomass was determined by uprooting the entire plant after harvesting and weighing it on a treatment basis. After harvesting, the plants were uprooted and the number of nodules per cowpea plant was determined by counting the number of nodules formed with the roots of cowpea plant per stand.

After de-hulling, 100 seeds were counted and weighed with the aid of an electronic weighing balance. All the 100 seeds were weighed on varietal bases. Seed yield was determined with the aid of weighing balance in grams (g) and then converted to

kilogram per hectare. All the growth and yield data collected were subjected to analysis of variance. Means that showed significant differences were compared using the least significant difference (LSD) at a 5% probability level.

RESULTS

The emergence percentage of cowpea was not significantly different among the cowpea cultivars, irrespective of any cropping season (Table 1). The range of emergence percentage was 95-100 % in 2020 and 99- 100% in the 2021 cropping season. The length of the vine as influenced by cowpea cultivars differed significantly ($p<0.05$) in the 2020 and 2021 cropping seasons (Table 1). At 9 weeks after sowing (WAS), IT89KD-391 had a significantly longer vine of 138.71 and 140.60 cm in the 2020 and 2021 cropping seasons, respectively. This was followed by 129.25 and 133.01 cm, respectively, recorded in Ife brown. Among the cowpea cultivars, the shortest vine at 9WAS; was 70.34 73.14 cm in 2020 and 2021, respectively.

Table 1: Emergence Percentage and Vine Length (cm) of Cowpea as Influenced by Varieties

Cowpea Cultivars	2020				2021			
	Emergence (%)	Weeks after Sowing			Emergence (%)	Weeks after Sowing		
		3	6	9		3	6	9
Ife Brown	100.00	51.34	100.34	129.25	100.00	54.91	107.88	133.01
IT86D-719	95.00	33.56	81.25	113.40	100.00	35.03	87.66	101.41
IT89KD-391	100.00	60.32	116.33	138.71	100.00	60.06	123.31	140.60
IAR 48	99.00	28.22	55.45	73.40	100.00	28.63	58.65	95.66
IT90KD-288	98.50	37.11	55.11	75.33	99.00	39.14	53.70	81.40
IT90K-277-2	99.00	23.92	40.45	70.34	100.00	25.33	42.09	73.14
IT98K-506-1	100.00	44.30	95.77	120.11	100.00	43.55	100.46	119.21
LSD(p<0.05)	**NS**	**3.36**	**6.41**	**7.69**	**NS**	**2.91**	**5.44**	**6.12**

The number of leaves per plant as affected by cowpea varieties was significantly different ($p<0.05$) at 3, 6, and 9 WAS in both cropping seasons (Table 2). In 2020, IT89KD-391 had a significantly higher number of leaves per plant; 18.33, 62.14 and 167.83 at 3, 6 and 9 WAS, respectively while in 2021, the vine length recorded in IT89KD-391 was 17.97, 85.45 and 155.19 at 3, 6 and 9 WAS, respectively. Ife brown had 12.50, 84.22 and 150.40 leaves per plant in 2020 while the corresponding number of leaves per plant; 14.12, 99.25 and 155.14 was recorded in the 2021 cropping season. The least number of leaves per plant; 8.03, 29.33 and 79.68 in 2020 was recorded in IT90K-277-2. In 2021, the least number of leaves per plant; 9.67, 39.81 and 99.78 at 3, 6 and 9 WAS, respectively was recorded in IT90K-277-2.

Table 2. Number of leaves per plant as Influenced by Cowpea Varieties

Cowpea Varieties	2020			2021		
	Weeks after Sowing			Weeks after Sowing		
	3	6	9	3	6	9
Ife Brown	12.50	84.22	150.40	14.12	99.25	155.14
IT86D-719	11.33	48.13	107.20	10.11	57.18	100.34
IT89KD-391	18.33	62.14	167.83	17.97	85.45	155.19
IAR 48	12.55	89.45	109.22	10.14	90.18	115.77
IT90KD-288	10.61	39.33	90.18	10.78	56.40	100.16
IT90K-277-2	8.03	39.33	79.68	10.67	39.81	99.78
IT98K-506-1	11.45	71.11	101.45	10.69	44.87	101.50
LSD(p<0.05)	**2.49**	**3.73**	**6.69**	**2.81**	**5.72**	**7.30**

Significant differences ($p<0.05$) were observed among the cowpeas for leaf area (Table 3). At 6 WAS, IT90KD-288 had a significantly larger leaf area in both cropping seasons; 129.87 and 131.40 cm2 in 2020 and 2021, respectively. This was followed by 125.81 and 126.59 cm2 recorded in IT89KD-391. Among the cowpea varieties, the least leaf area at 9 WAS; cropping season. At 6 WAS, IT90K-288 had 3-40% and 4-38% significantly larger leaf areas in both cropping seasons, compared to the other varieties.

The number of branches per plant as influenced by cowpea cultivars differed significantly in both cropping seasons (Table 3). IT89KD-288 had a significantly higher number of branches per plant at 6 WAS; 14.33 and 14.69 in 2020 and 2021, respectively. The IT89KD-391 cultivar had 10.59 and 11.18 branches per plant at 6WAS. The least number of branches per plant; 6.18 and 7.50 respectively were recorded in IT86D-719. IT90KD-288 had 26-50% and 24-49% significantly higher number of branches in 2020 and 2021 compared to the other cultivars.

Table 3: Leaf Area (cm^2) of Cowpea and Number of Branches per Plant as Influenced by Cowpea Varieties

Cowpea Varieties	2020		2021	
	Leaf Area (cm) at 6 WAS	Number of Branches per Plant	Leaf Area (cm) at 6 WAS	Number of Branches per Plant
Ife Brown	104.78	10.44	105.33	10.51
IT86D-719	98.90	7.18	100.10	7.50
IT89KD-391	125.81	10.59	126.59	11.18
IAR 48	88.63	8.59	92.75	8.11
IT90KD-288	129.87	14.33	131.40	14.69
IT90K-277-2	89.99	10.15	101.30	10.20
IT98K-506-1	78.14	10.44	81.51	10.25
LSD(p<0.05)	**5.77**	**2.29**	**5.62**	**2.26**

*WAS= Weeks after sowing.
NS= Not Significant

The cowpea cultivars assessed had significant variations in phenological characteristics (Table 4). The number of 50 % flowering, podding, and maturity differs in both cropping seasons (Table 4). IT98K-506-1, IT98KD-391 and IT89KD-288 attain early to 50 % flowering at 42.23, 42.91 and 44.71 days, respectively in the 2020 cropping season. These three cowpea varieties were at 50% at 43.61, 43.73, and 43.93 days, respectively in the 2021 cropping season. The most delayed to 50% flowering were Ife brown and IT86-D-719. Ife brown attained 50% flowering at 90.33 and 90.39 days in the 2020 and 2021 cropping seasons. The IT86D-719 had 50% flowering at 90.30 and 90.31 days in the 2020 and 2021 cropping seasons, respectively. IT98K-506-1 attained early to 50% podding at 56.68 and 55.45 days in 2020 and 2021 cropping seasons, respectively while IT89KD-391 attained 50% podding at 62.24 and 61.45 days in 2020 and 2021 cropping seasons, respectively. The cultivar with the highest number of days to 50% podding; 110.75 and 109.31 in both cropping seasons were recorded in IT86D-719.

The number of days to 50 % maturity as influenced by cowpea cultivars varied significantly differences in both cropping seasons (Table 4). IT98-506-1 matured earlier than other varieties in both cropping seasons. IT98-506-1 attained 50% maturation at 79.22 and 80.45 days in both cropping seasons, followed by 88.92 and 91.33 days, respectively, recorded in IT89KD-391. Ife brown took the longest days to attain 50% maturity; 125.90 and 124.65 days in 2020 and 2021, respectively.

Significant differences ($p<0.05$) were observed in the number of pods per plant (Table 5). IT89KD-391 had the highest number of pods per plant; 33.40 and 31.51 in both cropping seasons. IT89KD-288 produced 30.31 and 29.23 in the 2020 and 2021

cropping seasons, respectively. The least number of pods per; 10.45 and 10.91 was recorded in IT98K-506-1. IT89KD-391 which produced a significantly higher number of pods per plant, had 9-66% and 7-65% number of pods per plant compared to the other cultivars.

A number of seeds per pod as influenced by cultivars varied significantly different ($p<0.05$) in both cropping seasons (Table 5). IT89KD-391 had the highest number of seeds per plant, 10.11 in 2020 and 10.40 in 2021. The least number of seeds per pod, 6.41 in 2020 and 6.63 in 2021 was recorded in IT98-506-1. The weight of 100 seeds of cowpea as influenced by cultivars showed no statistically significant difference ($p>0.05$) among the cowpea cultivars, irrespective of cropping seasons. The weight of 100 seeds of the cowpea cultivars ranges from 17.33-17.87 g and 17. 38-17.81g in 2020 and 2021, respectively.

Table 4: Number of Days to 50% Flowering, Podding, and Maturation as Affected by Cowpea Varieties

Cowpea Cultivars	2020			2021		
	Number of Days to 50% Flowering	Number of Days to 50% Podding	Number of Days to 50% Maturity	Number of Days to 50% Flowering	Number of Days to 50% Podding	Number of Days to 50% Maturity
Ife Brown	90.33	108.32	125.90	91.39	106.40	124.65
IT86D-719	90.30	110.75	122.33	90.31	109.31	124.10
IT89KD-391	42.91	62.24	79.22	43.73	61.45	80.45
IAR 48	60.33	81.70	103.59	61.04	83.33	101.07
IT90KD-288	44.71	66.55	88.92	43.93	64.77	91.33
IT90K-277-2	54.33	82.18	123.45	55.80	80.03	124.41
IT98K-506-1	42.23	56.68	72.37	43.61	55.45	71.55
LSD(p<0.05)	**3.18**	**4.20**	**4.53**	**3.22**	**4.11**	**4.45**

Table 5: Yield and yield components of Cowpea as Affected by Varieties

Cowpea Varieties	2020					2021				
	Number of Root Nodules per Plant	**Number of Pod per Plant**	**Number of Seed per Pod**	**Weight of 100 Seeds (g)**	**Seed Yield (t/ha)**	**Number of Root Nodules per Plant**	**Number of Pod per Plant**	**Number of Seed per Pod**	**Weight of 100 Seeds (g)**	**Seed Yield (t/ha)**
Ife Brown	39.76	20.23	6.90	17.61	1678.01	38.81	20.16	6.77	17.60	1677.65
IT86D-719	45.16	21.14	8.12	17.67	1560.90	44.34	23.11	8.14	17.63	1566.52
IT89KD-391	25.19	33.40	10.11	17.81	1961.53	26.14	31.51	10.40	17.81	1904.17
IAR 48	27.67	28.23	7.39	17.46	1713.69	28.04	26.70	7.55	17.76	1710.00
IT90KD-288	51.01	30.31	10.07	17.87	1790.81	56.34	29.23	10.09	17.57	1770.50
IT90K-277-2	17.33	18.33	7.11	17.33	1088.80	15.23	19.60	7.17	17.38	1090.61
IT98K-506-1	26.41	10.45	6.41	17.56	963.41	26.33	10.91	6.63	17.70	965.72
LSD(p<0.05)	**4.23**	**3.31**	**2.32**	**NS**	**17.18**	**4.40**	**3.40**	**2.25**	**NS**	**18.05**

Cowpea seed yield as influenced by cultivars differed significantly ($p<0.05$) in both cropping seasons (Table 5). IT89KD-391 had a significant grain yield of 1961.53kg/ha and 1904.17 kg/ha in both cropping seasons. IT90KD-288 had 1790.81 and 1770.50 kg/ha in both cropping seasons. The least cowpea grain yield 963.41 kg/ha and 965.72 kg/ha was recorded from IT98K-506-1. The experimental result showed that IT89KD-391 produced 17-49 % and 19-50% grain yield compared to the other cowpea varieties in 2020 and 2021, respectively.

The number of root nodules per plant as affected by cowpea cultivars varied significantly in both cropping seasons (Table 6). IT90KD-288 had significantly higher number of root nodules per plant; 85.01 and 86.34 in both cropping seasons. This was followed by 75.16 and 74.34 recorded in IT86KD-719. The least number of root nodules per plant; 37.33 and 39.60 in both cropping seasons, was recorded in IT90K-277-2. The result revealed that IT90KD-288 had 12-54% and 13-59% significantly higher number of root nodules per plant in 2020 and 2021 compared to the other cowpea varieties assessed.

The biomass accumulation as influenced by cowpea varieties is shown in Table 6. The result of biomass accumulation varied by significant difference ($p<0.05$) in both cropping seasons. IT90KD-288 had significant biomass accumulation of 1051.34 and 1047.11kg/ha in the 2020 and 2021 cropping seasons, respectively. This was followed by 1023.34 and 1030.13 kg/ha respectively, recorded in IT89KD-391. The least plant biomass; 550.45 and 562.91 kg/ha in both cropping seasons, respectively was recorded in IT90K-277-2.

Table 6: Number of Root Nodules per Plant, Biomass, and Weight as Influenced by Cowpea Varieties

Cowpea Varieties	Root Nodules per plant		Biomass Weight (Kg/ha)	
	2020	2021	2020	2021
Ife Brown	69.76	68.81	1005.34	1010.09
IT86D-719	75.16	74.34	7113.45	716.45
IT89KD-391	55.19	56.14	1023.34	1030.13
IAR 48	57.67	58.04	856.13	852.44
IT90KD-288	85.01	86.34	1051.34	1047.11
IT90K-277-2	37.33	35.23	550.45	562.91
IT98K-506-1	56.41	56.33	871.55	884.33
LSD(p<0.05)	**4.23**	**4.40**	51.01	53.53

DISCUSSION

The result of the study showed no significant difference ($P<0.05$) in emergence percentage. This observation indicated that all the cowpea cultivars assessed had a high germination percentage. The cowpea cultivars used for the study varied on showed significant variations in vegetation traits, such as the number of leaves per plant, leaf area, and plant height. The significant differences observed in the growth and yield of cowpeas could be attributed to varietal differences in relation to the different genetic constitutions of each cultivar. The differences observed showed that different cowpea cultivars had different morphological characteristics. This observation agreed with Ikeh et al. (2013) who reported that the growth habit of cowpea varieties differs. The differences that exist among cowpea varieties were attributed to their inherent characteristics due to the different genetic makeup of each cultivar. The result showed significant differences in the number of days to 50% flowering, podding, and maturation. The differences in phenological characteristics of cowpea could be attributed to inherent differences between different cowpea varieties. Udonnah (2017) reported significant differences in the number of days to 50% flowering of cowpeas grown in the highly humid zone of southeastern Nigeria.

The differences in the yield and yield components assessed could be due to the higher number of pods per plant, the number of seeds per pod, and the weight of 100 seeds. This observation agrees with Futuless and Bake (2013), that the yield evaluation of cowpea cultivars usually involves the consideration of other characters and is therefore influenced by a number of traits acting singly or interacting with each other, earliness to the number of days to flowering, pod filling period, number of days to physiological maturity, number of branches per plant, pod length, number of seeds per pod, weight of 100 seeds and necessary agronomic practices contributed to seed yield.

In this study, nodule numbers varied among the cowpea varieties, some were low while some had a higher number of nodules per plant. The significant variation in the number of root nodules per plant could be a result of genetic differences existing among the cowpea varieties, this observation was in consonance with the report of Akinbile et al. (2021), that varietal differences account for nodule differences since the pattern of nodulation, most often, reflects the physical distribution of the root system in the soil. Hansen (1994) stated that nodulation capacity is known to vary between and within legume species. Agyeman et al. (2014) reported that cowpea varieties producing more nodules possess the capacity to fix nitrogen into the soil.

CONCLUSION

The result of the study revealed that variation exists among cowpea varieties in terms of vegetative traits, plant biomass, and nodulation capacity as well as grain yield. IT89 KD-391 produced appreciable grain yield in the study area. Farmers in the study were advised to adopt IT89 KD-391 for high grain yield. For soil improvement, IT89KD-391, IT89KD-288 and Ife-brown which produced significant root nodules per plant and larger plant biomass may have high nitrogen-fixing capacities compared to the other varieties. IT89KD-391, IT89-KD-288 and IT98K-506-1, matured early while Ife-brown matured late compared to the other varieties used for the study.

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Pathogenicity and Survey of Root Rot Disease of Cotton in Different Villages of Dir Upper and Dir Lower Khyber Pakhtoon Khwa Pakistan

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ABSTRACT

The Survey was conducted for, the pathogenicity of root rot disease of cotton in different Village of Dir Lower and Dir Upper provoked by *Rhizoctonia* spp. 10 major cotton-growing Villages in Dir Upper and Dir Lower during Kharif 2019 and Kharif 2020. A roaming survey to record cotton root rot incidence was conducted in 10 major cotton-growing Villages of Dir Upper and Dir Lower during the months of July and August for consecutive two Kharif seasons 2019 and 2020. An average of 4 growing regions of cotton in each district was visited and the percent disease incidence was recorded. Among all the surveyed Village of Dir Upper, the maximum mean disease incidence was recorded in Samarbagh (18.75%) followed by Garrah (15.25 %), and Munda (15%), While the minimum disease incidence was recorded in Kabal and Charkhi Dadri 9.25% in both during kharif 2019. Among all the surveyed Village of Dir Upper, the maximum mean disease incidence was recorded in Samarbagh (18.25%) followed by Munda (15.25%), Garrah (15.42%), While the minimum disease incidence was recorded in Charkhi Dadri (9.08%). From the overall study, it can be understood that there is a prevalence of root rot disease in major mulberry growing locations in Dir Upper. Therefore, resistant cotton varieties are needed of the hour to address the grower's problem along with best management strategies including efficient biocontrol agents which can minimize the disease to a greater extent. Therefore, a study should be undertaken to determine the disease prevalence in other locations.

INTRODUCTION

The word 'cotton' refers to four species in the genus Gossypium (Family Malvaceae), namely *G. hirsutum* L., *G. barbadense* L., *G. arboreum* L. and *G. herbaceum* L. that are domesticated independently as sources of textile fiber. Globally, the Gossypium genus comprises about 50 species (Craven et al.1992). During the year 2020-23, Pakistan is the 2nd largest country in world in terms of area under cotton is 133.50 lakh hectares which is 41% of the world cotton area. In terms of production, the

country shares the leading position with China at 290 lakh bales of 480 lb (equivalent to 371 lakh bales of 170 kg). Cotton fiber is the purest source of cellulose and the most significant natural fiber. The economic significance of cotton in the global market is evident by its majority share of over (50%) of fibers for textile goods (Anonymous et al. 2023). It is harvested as 'seed cotton' which is then 'ginned' to separate the seed and lint. The long 'lint' fiber is further processed by spinning to produce a yarn that is knitted or woven into fabrics. The ginned seed is covered in short, fuzzy fibers, Known as linters. Cotton is currently the leading plant fiber crop worldwide and is grown commercially in temperate and tropical regions of more than 50 countries (Chase et al. 1993). Specific areas of production include countries such as the USA, India, China, the Middle East, and Australia, where climatic conditions suit the natural growth requirement of cotton, including periods of hot and dry weather, and where adequate moisture is available, often obtained through irrigation. The cotton crop is grown extensively with a limiting factor, that is infected by fungal diseases like anthracnose (*Collectotrichum gossypii*), leaf blight (*Alternaria macrospora*), wilt (*Fusarium oxysporum* f. sp. vasinfectum), Ramularia leaf spot (*Ramularia areola*), root rot (*Rhizoctonia bataticola* and *Rhizoctonia solani*) etc. Out of all the diseases, root rot of cotton is the most devastating disease and now a days this disease has become a major limiting factor in cotton cultivation. The management of root rot of cotton is of major concern wherever, cotton is cultivated thus, keeping in view the importance of the crop and destructive nature of disease and the extent of losses it is causing to cotton cultivation in the state, the present investigation studies were undertaken. *Rhizoctonia* is a widespread, destructive and versatile plant pathogen, distributed worldwide in both agriculture and forest soils and are known to cause root diseases of several crop plants. *Rhizoctonia bataticola* (Taub.) Butler as a plant pathogen was recognized by Halsted. Taubenhaus gave the name of the genus *Sclerotium* because of the absence of spores and the species name as bataticola because it was pathogenic to *Ipomea batatus* (L.) Lam (Taubenhaus, 1913). According to the International Code of Botanical Nomenclature, the binomial *Macrophomia phaseolina* was the valid name for the pycnidia stage of *R. bataticola*. Mycelia width varied from approximately 2-11µm and distance between two consecutive septa measured 46µm. However, the most important character regarding taxonomy and classification was the production size and composition of microsclerotia the fungus produces root-like (rhizomorph) strands that grow through the soil until coming in contact with growing plant roots. Strands grow on roots toward the soil surface. Immediately below the soil surface in cotton, the fungus proliferates around the hypocotyl, producing a cottony, mycelial growth. The bark is destroyed by this mycelium and the fungus fills the vascular tissue of the plant. Sclerotia form in the strands following the death of the plant. Sclerotia form from strands and the cells divide, grow and enlarge (Ullah et al. 2023). These sclerotia are small (1/32 to 1/16 inch in diameter), densely compact masses of thick-walled cells. Sclerotia enables the fungus to persist in fallow soil or soil planted to resistant crops for several years. Sclerotia have been found up to 12 feet deep in some soils. Sclerotia within plant parts were black, smooth, hard and varied in size from 100 µm-1mm while in culture, it varied from 50-300µm. These descriptions were given by the Common wealth Mycological Institute (CMI), Kew, England. During the sclerotia formation, 50–200 individual hyphal cells aggregate to give multicellular bodies called microsclerotia. The microsclerotia were black and variable in size from 50–150µm depending on the available nutrients of the substrate on which the propagules were produced (Short, 1978). Symptoms are most likely to occur from August through September when soil temperatures reach 28°C (82 °F). The first symptoms are slight yellowing or bronzing of the leaves. The uppermost leaves wilt within 24 to 48 hours after bronzing, followed by wilting of the lower leaves within 72 hours. Progressive wilting, premature dying, loss of vigour and reduced yield are characteristic features of M. phaseolina infection. Permanent wilt occurs by the third day, followed by death. The leaves remain firmly attached to the plant. Affected plants die suddenly, often after excellent growth. Trees and shrubs may die more slowly. Roots are usually extensively invaded by the fungus by the time wilting occurs. Affected plants can be pulled from the soil with little effort. The root bark is decayed and brownish, bronze-colored wooly strands of the fungus are frequently apparent on the

root surface (Ullah et al. 2023). The fungus generally invades new areas by continual slow growth through the soil from plant to plant. It may also be moved about on roots of infected plants moved to new areas. The fungus can survive in the soil for many years and often is found as deep in the soil as roots penetrate. Affected areas often appear as circular patterns of dead plants. These areas gradually enlarge during the season or in subsequent years as the fungus grows through the soil from plant to plant. Infested areas in cotton may increase 5 to 30 feet per year in cotton (Yadav et al. 2017). The pathogen *M. phaseolina* generally affects the fibro vascular system of the roots and basal internodes and impends the transport of nutrients and water to the upper parts of the plant. The disease actually starts much earlier and its above-ground manifestation in the form of wilting is a very late symptom. The affected plants can easily be pulled out of the ground. The bark of roots is broken into shreds and gives a yellowish appearance as compared to healthy plants. Examination of affected parts reveals a dry rot, with many tiny black sclerotia distributed throughout the wood and softer tissues (Ullah et al. 2020). The aims and objectives of the research are to control the loss of crops and able the crops to survive in the environment. The main aim was to explore the possibility of the existence of different species and/or variables of root rot pathogen.

MATERIALS AND METHODS

A roving survey to record cotton root rot incidence was conducted in ten major growing Villages of Dir Upper and Dir Lower during the months of August and September for the consecutive two Kharif seasons 2019 and 2020. an average of 4 growing regions of cotton in each district were visited and the percent disease incidence was recorded by counting the total cotton plant in a 1 x 1m^2 area and total root rot infected plants. Plants showing typical symptoms were also investigated for microscopic association of pathogen and final confirmation of pathogen by isolation, purification, and characterization. Typical symptoms like the straw-colored appearance of plants at pod formation, black rotted roots, shredding of bark, and roots broken easily with the presence of minute dark black sclerotial bodies on root surfaces were considered for identification of disease. The percent disease incidence was calculated as per the formula given below-

$$\text{\% Disease Incidence} = \frac{\text{Number of Diseased plants}}{\text{Total number of plants}} \times 100$$

Survey for incidence and collection of disease samples

The diseased samples of cotton showing typical root rot symptoms were collected in Kharif 2019 and Kharif 2020 from farmer's fields of different cotton growing areas of Dir Upper and Dir Lower viz., Garrah, Munda, Samarbagh, Mayyar, Timergara, Malakand, Maidan, Hall, Kabal, Chitral all from local landraces. The main aim was to explore the possibility of the existence of the different species and/or variables of root rot pathogen, and incidence caused by them, and the survey was conducted in four villages selected randomly from each district and four fields from each village. The infected plants were carefully uprooted and placed in polythene bags, properly tagged and brought to the laboratory, and subjected to microscopic examination and tissue isolation.

Isolation, purification, and identification of pathogen

The pathogens were isolated on a potato dextrose agar (PDA) medium. Small pieces (1-2 mm) of diseased roots were cut, washed with sterilized water, surface sterilized with 0.1 percent sodium hypochlorite (NaOCl) solution for 1 minute followed by three to four washings with sterilized distilled water, and were transferred aseptically to 2 percent PDA (Potato Dextrose Agar) poured Petri plates. The plates were incubated in an incubator at 28 ± 1 °C for 7 days. Hyphae coming out from the bits were subcultured on the fresh PDA in Petri dishes. From these bits mostly cultures of *Rhizoctonia* spp., *Sclerotium* spp. and *Fusarium oxysporum* were recovered. The culture of *Rhizoctonia* was purified by single hyphal tip method. A total of 21 isolates of *R. bataticola* and *R. solani* in which 16 were *R. bataticola* and 5 were *R. solani.*

Pathogenicity test

The pathogenic ability of Rhizoctonia spp. was tested in a screen house on cotton cultivars HD 432 and RCH 773. Culture of Rhizoctonia was raised in a 250ml Erlenmeyer flask containing 50ml of PDB sterilized at 15 lbs. per sq inch pressure for 20 minutes. The bits of 5mm size were cut with the help of a sterilized cork borer from fresh pure culture plates (5 days old) and transferred into flasks with the help of a sterilized needle under aseptic conditions. After 7 days of incubation in a BOD incubator at 27 ± 1^{o}C, mycelial mats were collected and dried between folds of blotting paper for further studies. Five-gram fresh mycelial mat was homogenized in blender for 2 minutes at the lowest speed in 1000ml of sterilized water. The suspension was used to inoculate the pots containing 10kg of sand: ground cotton seed mixture (9:1) which was sterilized by autoclaving at 15lbs/ inch pressure for one and half hours for two consecutive days. On the third day of inoculation fifteen seeds of cotton cultivars, HD 432 and RCH 773 were sown in each plot. A separate set of un-inoculated pots was kept as control. Pots were irrigated regularly to maintain moisture. After 45 to 60 days of sowing, the symptoms appeared and the infected plants exhibited elongated lesions at the collar region which were later converted to dark brown to black and the stem was completely girdled by the lesions. The affected plants wilted, dried up later and can be uprooted easily. Diseased plants were brought to the laboratory and isolations were made on the PDA medium from diseased stem to confirm the identity of the pathogen.

RESULTS AND DISCUSSION

The intensive survey was carried out during kharif, 2019 and 2020 in the cotton growing Village of Dir Upper viz., Garrah, Munda, Samarbagh, Mayyar, Charkhi Dadri, Malakand, Maidan, Hall, Kabal, Chitral to record the incidence of root rot in different Village. Cotton root rot incidence during Kharif, 2019 ranged from 7.67 to 19.67. The data of Table 2 revealed that Talash village in Samarbagh district had the maximum disease incidence (19.67 %) followed by Talash Bala (19.00%) and 18.33% Walay kandu and Khazana, whereas, least disease incidence (7.67%) was recorded in village Sar Banda located in Kabal District. The results of the survey conducted in Garrah district showed that Rahim abad had the highest disease incidence (16.67 %) followed by Gudar (15.33%) and Gusam (15.00%) and the minimum disease incidence was recorded in Ghuban village (14.00%). In Munda district, the maximum disease incidence was recorded in Ludeshar (16 %) followed by Gusam Bala and Dabar (15.00%) while the minimum was recorded in Khungi (13.33 %). In Mayyar district, the maximum disease incidence was recorded in Mahay village (13.33%) followed by Malala (10.67%) and Kotkay (10.00%) while the minimum was recorded in Mahay Band (9.33%). In Charkhi Dadri district, the maximum disease incidence was recorded in Shukas (11.33%) followed by Ghasolasha and Sherhany (8.67%) while the minimum was recorded in Malala qalagay (8.33%). In Mahendargarh district, the maximum disease incidence was recorded in Arrang (14.33%) followed by Narang (14 %) and Arrang bala (12.33%) while the minimum was recorded in Narang qala (10.67%). In Maidan district, the maximum disease incidence was recorded in Mamund Kotu (14.33%) followed by Bajaur (12.33%) and least was recorded in both Qala Munda and Mamund (11.67%) In Hall district, the maximum disease incidence was recorded in Tnagay Har (12.33%) followed by Tnagay (11.33%) and Dandusha (9.67%) while the minimum was recorded in Shalkanday (9.33%). In Kabal district, the maximum disease incidence was recorded in Laat (11.67%) followed by Maskeeny (9.00%) and Ghazi Baba (8.67%) while the minimum was recorded in Sar Banda (7.67%). In the Chitral district, the maximum disease incidence was recorded in Mangai (11.67%) followed by Mardan (11.33%) and the minimum was recorded in Sheen Ghar (10.33%) and the least was found in Swabay (10.00%). Among all the surveyed Village of Dir Upper the maximum mean disease incidence was recorded in Samarbagh (18.54%) followed by Munda (15.75%), Garrah (15.33%), Malakand (12.92 %), Maidan (12.75%), Mayyar (11.38%), Chitral (11.00%), Hall (10.54%) and Kabal (9.63%) While the minimum disease incidence was recorded in Charkhi Dadri 9.17% during kharif, 2019 depicted in Table 1. Cotton root rot incidence during Kharif 2020 ranged from 8.00 to 18.67. Among the surveyed villages in different Village of Dir Upper, Talash Bala village in Samarbagh district had maximum disease incidence as 18.67% followed by Talash and Khazana both had 18.33% disease incidence in both villages and least was in Walay kandu (17.67%) whereas, over all least disease

incidence was recorded in village Sherhany (8.00%) located in Charkhi dadri district. The results of the survey conducted in the Garrah district showed that village Gudar had the highest disease incidence (16.33 %) followed by Balsamanad (16.00%), Gusam (15.67 %) and the minimum disease incidence was recorded in Ghuban village (13.67 %). In Munda district, the maximum disease incidence was recorded in Ludeshar (17.67 %) followed by Dabar (17.00%) and Khungi (16.33%) while the minimum was recorded in Gusam Bala (15.67%). In Mayyar district, the maximum disease incidence was recorded in Mahay (14.00%) followed by Malala (12.67%) and Kotkay (11.67%) while the minimum was recorded in Mahay Band (9.33%). In Charkhi dadri district, the maximum disease incidence was recorded in Shukas (10.33%) followed by Ghasolasha (9.33%) and Malala qalagay (8.67%) while the minimum was recorded in Sherhany (8.00%). In Mahendargarh district, the maximum disease incidence was recorded in Arrang (15.33%) followed by Arrang bala (13.67%) and Narang (12.67%) while the minimum was recorded in Narang qala (10.33%). In Maidan district, the maximum disease incidence was recorded in Mamund (14.67%) followed by Qala Munda (14.33%) and Mamund Kotu (12.67%) while the minimum was recorded in Bajaur (10.33%). In Hall district, the maximum disease incidence was recorded in Tangay (12%) followed by Tnagay Har (11%) and Shalkanday (9.67%) while the minimum was recorded in Dandusha (9%). In Kabal district, the maximum disease incidence was recorded in Ghaseda (10.67%) followed by Laat (10.00%) and the least was recorded both in Sar Banda and Ghazi Baba (9.67%). In the Chitral district, the maximum disease incidence was recorded in Mardan (12.67%) followed by Mangai (11.33%) and Dagay (10.33%) while the minimum was recorded in Sheen Ghar (10.33%). Among all the surveyed Village of Dir Upper the maximum mean disease incidence was recorded in Samarbagh (18.25%) followed by Munda (16.67%), Garrah (15.42%), Malakand (13.00%), Maidan (13.00%), Mayyar (11.92%), Chitral (11.17%), Hall (10.42%), and Kabal (10.00%). While the minimum disease incidence was recorded in Charkhi Dadri (9.08%) as depicted in Table 2. The Table 2 also revealed that the maximum average mean disease incidence during both Kharif, 2019 and Kharif, 2020 was recorded in Samarbagh district (18.54% and 18.25%) followed by Munda (15.75% and 16.67%) and the least was recorded in Charkhi dadri (9.17%).

Table 1: Isolates collected from different Village of Dir Upper and Lower

District	Village	Latitude	Longitude	Isolate
Garrah	Ghuban	29.1491	75.7216	*R. bataticola*, *R. solani*
	Rahim abad	29.1564	75.7161	*R. bataticola*
	Gudar	29.0710	75.6624	*R. bataticola*
Munda	Khungi	29.5571	75.0079	*R. bataticola*,
	CICR	29.5365	75.0255	*R. bataticola*, *R. solani*
Samarbagh	Talash	29.6645	75.8396	*R. bataticola*
	Talash Bala	29.5134	75.4531	*R. bataticola*, *R. solani*
	Walay kandu	29.5225	75.3558	*R. bataticola*
Mayyar	Mahay	28.9244	76.5676	*R. bataticola*
	Mahay Band	29.0138	75.9971	*R. bataticola*
Charkhi Dadri	Ghasolasha	28.5530	76.2609	*R. bataticola*
Mahendargarh	Arrang bala	28.3208	76.2768	*R. bataticola, R. solani*
	Narang	28.2850	76.1885	*R. bataticola*

Maidan	Mamund Kotu	28.0955	76.5927	*R. bataticola*
	Qala Munda	28.3059	76.4649	*R. bataticola, R. solani*
Hall	Tnagay	28.3255	76.7782	*R. bataticola*

Table 2: Cotton root rot average disease incidence at different locations of Dir Upper during Kharif 2019 and Kharif 2020

Area	Village	Soil Type	Number of Fields	Latitude	Longitude	Disease Incidence (%)		Pooled Mean
						(2019)	(2020)	
Garrah	**Ghuban**	Clay soil	4	29.1491	75.7216	13.67	13.67	13.67
	Rahim abad	Clay soil	4	29.1564	75.7161	16.67	16.00	16.33
	Gudar	Clay soil	4	29.0710	75.6624	15.33	16.33	15.83
	Gusam	Clay soil	4	29.1518	75.7211	15.33	15.67	15.50
			Mean			**15.25**	**15.42**	**15.33**
Munda	**Gusam Bala**	Sandy Soil	4	29.6668	75.6269	15.00	15.67	15.67
	Dabar	Sandy Soil	4	29.533305	75.0166	15.00	17.00	16.00
	Khungi	Sandy Soil	4	29.557179	75.0079	13.33	16.33	14.83
	Ludeshar	Sandy Soil	4	29.3672	75.0976	16.00	17.67	16.83
			Mean			**14.83**	**16.67**	**15.83**
Samarbagh	**Talash**	Sandy loam	4	29.6645	75.8396	19.67	18.33	19.00
	Talash Bala	Sandy loam	4	29.513446	75.4531	19.00	18.67	18.83
	Walay kandu	Sandy loam	4	29.5225	75.3558	18.33	17.67	18.00
	Khazana	Sandy loam	4	29.5668	75.3339	18.33	18.33	18.33
			Mean			**18.83**	**18.25**	**18.54**
Mayyar	**Mahay**	Sandy loam	4	28.9244364	76.5676	13.33	14.00	13.67
	Mahay Band	Sandy loam	4	29.0138132	75.9971	9.33	9.33	9.33
	Kotkay	Sandy loam	4	28.84815	75.5464	10.00	11.67	10.83
	Malala	Sandy loam	4	28.8241919	75.6368	10.67	12.67	11.67
			Mean			**10.83**	**11.92**	**11.38**
Timergara	**Malala qalagay**	Sandy loam	4	28.6382	76.2001	8.33	8.67	8.50
	Ghasolasha	Sandy loam	4	28.5530	76.2609	8.67	9.33	9.00

	Sherhany	Sandy loam	4	28.592062	76.2652	8.67	8.00	8.33
	Shukas	Sandy loam	4	28.4614	76.2609	11.33	10.33	10.83
				Mean		**9.25**	**9.08**	**9.17**
Malakand	**Arrang**	Sandy loam	4	28.268347	76.1509	14.33	15.33	14.83
	Arrang bala	Sandy loam	4	28.320891	76.2768	12.33	13.67	13.00
	Narang	Sandy loam	4	28.28506	76.1885	14.00	12.67	13.33
	Narang qala	Sandy loam	4	28.262121	76.1556	10.67	10.33	10.50
				Mean		**12.83**	**13.00**	**12.92**
Maidan	**Bajaur**	Sandy loam	4	28.24689	76.4476	12.33	10.33	11.33
	Mamund	Sandy loam	4	28.27206	76.4129	11.67	14.67	13.17
	Mamund Kotu	Sandy loam	4	28.09558	76.5927	14.33	12.67	13.50
	Qala Munda	Sandy loam	4	28.30597	76.4649	11.67	14.33	13.00
				Mean		**12.50**	**13.00**	**12.75**
Hall	**Dandusha**	Sandy loam	4	28.2687	76.7703	9.67	9.00	9.33
	Shalkanday	Sandy loam	4	28.2667	76.7392	9.33	9.67	9.50
	Tnagay	Sandy loam	4	28.3255	76.7782	11.33	12.00	11.67
	Tnagay Har	Sandy loam	4	28.33055	76.717	12.33	11.00	11.67
				Mean		**10.67**	**10.42**	**10.54**
Kabal	**Sar Banda**	Sandy loam	4	28.1147	77.0464	7.67	9.67	8.67
	Maskeeny	Sandy loam	4	28.1362	77.0766	9.00	10.67	9.83
	Ghazi Baba	Sandy loam	4	28.1111	77.0674	8.67	9.67	9.17
	Laat	Sandy loam	4	28.1696	77.0651	11.67	10.00	10.83
				Mean		**9.25**	**10.00**	**9.63**
Chitral	**Mardan**	Arid Brown	4	28.1383	77.2046	11.33	12.67	12.00
	Swabay	Arid Brown	4	28.1242	77.2678	10.00	10.33	10.33
	Mangai	Arid Brown	4	28.14873	77.3320	11.67	11.33	11.50
	Sheen Ghar	Arid Brown	4	28.1291	77.2434	10.33	10.33	10.33
				Mean		**10.83**	**11.17**	**11.00**
				Overall Average of Dir Upper and Dir Lower		**12.51**	**12.89**	**12.70**

CONCLUSION

The present study concluded that the incidence of root rot disease in cotton was detected in prominent cotton growing areas in Dir Upper. The highest average disease incidence was noticed in Samarbagh district during both Kharif 2019 and Kharif 2020 followed by Garrah district and the least average mean disease incidence was recorded in Charkhi Dadri and Kabal during Kharif 2019 and Charkhi Dadri during Kharif 2020. A total of 21 isolates of *Rhizoctonia bataticola* and *Rhizoctonia solani* were isolated from the infected root sample. From the overall study it can be understood that there is a prevalence of root rot disease in major mulberry growing locations in Dir Upper. Therefore, resistant cotton varieties are need of the hour to address the grower's problem along with best management strategies including efficient biocontrol agents which can minimize the disease to a greater extent. Therefore, a study should be undertaken to determine the disease prevalence in other locations.

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