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CONTENTS

Articles

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Articles

Determining the Level of Soil Contamination Using an Oat Bioindicator

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Abstract

The article presents the results of soil assessment using a bioindicator – germination of oats in room conditions. The task included sowing seeds and monitoring the dynamics of plant growth and development. The work of a team of two people ("B" and "A") was carried out on the territory of the Industry Agricultural Business Incubator, as well as at the home of each team member. As a result of the research, the following was noted. The shoots were unfriendly. Phytotoxicity coefficients showed that the cleanest point chosen for sampling was calculated to be the dirtiest of all. The seeds that grew best were those planted in the soil from the first (dirtiest) point; they had 100 % germination. As a result of seed germination, data was obtained that indicated that oats, with due attention, can grow equally in different soil conditions, perhaps this is due to the unpretentiousness of this plant or the insufficient distance between soil sampling points.

Keywords: oats, phytotoxicity, bioindicator, samples, above-ground part, underground part, soil.

1. Введение

Существует много способов оценки почвы. В данной работе она производится с помощью биоиндикатора, в роли которого выступил проращивание овса.

2. Обсуждение и результаты

Эксперимент

Опыт проходил у каждого из членов бригады на подоконнике. Первый опыт проводился в период с 01.11.19 по 12.11.19, но он оказался неудачным. Второй опыт начался 16 ноября в 23:00. Были посажены семена овса, на 4 сутки произошел практически дружный всход ростков, контейнеры с саженцами были помещены в разных точках: на освещенном участке, на письменном столе, а также в мало освещенном участке. Пробы почвы взяты из трёх точек (Рисунок 1).

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Рис. 1. Точки отбора проб

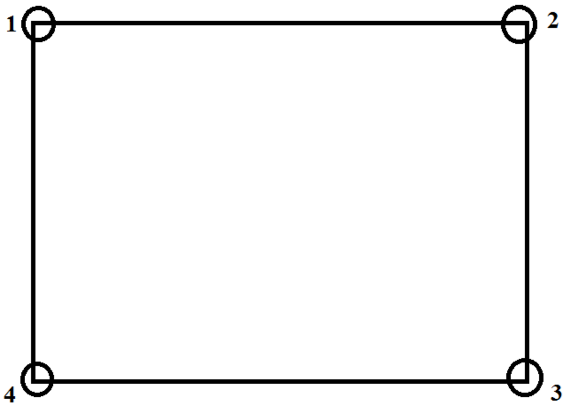

Рис. 2. Схема отбора проб почвы с точки № 2

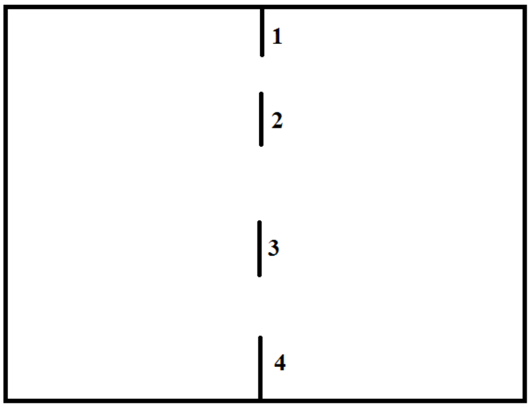

Рис. 3. Схема отбора проб почвы с точек № 1 и № 3

1 точка – наиболее загрязненная точка, находящаяся рядом с дорогой, рядом проходит пешеходная дорожка, вымощенная плиткой.

2 точка – точка, обладающая умеренной антропогенной нагрузкой, выражающейся в удалении от проезжей части на 20 метров и относительной близостью лесного массива.

3 точка является наиболее чистым местом среди всех точек отбора почвы, так как она располагается рядом с Дендрологическим садом имени Р.И. Шредера (Груздев, 2020), (Опекунова, 2016).

Процесс отбора проб

На всех трёх точках сбор был одинаковым. На участке размером 50 × 50 см расчищалась земля от листьев, веток и камней до начала самого почвенного покрова. Далее подручными средствами (небольшими пластиковыми стаканами и лопатками) производилось выкапывание земли до глубины приблизительно 15 см. Собранный грунт помещался в пакет, чтобы донести до места обработки.

Далее в течение недели происходила просушка почвы (на бумаге формата А3) так, чтобы лишняя влага испарилась, и земля оказалась сухой, после этого почва очищалась от лишних примесей и перемешивалась до равномерной консистенции и далее производилась посадка.

Первый опыт проращивания был неудачный. Овес не пророс, причина – обильное количество воды в почве.

Второй опыт: после просушки почва снова просеивалась, убрались лишние семена и проростки, оставшиеся после прошлого опыта, далее посев происходил повторно.

Взяв по 6 (на каждую точку по 2) контейнеров-стаканов на 2 человека («В» и «А») из бригады, производилось рассаживание семян. Предварительно в контейнеры положили по одной салфетке, чтобы задерживать почву, которая вымывалась бы при поливе растений. Далее, просеяв почву, началось выкладывание ее слоем в 4-5 см. Далее в каждый контейнер клалось по 10 семян (в сумме 120), которые немного присыпались тонким слоем сухой земли (0,3–0,5 мм). Затем следовала необильный полив, чтобы семена прижились. Засев происходил 16 ноября в 22:00. В течение следующих двух недель отслеживалось состояние, периодически поливая или же брызгая с пульверизатора контейнеры, и уже 20 ноября произошел всход первых ростков (Скупченко, Соколова, 2009), (Гелашвили, 1995), (Чеснокова, Чугай, 2008).

Рис. 4. Проростки второго посева

Рис. 5. Проба на пятый день опыта

По итогам произведенных испытаний были получены данные, которые сведены в Таблицах 1–5. В Таблицах 1–2 вписаны значения измерений в формате: длина ростка от семечка/длина корешка. Все измерения даны на последний день опыта. На основе Таблиц 1–5 произведены выводы и данные по которым сведены в Таблицах 6–7.

Таблица 1. Пробы проращивания овса (опыт «В»)

Точка	Данные (надземная часть / подземная часть, в см)								
1.1	11,5 / 3,4	11 / 10	13,4 / 2,2	15 / 3,8	20 / 4	13,6 / 6,5	15,2 / 5,2		
1.2	20,7 / 3,4	18,5 / 1,9	15,7 / 3,8	13,5 / 2,9	14,4 / 1,8	22,9 / 3,6	18,2 / 3,8	18,7 / 4,5	13,1 / 2,3	
2.1	16,7 /4,6	5,6 /1,2	12,2 /2,4							
2.2	18,2 / 4,8	19,5 / 3,2	17,9 / 3,5	16,8 / 4,7	19,7 / 5,2	21,2 / 1,6	23,6 / 3,9			
3.1	18,7 / 3,4	19,5 / 2,5	21,3 / 2,9	21,7 / 4,1	8,6 / 1,2	13,8 / 4,6	16,4 / 2,7	18,9 / 3,1		
3.2	18,9 / 3,9	22,2 / 2,9	20,3 / 3,1	17,5 / 2,6	20,8 / 3,6					

Таблица 2. Пробы проращивания овса (опыт «А»)

Точка	Данные (надземная часть / подземная часть, в см)									
1.1	24 / 3,5	22 / 2,8	8,3 / 1,4	18 / 1,5	24,2 / 5,4	23 / 4,2	7,7 / 2,8			
1.2	13 / 2,8	22 / 4,5	20 / 5,6	21,8 / 6,5	24 / 2,8	23 / 4,7	6 / 2,9	22,5 / 2,8		
2.1	15,5 / 2	18,4 / 2,8	14,3 / 2,1	18 / 3,9	13,2 / 1,7	15 / 3,8				
2.2	23,5 / 2	21,5 / 3	20,7 / 7	23,1 / 4,2	21,3 / 3,5	19,5 / 3,6	16 / 2,1	17 / 2,9	22 / 1,5	22,5 / 3,3
3.1	25 / 3,5	21 / 4,2	19,6 / 3,2	16,7 / 2,9	20,7 / 3,7	20,3 / 5,2				
3.2	11,5 / 3,5	11,8 / 3,1	22,1 / 3,6	22,5 / 2,8	17,9 / 2,6					

Таблица 3. Средние значения вершков и корешков по точкам, в сантиметрах

Точка	«В»		«А»	
	Надземная часть	Подземная часть	Надземная часть	Подземная часть
1.1	12,94	3,15	18,17	3,08
1.2	17,3	3,1	18,04	2,9
2.1	11,5	2,73	15,73	2,72
2.2	19,0	4,3	20,71	3,31
3.1	19,56	3,06	20,55	3,78
3.2	19,94	3,22	17,16	3,12

Таблица 4. Всхожесть по дням

День	20.11	21.11	22.11	23.11	24.11	25.11	26.11
«В»							
1.1	0	2	4	5	5	6	7
1.2	1	3	3	4	6	8	9

День	20.11	21.11	22.11	23.11	24.11	25.11	26.11
2.1	0	0	0	1	2	3	3
2.2	0	2	3	5	6	6	7
3.1	1	2	3	5	6	6	8
3.2	0	0	2	3	4	5	5
«А»							
1.1	0	3	4	5	5	7	7
1.2	1	1	4	6	7	7	8
2.1	0	1	3	4	5	5	6
2.2	2	4	6	8	9	10	10
3.1	2	3	4	4	6	6	6
3.2	2	3	4	4	4	5	5

Таблица 5. Сравнительная таблица

Всхожесть проростков (%)	Характеристика проростков	Оценка загрязнения
Менее 20	Мелкие и уродливые	Сильное
20-60	Тонкие и короткие	Среднее
60-90	Почти нормальной длины	Слабое
90-100	Ровные и крепкие	Отсутствует

Таблица 6. Всхожесть ростков в процентах

	Точки					
	1.1	1.2	2.1	2.2	3.1	3.2
«В»	70	90	30	70	80	50
«А»	70	80	60	100	60	50

Таблица 7. Оценка загрязнения почвы

	Точки					
	1.1	1.2	2.1	2.2	3.1	3.2
«В»	Слабое / Отсутствует		Среднее / Слабое		Слабое / Среднее	
«А»	Слабое		Слабое / Отсутствует		Слабое / Среднее	

Проанализировав Таблицы 7, можно сделать вывод о том, что первая точка является наиболее чистой, вторая – среднезагрязненной, а третья самой загрязненной из всех.

$$Ф_з = \frac{L_K - L}{L_K} * 100, \% \quad (1)$$

где $Ф_з$– коэффициент фитотоксичности; L_K, – длина вершка или корешка на контроле (чистая точка), L– длина вершка/корешка на загрязненной или среднезагрязнённой точке.

$$Ф_з(2т"В"надз.) = \frac{15,25 - 15,12}{15,25} * 100 = 0,85\%$$

$$Ф_з(2т"В"подз.) = \frac{3,515 - 3,125}{3,515} * 100 = 11,09\%$$

$$Ф_з(3т"В"надз.) = \frac{19,75 - 15,12}{19,75} * 100 = 23,44\%$$

$$Ф_з(3т"В"подз.) = \frac{3,14 - 3,125}{3,14} * 100 = 0,48\%$$

$$Ф_з(2т"А"надз.) = \frac{18,22 - 18,105}{18,22} * 100 = 0,63\%$$

$$Ф_з(2т"А"подз.) = \frac{3,015 - 2,99}{3,015} * 100 = 0,83\%$$

$$Ф_з(3т"А"надз.) = \frac{18,855 - 18,105}{18,855} * 100 = 3,98\%$$

$$Ф_з(3т"А"подз.) = \frac{3,45 - 2,99}{3,45} * 100 = 13,33\%$$

Таблица 8. Сводная таблица по фитотоксичности, %

	«В»	«А»
2 точка – надземная часть	0,85	0,63
2 точка – подземная часть	11,09	0,83
3 точка – надземная часть	23,44	3,98
3 точка – подземная часть	0,48	13,3

Исходя из результатов расчетов коэффициентов фитотоксичности, можно сделать вывод, что коэффициент на второй точке меньше, чем на третьей. Это свидетельствует о том, что третья точка отбора проб более загрязненная (Белюченко и др., 2014; Манаенков и др., 2020).

3. Заключение

В результате проведённых исследований было отмечено следующее.

Всходы были недружные. Коэффициенты фитотоксичности показали, что самая чистая точка, выбранная для отбора проб, является по результатам расчетов самой грязной из всех. Лучше всего росли те семена, посаженные в почву с первой (самой грязной) точки, дали 100 % всхожесть.

Точки отбора проб были расположены примерно в одной местности – на территории отраслевого бизнес-инкубатора. В итоге проращивания семян были получены данные, которые свидетельствовали о том, что овёс при должном внимании может произрастать одинаково в разных почвенных условиях, возможно, это связанно с неприхотливостью данного растения или недостаточной удаленностью между точками отбора проб почвы.

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Определение уровня загрязнения почвы с помощью биоиндикатора овса

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Аннотация. В статье представлены результаты оценки почвы с помощью биоиндикатора – проращиванием овса в комнатных условиях. В задачу входило проведение посева семян, отслеживание динамики роста и развития растений. Работа бригады из двух человек («В» и «А») проводилась на территории Отраслевого аграрного бизнес-инкубатора, а также в домашних условиях каждого члена команды. В результате проведённых исследований было отмечено следующее. Всходы были недружные. Коэффициенты фитотоксичности показали, что самая чистая точка, выбранная для отбора проб, является по результатам расчетов самой грязной из всех. Лучше всего росли те семена, посаженные в почву с первой (самой грязной) точки, дали 100 % всхожесть. В итоге проращивания семян были получены данные, которые свидетельствовали о том, что овёс при должном внимании может произрастать одинаково в разных почвенных условиях, возможно, это связанно с неприхотливостью данного растения или недостаточной удаленностью между точками отбора проб почвы.

Ключевые слова: овёс, фитотоксичность, биоиндикатор, пробы, надземная часть, подземная часть, почва.

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Evaluation of Antimalarial Activity of Methanolic Extract of *Carica Papaya* (*Carecaccaea)* Yellow Leaf in Mice

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Abstract

Malaria still remains a public health problem in developing countries. Malaria is one of the most prevalent diseases as people still rely on traditional medicine as source of treatment for this disease. Malaria causes mortality and morbidity with social economic impact in developing countries where the burden is high. Reports showed that the high global health challenges is partly due to multidrug resistance *P. falciparum* develop on existing and available antimalarial drugs and that has spur the search of alternate treatment with low or less side effect. The purpose of this study is to evaluate the antimalarial potential of methanolic extract of *Carica papaya* yellow leaf on animal model. In vivo screening for antimalarial drug discovery is of the recommended stream line process for new compound in path from drug discovery to developing. The Rane's curative method of established infection was employed in vivo for assessing antimalarial activity. Swiss albino mice of both sexes weighing between 23-27 g and aged 6 weeks were infected with $1x10^{-7}$ *P. berghei* (NK-65) RBC/ml intraperitoneally and were treated with various dose (100, 200 and 400mg/lg bt.wt) of *C. papaya* yellow leaf methanolic extract. Acute oral toxicity test was employed using OECD method. The mice treated with 400 mg/kg b.wt of *C. papaya* yellow leaf extract showed significant ($P < 0.05$) antimalarial activity. In acute oral toxicity result showed that the maximum tolerated dose was found to be 5000 mg/kg body weight. *C. papaya* leaf extract showed antimalarial activity and study has validated its use by locals in the treatment of malaria in most developing countries. Recommendations are made for the isolation and identification of bioactive substance for possible drug development.

Keywords: Antimalarial activity, *P. berghei* (NK-65), infected mice, *C. papaya* yellow leaf.

1. Introduction

Malaria is a serious pathogenic disorder, which causes mortality and morbidity with social and economic impact most especially in developing countries where the burden of malaria is very high. According to WHO 2021, there were an estimated 241 million malaria cases and 627,000 malaria related cases worldwide which represent 14 million more case in 2021 compound to 2019, and 69,000 more death. Which were linked to disruption to the provision of malaria prevention, diagnosis and treatment drug the pandemic. This disease has positioned about 3.3 billion people at risk. The recommended preventive drugs include a combination of sulfadoxine, pyrimethamine and amodiaquine, while the therapeutic strategy includes use of first lane drugs – artemisinin

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compound therapy in areas where *P. falciparum* is endemic and chloroquine (CQ), in the areas where it is still efficient.

The high global challenges developed by existing and partly available antimalarial drug due to multidrug resistance *P. falciparum* has led to the urgent need in search for newer treatments to eradicate malaria most especially in developing countries.

Although the available synthesized drugs may have side effects, indigeneous drugs are better alternate sources for the treatment of malaria due to low or less side effect. The resistance in malaria parasite is believed to have emerged through mutation in the active sites of drug targets or from biochemical changes in drug receptors.

The plant *C. papaya L* (English Paw-Paw; Hausa: Gwanda; Marghi; Ron: Mban) is a large tree-like plant belonging to the *Caricaceae* family, it is commonly called "Paw-Paw". *C. papaya* is widely grown in tropical and subtropical lowlands region. Among the developing countries, India, Indonesia, Mexico, Nigeria and Thailand are the largest papaya grown countries (Wimalawansa, 1981).

In contains pawpaw, chymoparinad vegetable pepsin (Wimalawansa, 1981). The presence of papaya endopeptidase II and *Carica papaya* endopeptidase IV were also reported. Protein, carpaine were also found to be present (Gills, 1992), leaves contain Carposide and seed contain Myrosinase carian and Sinigrin glycoside (Otskia et al., 2010). Phytochemicals present includes tanins, flavonoid, saponin, anthroquinones, steroids reducing sugars, cardinolides and phenolics (Owoyele et al., 2008).

2. Material and methods

Collection and authentication of plant materials

The yellow leaf of C. papaya were collected from university permanent site Naraguta Campus in April 2021 and was authenticated by a taxonomist at the Department of Plant Science and Biotechnology, Faculty of Natural Science University of Jos, Nigeria and specimen with voucher number JUHN21000418 was deposited in the departmental herbarium.

Preparation of the yellow leaf extract

After the collection of the yellow leaf water to remove any dirt and foreign particles and then shade dried. The dried yellow leaves were then crushed and grounded to get a powder form and weighed the powdered material (50 g) was weighed and extracted with 300 ml of methanolic for 72 hrs as described by Mankilik et al., 2021a, Mankilik et al., 2021b the solution obtained was sieved and extract kept in a desiccator to evaporate. It was then kept in a clean sterile bottle for further use.

Chemicals

All chemicals and reagents used were of analytical grade procured from various certified local and international suppliers.

Acute oral toxicity studies

A safe oral dose of the extract was determined by accurate oral toxicity test of Organization of Economic Cooperation and Development (OECD, 2008) as per 425 guidelines as described by Mankilik et al., 2021a. The animals were observed for any sign of toxicity OECD, 2008.

Experimental animals

Swiss albino mice weighing 18-30 g of either sex were used in the study. All the animals were housed for a week in a ventilated standard environment condition. The animals were used in this study were obtained from animal house unit of Pharmacology Department, Faculty of Pharmaceutical Sciences, University of Jos. The experiment was approved by the ethical committee Animal experimental unit, Department of Pharmacology and experiment were conducted as per guidelines of Institutional Animal Case and Use Committee (IACU) in collaboration with Office of Laboratory Animal Welfare office of laboratory animal (OLAW) with approval number F17-00379.

Maintenance of *P. berghei*

The chloroquine (CQ) sensitive rodent malarial parasite *P. berghei* (NK-65) strain was purchased from the National Institute of Medical Research, Ibadan, Oyo State, Nigeria. The blood stage parasite was maintained in an adult donor mice y serial blood passage and mice with 20-30 % rising parasiteamia was aneasthesized using chloroform dapped in a cotton wool. The blood collected in heparinized tubes contain 0.5 % trisodium citrate buffer and adjusted with 0.9 % physiological saline so that each 0.2 ml aliquate contain $1x10^{-7}$ infected red blood cell/ml of blood.

Antimalarial test – Rane's curative assay

In the curative assay on Day 0 (D_o) mice were intraperitoneally infected with $1x10^{-7-}$ *P. berghei* infected erythrocytes followed by random division of into four groups of 3 mice, each group 72 hrs after observation, the groups 1-3 orally received the plant extract of 200, 300 and 400 mg/kg bwt/day respectively. The group 4 (negative control) and group 5 (positive control) received 0.2 ml of vehicle and CQ phosphate 25 ml/kg b.wt/day respectively. The animals were dosed accordingly once daily for 5 consecutive days (D_2-D_7). On D_8, the blood parasiteamia in the all the groups were determined by using Giemsa stain. The mean survival of the treatment group were. Arithmetically determined by calculating the average survival time starting from day of infection to 30 days (D_o-D_{29}), in the Rane's test, the body weight was measured 3 hrs between infection on day 0 and consecutively from D_3 – D_8 during treatment period to establish the effect of plant drug on malarial mice (Ryley, Peters, 1970).

Determination of mean survival time

Mortality in each group was monitored daily from the time of parasite inoculation to death in the treatment and control groups throughout the study period. In the curative assay (Rane's test) the survival was observed for 30 days (D0 – D29). The Mean Survival Time (MST) of each group was calculated as:

$$MST \frac{Sum\ of\ survival\ time\ of\ all\ mice\ on\ a\ group}{total\ number\ of\ mice\ in\ a\ group}$$

Statistical data analysis

Each experiment was done in triplicate and data's were expressed as mean ± standard error on mean. Statistical significance was determined by one way analysis variance (ANOVA). The $P \leq 0.05$ from percentage parasiteamia were considered statistically significant when compared to control group.

3. Results

Phytochemical screening

The phytochemical screening of *C. papaya* yellow leaf methanolic extract reveals the presence of flavonoid, tannins, balsam, phenols and resins (Table 1).

Acute toxicity

The result of the toxicity study was depicted in Table 2. The extract was found to be safer up to 5000mg/kg b.wt.

Body weight

Result of Figure 1 showed that body weight of mice in the control group (CQ = 25 mg/kg) significantly increased, compared to negative control and other treatment groups. Dose dependent decrease was seen in treatment group (400 > 300 > 200).

PCV

Extracts did not ameliorate reduction in PCV level (Figure 2) reduction in PCV treatment group is dose is dependent as standard drug treatment group prevented reduction in PCV.

Antiplasmodial activity of plant extract and chloroquine

The result showed that the percentage increase in mice treated with extract at different doses on day 2 (D_2) while the parasiteamia of the mice treated with CQ 10 mg/kg did not increase compound compared to to those treated with *C. papaya* extract on day 2. In the chloroquine treated group, there was significant reduction in *P. berghei* to non-detectable level (D_8 – D_{10}). (Figure 3) there was significant ($P < 0.05$) decrease in parasiteamia level of mice infected with *P. berghei* and treated with 400mg/kg of *C. papaya* yellow leaf extract on Day 10 (D_{10}).

Mean Survival Time

All extract prolonged survival time, with 400 mg/kg b.wt of extract surviving being standard drug experimental period compared to the infected untreated (Table 3).

Table 1. Phytochemical profile of the Yellow Leaves Methanolic Extract On *Carica papaya*

PHYTOCHEMICAL	RESULT
Alkaloids	+
Flavonoids	+
Tannins	+
Saponins	-
Terpenes and steroids	+
Cardiac glycosides	-
Balsams	+
Carbohydrates	-
Phenols	+
Resins	+

KEY
- = absent
+ = present

Table 2. Acute toxicity of plant extract in mice with behavioral changes

Plant	Behavioral changes
C. papaya Yellow leaf methanolic extract	2000 mg/kg b.wt 5000 mg/kg b.wt No behavioral changes or mortality, except hair erection, no other symptoms were observed, No signs of toxicity and mortality was observed.

Table 3. Mode of Survival Time (MST) of Swiss albino mice

GROUPS	SURVIVAL RATE
200 mg/kg b. wt	18 days
300 mg/kg b. wt	16 days
400 mg/kgb.wt	Lived beyond experimental period
Infected/Untreated	13 days
25 mg/kgb. wt of chloroquine	Lived beyond experimental period

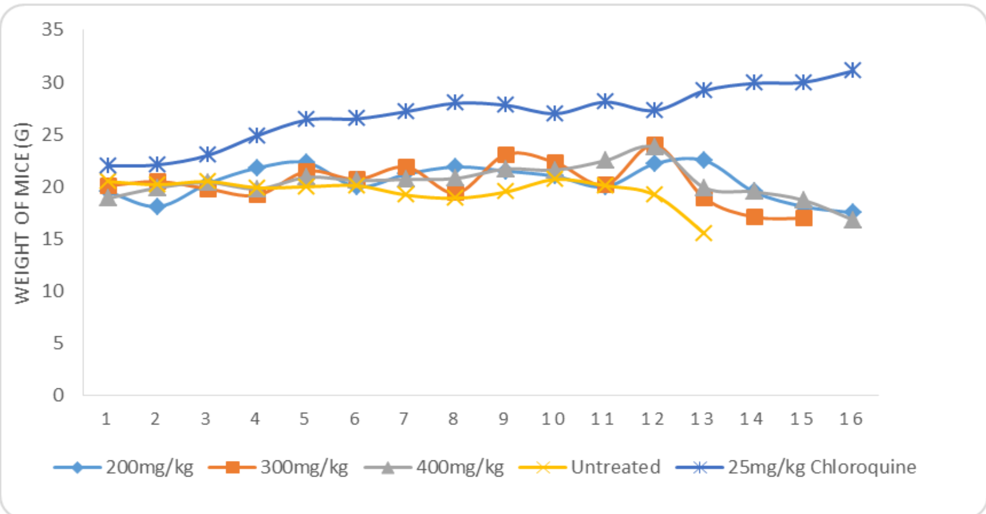

Fig. 1. Effect of yellow leaves methanolic extract of *Carica papaya* on body weight of *Plasmodium berghei* mice

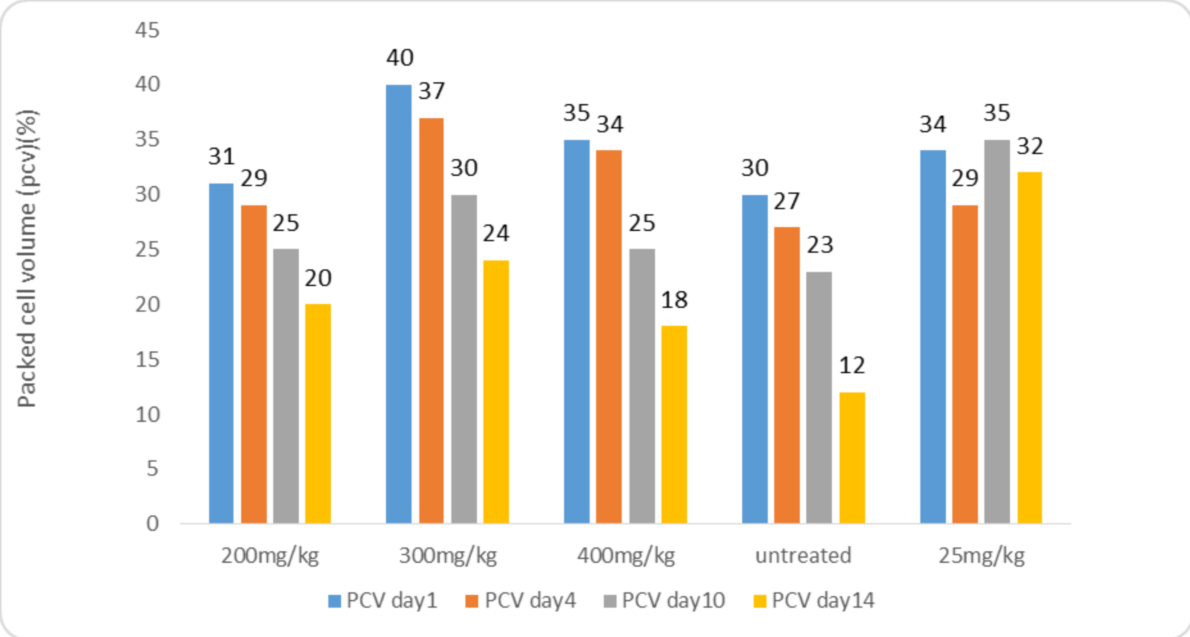

Fig. 2. Effect of yellow leaves methanolic extract of *Carica papaya* on PCV of *Plasmodium berghei* mice

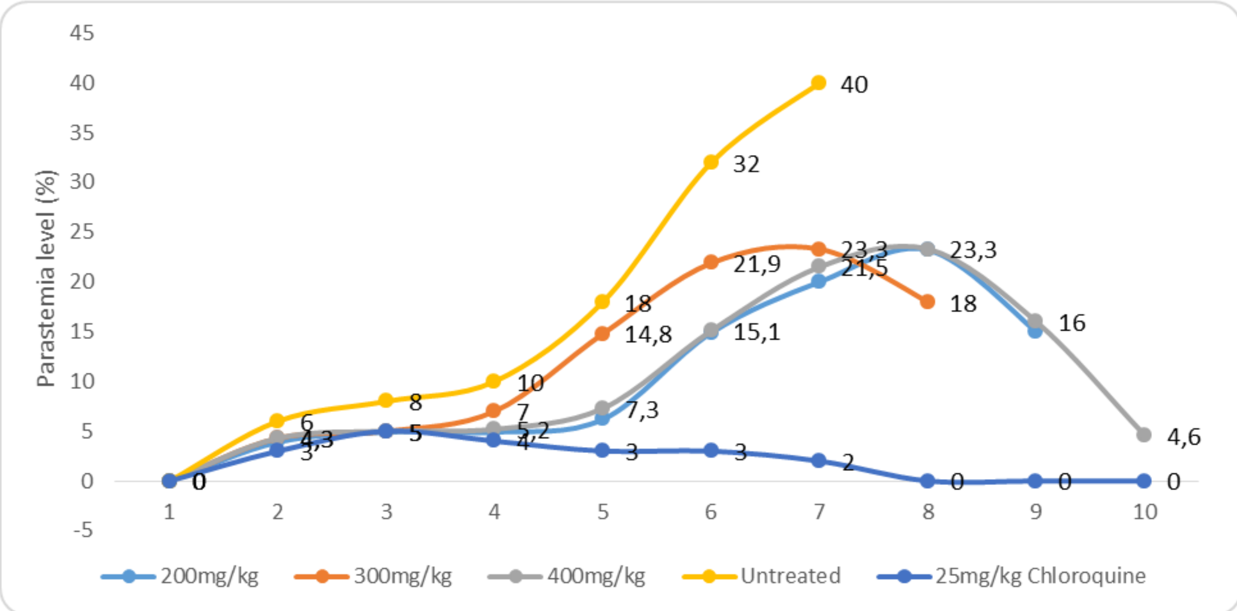

Fig 3. In vivo antiplasmodial activity of yellow leaves extract of *Carica papaya* against *Plasmodium berghei* infected mice

4. Discussion

Malaria remain the most vital pathogen disease. The rodent malaria parasite *P. berghei* is reported to be analogous to human malaria parasites in most essential aspect of structures, physiology life-cycle and model for the investigation of biology of malaria parasites, parasite – host interaction, vaccine development and drug testing (Fidock et al., 2004).

In toxicity test of yellow leaf methanol extract of *C. papaya* showed no visible toxic effects up to 5000 mg/kg b.wt. This study is similar to our previous study on the aqueous and methanolic extract of *A. aspera* shoot (Mankilik et al., 2021a; Mankilik et al., 2021b).

In the antiplasmodial study, the chloroquine sensitive *P. berghei* (NK-65) strain was used to check the efficacy of *C. papaya* yellow leaf methanolic extract along with conventional antimalarial agent chloroquine. Hence in the antimalarial screening the drug is expected to prevent body weight loss under parasiteamia. The crude extract of *C. papaya* at various doses prevented weight loss induced with increased in parasiteamia level. In our study there was steady decrease in weight by extract treated group, except for dose 400 mg/kg b.wt where steady increase was recorded. Decrease in weight has been associated with decreased food intake, disturbed metabolic function and likely hypoglycaemia (Atkinson et al., 2000; Bashar et al., 2012).

The plant extract was effective in curative assay exhibiting above 50 % antiplasmodial activity. In our studies there was a remarkable increase of parasiteamia level by infected untreated groups of mice with remarkable decrease in chloroquine treated group from day 8 to a non-detectable level. The extract treated groups also reduced *P. berghei* levels compared with infected untreated. The present study was also comparable to our previous antiplasmodial study reported (Mankilik et al., 2021a; Mankilik et al., 2021b) on *A. aspera L.; Vernoma amgadalina* (Longdet et al., 2021); *Eucalyptus cameldulensis* ethylacetate extract (Longdet et al., 2020) with array of positive approaches for medicinal plants in malaria. The methanolic extract revealed the presence of bioactive component contained in the plant such as, terpenoids, alkaloids, flavonoids, tannins and phenol. Proving that the may be the major constituent for antimalarial activity. This activity could be attributed to the presence of good concentration of active compounds in higher doses (Zaruwa et al., 2018).

The observation of mean survival time in days revealed that the drug treated group prolonged the survival time of mice compared to the untreated group. The chloroquine group animals' survival beyond the experimental period (D_{29}) compared to negative control which displayed 13 days of survival. At higher doses of 400 mg/kg b.wt of *C. papaya,* survival days were beyond the experimental period, while at dose 200 mg/kg and 300 mg/kg b.wt prolonged survival of mice for 18 and 16 days respectively. These could be due to the reduced parasiteamia could and overall reduction in pathologic effect of the parasite strain on the study mice and thus agreed with the report that bioactive compounds of medicinal plants that prolonged survival time greater than twelve days in considered as active (Ural et al., 2014). This study is consistent with previous study (Mankilik et al., 2021a; Mankilik et al., 2021b).

From our study, there was remarkable decline in PCV levels of mice in all treatment group from D_2-D_{10} compared to the standard control. The low PCV observed in the infected and untreated groups may be as a result of heamolysis due to growing infection. This is in tandem with report that induced reduction in PCV levels during malaria in rodent occurred approximately 48 hrs post infection (Mace et al., 2015). The destruction of RBC either by parasite multiplication or spleen reticuloendothelial cell action in the pressure of many abnormal RBC stimulate the spleen to produce many phagocytes which could lead to aneamia *P. berghei* infected mice (Chinchilla et al., 1998). *Carica papaya* displayed antimalarial effect this has ability to reduce the erythrocytes stages (merozoites, schizonts and gametocytes) of *P. berghei* and hence justify its traditional usage of malaria remedy. This is in tandem with previous research that *C. papaya L.* extracted from leaf was reported having antidengue, anti-inflammatory and antimalarial (Charan et al., 2016; Pandey et al., 2016; Ansari, 2016).

5. Conclusion

The study showed that yellow leaf methanolic extract of *Carica papaya* leaf could possess useful phytocompounds and may be a potential candidate for isolation of antimalarial compound and may provide scientific support for its use in traditional medicine. Extract is safe as no sign of mortality or morbidity was seen.

6. Conflict of interest

The authors declare that they have no competing interest.

7. Acknowledgements

The authors would like to acknowledge the Department of Biochemistry and staff of Animal House unit.

Ethics and consent approval to participate:

The study was approved by the institute of Animal Ethical Committee, University of Jos, Ethical clearance obtained with approval number UJ/FPS/F17-00379.

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Ethnobotanical and Bioactive Characteristics of some Sideritis L. Taxa and Major Essential Oil Compounds

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Abstract

Turkey with a huge and rich variety of flora reserves lots of medical, aromatic and bioactive properties plants within its structure. In Turkey public medical science applications are encountered extensively and Turkey is one of the leading countries in the trade of medicinal and aromatic plants because of its geographical location, difference climate conditions, plant diversity and agricultural potential. As in whole world and in Turkey, use of plants existing in the natural flora for different purposes in traditional medicine; as spice, tea, insecticide, resin, veterinary cure, glue, essential oil, beverage, beekeeping, landscape and cosmetic industry. On the other hand, this important ethnobotanical knowledges are facing a danger of being lost by contemperary urbanisation and other negative factors.

The local population has long utilized the taxa of the genus *Sideritis* L., as herbal tea and in traditional medicine. Most of *Sideritis* taxa have significant biological activity, the biological activities and traditional usage of the *Sideritis* taxa are far better understood in recent years but still needs attention. The majority of *Sideritis* taxa exhibit a variety of biological functions and are highly interesting for future research on their pharmacological characteristics and potential for pharmacy and medicine.

In this study, it is aimed to review major essential oil compound, usage of traditional knowledge and biological activities of some *Sideritis* taxa in Turkey.

Keywords: *Sideritis*, Ethnobotany, Medicinal plant, Aromatic plant, Traditional use, Biological activity, Essential oil.

1. Introductıon

Sideritis L. genus is in the Lamiaceae family. Lamiaceae is a family include economically important grasses, shrubs and rarely in tree form. *Sideritis, Salvia, Thymus, Mentha, Origanum, Phlomis, Nepeta, Teucrium, Rosmarinus, Lavandula, Thymbra, Satureja, Ballota, Stachys, Ajuga, Prunella, Melissa, Lamium, Marrubium* are most known genuses of Lamiaceae; which have many aromatic and medicinal importance taxa. While Lamiaceae members naturally grow in many parts of the world, especially in the gene center of Mediterranean region, Labiatae is represented by very few species in cold regions.

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The Lamiaceae family is one of the rich and important cosmopolitan families of Angiosperms, represented by 224 genera and approximately 5600 species in the world. According to the Flora of Turkey, there are approximately 45 genera and more than 850 taxa of which mor ethan 235 are endemic. In addition, Lamiaceae members are in the first place among the plants traded in Turkey (Kılıç, 2014).

Members of Lamiaceae have a unique aromatic odor and are aromatic plants, and these fragrances they carry are due to essential oils. Due to have abundant essential oils, they have been used in medicine, cuisine, landscaping, pharmacy and perfumery for a long time. In addition, it is known that aromatic compounds, which are abundant in Lamiaceae members, affect the mood and health of individuals intensely and are used extensively in phytotherapy and aromatherapy. The Lamiaceae family is the family of plants most known and studied for their essential oils all over the world (Lee et al., 2011).

The genus *Sideritis* is one of the genus with the highest endemism rate in Turkey, and approximately 1/3 of the *Sideritis* taxa are endemic for Turkey. Due to its high endemism rate (79.5 %), Turkey is one of the gene centers of this genus. In Turkey, the species belonging to the genus *Sideritis* are known by different names among the people (Kılıç, 2002).

In this review study, major essential oil compound, usage of traditional knowledge and biological activities of some *Sideritis* taxa in Turkey are compiled.

2. Results and discussion

Usage propertıes of some *sıderıtıs* taxa

Medicinal aromatic plants are generally used as a source of tea, spice, folk medicine and source of essential oil, and *Sideritis* members are ethnobotanically important and economically valuable plants used for these purposes. The first information about the use of *Sideritis* taxa as medicinal plants dates back to the first century. In many country *Sideritis* taxa are used as herbal tea. In addition, *Sideritis* taxa are usage as herbal tea, many taxa are used in the traditional medicine for treatment of different diseases and health problems (Başer, 2000).

Sideritis taxa are widely used as folk medicine and herbal tea in Turkey ethnobotany. Commonly used because of its nervous system stimulant, anti-inflammatory, antispasmodic, carminative, analgesic, sedative, antitussive, stomachic and anticonvulsant effects. Members of the *Sideritis* genus are also widely used in the treatment of colds and gastrointestinal diseases (Table 1).

Sideritis taxa are also widely used in the aromatherapy and in phytoteraphy, because they contain high rates of fragrant oils and commonly used aromatic substances. For this reason, some members of the *Sideritis* genus, which have high economic value. *Sideritis* species are often used in the treatment of inflammation and gastrointestinal disorders. These activities are based on the antioxidant properties of terpenoids and flavonoids in its composition (Koleva et al., 2002).

Sideritis albiflora, Sideritis congesta, Sideritis libanotica, Sideritis perfoliata and *Sideritis sipylea* have also been reported to be used as analgesics in stomach pain (Özaydın et al., 2005). *S. vulcanica* is consumed as an antipyretic and as an antipyretic among the people, and it is also ground and inhaled as a powder against headache (Arslan, 1999). *Sideritis libanotica* as a sedative, in colds, in the treatment of skin wounds, as an astringent. It has been reported that *S. montana* is used as a cough suppressant (Altundağ, Öztürk, 2011).

According to another study, *Sideritis perfoliata* is used in folk medicine for colds, bronchitis, stomach disorders. It has been noted that *Sideritis trojana* is also used in stomach disorders, abdominal pain, laxative, kidney diseases and sore throat (Bulut, Tuzlacı, 2015). *Sideritis trojana* was used as a folk remedy for digestive problems and colds (Polat, Satıl, 2012).

In another study, *Sideritis leptoclada* was used as a sedative in the treatment of colds and shortness of breath. It has been noted that *Sideritis montana* is used as a folk remedy in the treatment of stomach ailments (Kılıç et al., 2021). It has been reported that *Sideritis albiflora* is used as a diuretic, diabetic, relieving stomach and respiratory ailments (Sarı et al., 2010). *S. scardica* for calming down after work and *Sideritis condensata* is used traditionally for stress relief (Bruno et al., 2002).

Many *Sideritis* taxa are used for treatment of flu and colds, respiratory diseases, diseases of the digestive system, diseases of the urinary system, diseases of the cardiovascular system and anemia. In addition pharmacological activity of *Sideritis* members can be listed as; antimicrobial and antivirus activity, antioxidant activity, anti-iflammatory activity, gastroprotective activity, pharmacologic activities on the central nervous system diseases, cytotoxic activity and other activites (Aneva et al., 2019).

Table 1. Used part, ethnobotanical uses, bioactivity and major essential compund of some *Sideritis* taxa.

Botanical name	Location of the Plant	Used Part	Preparation method	Ethnobotanical uses	Reported bioactivities	Major essential oil compound
S. athea	Bingöl, Kazdağı/Balıkesir, Edremit/ Balıkesir	Aerial parts, flowers	Infusion	Common cold, flu, stomach ailments (Polat et al., 2011; Kalankan et al., 2015) (Polat, Satıl, 2012; Şahin, Kılıç, 2022)	Antimicrobial, Antidepressant, Ability to memorize (Kılıç et al., 2003; Öztürk et al., 1996)	Carvacrol (Küçük et al., 2021)
S. bilgeriana	Aladaglar/Nigde	Aerial part	Infusion	Heartburn, cold, hemorrhoids (Özdemir, Alpınar, 2015; Şahin, Kılıç, 2022)	Antimicrobial, Antioxidant (Dulger et al., 2006; Iscan et al., 2005; Aydin et al., 1996)	β-pinene (Iscan et al., 2005)
S. brevidens	Eğirdir/Isparta, Erdemli/Mersin, Gölhisar/Burdur, Fethiye/Muğla	Unspecified	Unspecified	Common cold (Başer et al., 2006)	Antioxidant, Antimicrobial, Antifungal (Tunalier et al., 2004; Dülger et al., 2005)	β-pinene (Kirimer et al., 1999)
S. caesarea	Pinarbasi/ Kayseri	Aerial parts	Fresh herb is ingested. boiled in water, after filtering drunk as tea	Stomach ailments, ulcer (Gürbüz et al., 2005; Şahin, Kılıç, 2022)	Antifungal, Antimicrobial, Antioxidant, Antiulcerogenic, Antioxidative (Gürbüz et al., 2005; Dulger et al., 2006; Sağdıç et al., 2008; Aşkun et al., 2008; Çelik, Kaya, 2011)	β-caryophyllene (Günbatan et al., 2017)
S. condensata	The Middle Aegean Region	Aerial parts	Decoction	Food (Kargıoğlu et al., 2010)	Antimicrobial, Antioxidant (Dülger et al., 2005; Özkan et al., 2001; Özkan et al., 2005; Güvenç et al., 2010; Özcan et al., 2005)	β-caryophyllene (Kirimer et al., 1996)
S. erythrantha var. *cedretorum*	Bozyazı/Mersin	Aerial parts	İnfusion, gargle, mixture, spice	Cold, flu, pharyngitis, blurred vision, pleasure, as tea (Sargin, 2015)	Antimicrobial, Antioxidant (Köse et al., 2010)	α-pinene (Tabanca, 2001)
S. erythrantha var. *erythrantha*	Bozyazı/Mersin, Sütçüler/Isparta	Aerial parts, leaf, flowers	İnfusion, gargle, mixture (Pickles, jam i.e.), spice	Cold, flu, pharyngitis, blurred vision, pleasure, as tea, antiseptic, germicidal, nausea, cold, asthma, desiccant, night sweats, spinal cord discomfort, blood purifier, gas reliever, breast milk booster (Sargin, 2015; Demirel, 2021)	Antimicrobial, Antioxidant, Antiviral (Köse et al., 2010; Altundağ et al., 2011; Altundağ, Aslım, 2011; Özkan et al., 2005; Yesilada, 2023)	α-pinene (Başer, Kırımer, 2018)
S. germanicopolitana	Kisecik/ Karaman	Flowers	İnfusion	For tea purpose (Yücel et al., 2016)	No studies found	Myrcene (Kirimer et al., 1992)
S. lanata	Bozyazı/Mersin	Aerial parts	Infusion	Kidney renewing, pleasure, as tea (Sargim, 2015)	Antidepresan, Antimicrobial (Uğur et al., 2005)	Spathulenol (Kırımer, 2000)
S. leptoclada	Acıpayam/ Denizli	Aerial parts	Infusion	Sedative (Bulut et al., 2017)	Antimicrobial, Antioxidant (Saraç, Uğur, 2007; Askun et al., 2009; Güvenc et al., 2005)	Germacrene D (Deveci, 2019)

S. libanotica Subsp. *microchlamys*	Gölbaşı/Adıyaman, Tut/Adiyaman, Birecik/Şanlıurfa, Adıyaman (centre), Yaslıca/Şanlıurfa	Aerial part	İnfusion	Stomach relaxing, fatigue relieving, pleasant,cold, flu, shortness of breath, cough (Güldaş, 2009; Furkan, 2016; Balos, Hakan, 2007; Abak, 2018)	Antioxidant, Antimicrobial, Cytotoxicity, Anticholinesterase (Atas et al., 2019)	β-caryophyllene (Kirimer et al., 2004)
S. libanotica subsp. *linearis*	Kürecik/Malatya, Midyat/Mardin, Andırın/Kahramanmaraş	Aerial parts, leaf	Infusion, decoction	Food, cold, for tea purpose (Kargıoğlu et al., 2010; Akgül et al., 2018; Demirci, Özhatay, 2012; Tevent, 2020)	Antioxidant, Insektisit, Anti-inflammatory, Antimicrobial, Antiproliferative (Ayhan, 2008; Demirtaş et al., 2009; Yeşilada, Ezer, 1989; Ezer et al., 1994; Ezer et al., 1995)	α-bisabolol (Erbaş, Fakir, 2012)
S. libanotica subsp. *libanotica*	Sarıveliler/Karaman, Hatay (centre), Yeşildere/Karaman	Flowers, aerial part	Infusion, decoction	For tea purpose, appetizer, carminative, sedative (Bağcı et al., 2016; Güzel et al., 2015; Akdag, Dogu, 2016)	Antioxidant (Güvenc et al., 2005)	Siderididiol (Formisano et al., 2015)
S. libanotica subsp. *violascens*	Sarıveliler/Karaman, Yeşildere/Karaman	Flowers	Infusion	As tea (Bağcı et al., 2016; Akdag, Dogu, 2016)	Antimicrobial (Yılmaz, 2013)	β-caryophyllene (Kirimer et al.,2004)
S. libatonica subsp. *kurdica*	East Anatolia, Artuklu/Mardin, Bozova/Şanlıurfa, Şanlıurfa (centre), Gölpınar/Şamlıurfa	Leaf, flowers, aerial parts	Infusion, decoction, diabetes, a pinch is consumed as raw.	Sedative, colds, skin wounds, astringent, for tea purpose, gargle, diabetes (Abak, 2018; Altundag, Ozturk, 2011; Akan, Ayaz, 2015; Fidan, 2018; Kılıç, 2019; Oymak, 2018; Şahin-Fidan, 2018)	Antidepressant (Öztürk, 1996)	α-pinene (Kirimer et al.,2004)
S. montana subsp. *montana*	Kırklareli (centre)	Aerial parts	Decoction	Cold, flu, cough (Kültür, 2011)	Anticancer, Antioxidant (Venditti et al., 2016)	Germacrene D (Kirimer et al., 2000)
S. perfoliata	Kazdağı/Balıkesir, Bayramiç/Çanakkale, Acıpayam/Denizli, Andırın/Kahraman maraş, Sütçüler/Isparta, Bigadiç/Balıkesir, Bergama/Izmir	Aerial parts, leaf, flowers	İnfusion	As tea, cold, bronchitis, stomach ailments, diuretic (Saçlı, Akalın, 2001)	Antimicrobial, Antidepressant, Anticancer, Ability to memorize Antioxidant, Anti-inflammatory, Reducing blood pressure, Hypoglycaemic, Antioxidant, Antimicrobial, Cytotoxic, Anticholinesterase (Ezer et al., 1994; Kırımer et al., 2008; Atalay, 2014; Carıkcı, 2020)	Limonene (Kirimer et al., 2008)
S. phrygia	Yahyalı-Pınarbaşı/Kayseri, Develi/Kayseri	Flowers	Infusion	As tea (Çelikel, 2002)	Antioxidant (Öztürk et al., 1996; Güvenc et al., 2005)	Limonene (Özer-Sağır, 2016)
S. pisidica	Yörenler-Elmalı/Antalya, Dumanlı-	Leaf	Infusion, externally as porridge	Tonic, as a tea, for stomachaches (Yeşilada et al.,	Antimicrobial, Anti-inflammatory, Antioxidant,	Caryophyllene (Özer-Sağır, 2016)

	Beyşehir/Konya			1993) (Yeşilada et al., 1995)	Anticholinesterase, Anti-urease (Dülger et al., 2005; Yeşilada, Ezer et al., 1994; Özer-Sağır, 2016; Deveci et al., 2017)	
S. rubriflora	Bozyazı/Mersin	Aerial parts	Infusion, gargle	Cold, flu, pharyngitis, pleasure, as tea (Demirel, 2021; Bulut et al., 2017; Demirci, Özhatay, 2012; Bulut, Tuzlacı, 2015; Kocabaş, Gedik, 2016; Tanaydın, 2021; Arasan, 2022)	Antimicrobial, Antifeedant, Antifungical, (Dulger et al., 2006; Bondi et al., 2000)	β-pinene (Kirimer et al., 1999)
S. scardica subsp. *scardica*	Kırklareli (centre),	Aerial parts	Decoction	Bronchitis, cough, cold, flu (Sargin, 2015; Şahin, Kılıç, 2022)	Antioxidant (Tunalier et al., 2004)	b-pinene (Solomou et al., 2019)
S. sipylea	Sarıgöl/Manisa	Aerial parts	Infusion	Foot odor, haircare, pleasure, cold, flu, as tea (Kültür, 2007)	Antimicrobial, Antioxidant (Dulger et al., 2006; Güvenc et al., 2005; Loğoğlu et al., 2006; Aligiannis et al., 2001; Gergis et al., 1991)	β-myrcene (Maškovic et al., 2023)
S. stricta	Aladaglar/Nigde	Aerial parts	Infusion	Cold, flu (Akgül et al., 2016; Sarı et al., 2010)	Antimicrobial, Alzheimer's disease, Parkinson's disease, Anti-inflammatory, Analgesic (Küpeli et al., 2007; Kılıç, 2006; Turkmenoglu et al., 2015; Küpeli et al., 2007)	β-pinene (Sattar, 1995)
S. syriaca subsp. *nusairiensis*	Kahramanmaraş (centre)	Aerial parts	Unspecified	Cold (Güzel et al., 2015; Kocabaş, Gedik, 2016; Altay et al., 2015; Varlıbaş-Odunkıran, 2020; Özer, Türkmen, 2019)	Antiviral, Antimicrobial, Antioxidant, Analgesic, Antiinflamatory (Sattar, 1995; Koutsaviti et al., 2013; Goulas et al., 2014; Karapandzova et al., 2013; Menghini et al., 2005)	α-pinene (Kirimer et al., 2004)
S. trojana	Kazdağı/Balıkesir, Bayramiç/Çanakkale, Edremit/Balıkesir	Herbs, aerial parts	İnfusion	As tea, stomach ailments, Abdominal pain, laxative, kidney ailments, sore throat, cold (Şahin, Kılıç, 2022; Bulut, Tuzlacı, 2009)	Cytotoxic, Antimicrobial, Anti-helicobacter, Insecticidal, Antioxidant, Antifungical, (Kılıç et al., 2003; Dulger et al., 2006; Kırımer et al., 2008; Kılıç et al., 2003; Kırmızıbekmez et al., 2017; Aslan et al., 2006; Kırmızıbekmez et al., 2012)	β-pinene (Kirimer et al., 2008)
S. vulcanica	Arıcak/Elazığ	Aerial parts	Infusion	Appetizer, germicidal, anti-inflammatory, carminative, urinary tract infections, Cold (Polat, Satıl, 2012; Saçlı, Akalın, 2001; Bulut, Tuzlacı, 2015)	Antioxidant (Tunalier et al., 2004)	α-pinene (Başerı, Kırımer, 2018)

3. Conclusion

In Turkey ethnobotany the domestic people used *Sideritis* taxa for preparing beverages like herbal tea, and also for the treatment of various diseases and health problems, as wound healing and for some blood disorders.

Most information available is about the use of *Sideritis* taxa in the case of respiratory deseases, especially cold and flu. Many *Sideritis* taxa also have high antibacterial and antiviral activities. These activities are supposed to be due mostly to the terpenes, iridoids, some flavonoids, sterols and essential oils. The traditional use of many species of *Sideritis* genus for treatment of digestive system diseases could be linked to the inflammatory activity, due to the flavonoids.

Studies of the biological activities of *Sideritis* taxa (Figure 1) are dominated by these focused on the antioxidant and antibacterial activity of the plant extracts. Still, the predominant studies are of screening type, with emphasis on the selecting of appropriate species, extraction method and testing material, while the studies on the mechanism of action of the active substances are scarce.

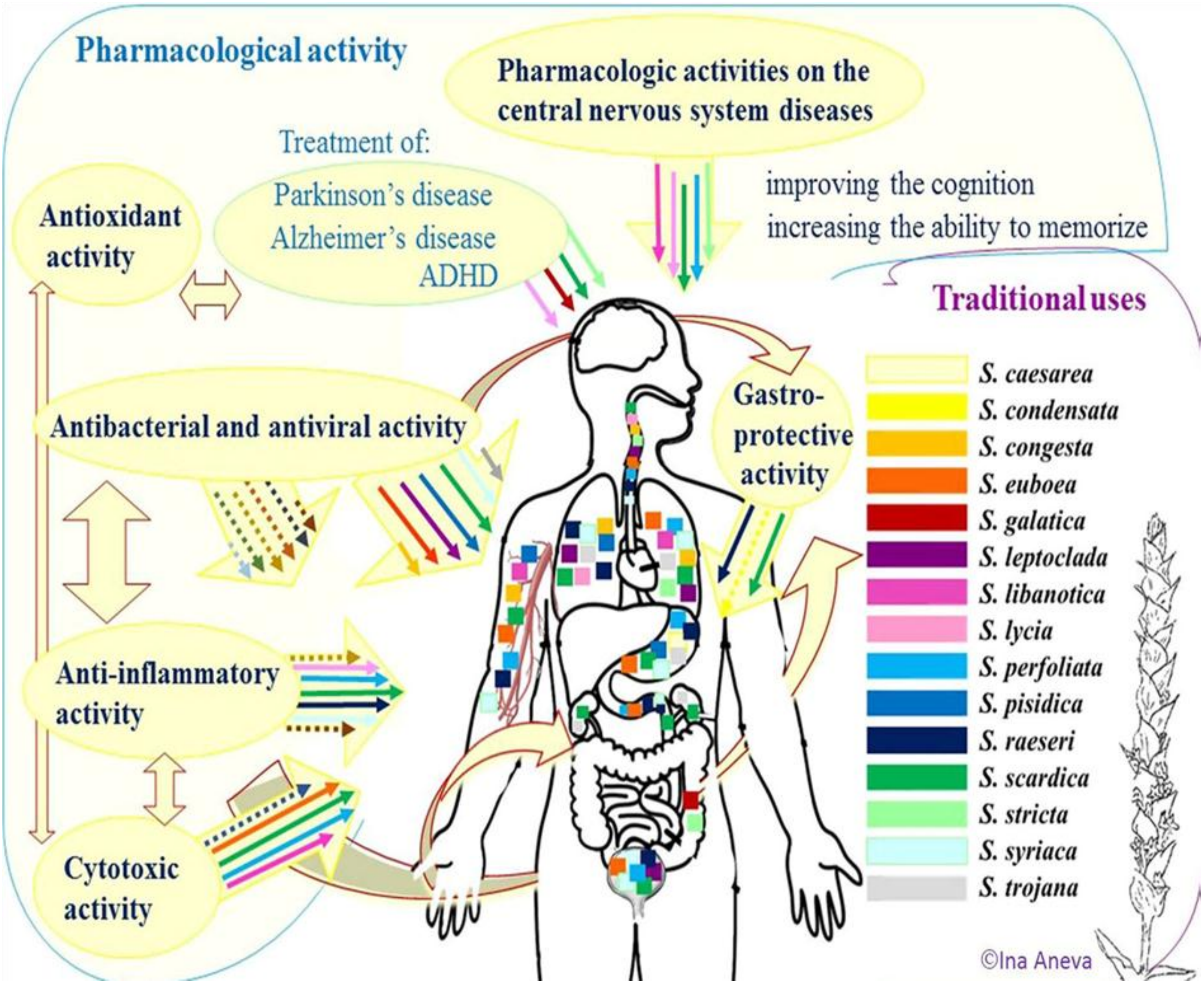

Fig. 1. Biological activities of some *Sideritis* taxa in human body (Aneva et al., 2019).

In conclusion, *Sideritis* taxa offers a wide source in different research fields and these taxa are provides a wide range of possibilities that can be found in further scientific studies like; phytochemistry, phytoteraphy, pharmacology, pharmacognosy, aromateraphy, toxicology etc.

4. Conflıct of interest

The authors declare that there are no conflicts of interest.

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Ethnobotanical Features and Pharmacological Studies of Some Nepeta L. Taxa

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Abstract

Ethnobotany is a multidisciplinary science that studies plant-human relationship and tries to understand human interaction with plants. Ethnobotanical studies aim to record the information about plants that people have passed down from generation to generation for centuries. In recent years, developments in technology, migration from village to city, modern life, relative loss of traditions and customs cause the loss of orally transmitted information about plants. In this respect, ethnobotanical studies are valuable studies that will record "humanity's knowledge of plants".

The local population has long utilized from *Nepeta* taxa for different purposes. Most of *Nepeta* taxa have important pharmacological and biological activities and *Nepeta* taxa have many traditional usage. The majority of *Nepeta* taxa exhibit significant pharmacological characteristics and potential for pharmacy, cosmetic industry, medicine and etc.

In this study, it is aimed to review ethnobotanical and pharmacological properties of some *Nepeta* taxa to contribute to studies on the subject.

Keywords: *Nepeta*, ethnobotany, pharmacological effect, medicinal plant, aromatic plant.

1. Introductıon

Since ethnobotany is a branch of science that examines the human-plant relationship, including the cultural context, it is studied by researchers from many disciplines such as botanists, pharmacists, nutritionists, agriculturalists, environmental scientists, anthropologists, political scientists, historians, geographers, economists and linguists (Ghorbani et al., 2006).

This situation allows each discipline to contribute to ethnobotany in line with their own needs. For example, pharmacists focus more on medicinal plants used by the public, while economists contribute to the registration of ethnobotanical heritage by examining plants with economic value. Today, it is possible to talk about sub-branches of ethnobotany such as archeoethnobotany and economic botany. In addition, ethnobotany is in the intersection cluster with other disciplines researching folklore such as ethnopharmacology, ethnoecology, ethnocosmetic (Saroya, 2017).

Ethnobotanical studies have important contributions to nature, people, economy and protection of cultural heritage.In addition, it allows the identification of species that are collected intensively from nature, the identification and protection of endangered species.Recording ethnobotanical information is also very important for the discovery of new drug molecules. As in the past, plants are undoubtedly important raw material sources for the treatment of diseases today.The production of plants and herbal products is an area that affects nations economically and

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socially, and also directs international relations. It enables the transfer of traditional knowledge to scientific research and thus the development of new treatment agents. It is known that many drugs used in treatment today are derived from ethnobotanical studies (Pandey and Tripathi, 2017).

It can be said that Turkey is an important center in terms of ethnobotany, thanks to its phytogeographic location and the deep-rooted cultural heritage of Anatolia. When the ethnobotanical studies conducted in Turkey are examined, it is seen that the studies mostly focus on medical uses. Although the most focused subject in the studies is the use of medicinal and food purposes, plants are frequently used for various purposes in our country such as shelter, heating, cleaning, paint, musical instruments, agricultural tools, basket-wicker making, and belief.

In this review, ethnobotanical and bioactive properties some *Nepeta* taxa are compiled, to contribute to the studies on the subject.

Table 1. Ethnobotanical and Bioactivitical Properties of Some *Nepeta* taxa

Botanical name	Location of the Plant	Parts used in ethnobotany	Method of preparation in ethnobotany	Ethnobotanical uses	Reported bioactivities
N. cataria	Turkey (East Anatolia, Mardin), Chinese	Herb, Aerial part,	Decoction	Stomachic, stimulant, Food, Cold, Sore throat and shortness of breath, Antidepressant, Sedative, Analgesic, Bronchitis (Zhang et al., 2015; Formisano et al., 2011; Sharma et al., 2019; Altundag, Ozturk, 2011; Eksik, 2020; Özer, 2021; Kılıç, 2019; Şahin, Kılıç, 2022)	Antibacterial anti-inflammatory Aphrodisiac antimicrobial, antioxidant, bacteriostatic and fungistatic, puberty retarder (Süntar et al., 2018;Abdalla et al., 1999; Dapkevicius et al., 1998; Bourrel et al., 1993; Bernardi, 1998)
N. ciliaris	Uttarakhand, India	Leaf	Decoction	Flu, cough, respiratory disorders, cold and antipyretic (Joshi et al., 2016; Vohora, 1986)	Anti-inflammatory Analgesic (Hussain et al., 2012; Süntar ve ark.,2018).
N. congesta var. *cryptantha*	Turkey (Şanlıurfa)	Aerial part	Infusion	Headache, Cold (Abak, 2018)	-------
N. crispa	Iranian (Hamadan)	Aerial part	Infusion	Carminative, relaxant, sedative, restorative tonic for respiratory and nervous disorders (Sonbolia et al., 2004)	Antibacterial Anti-angiogenic Antinociceptive and anti-inflammatory Anti-proliferative (Sonboli et al., 2004; Haseli et al., 2023; Badrhadad et al., 2015; Taskina et al., 2012; Zahirnia et al., 2019)
N. depauperate	Iranian	Whole plant	Unspecified	Wound healing and wasp, scorpion and snake bites, rheumatism (Mousavi et al., 2016)	___________
N. discolor	Uttarakhand - India Leh-Ladakh-	Leaf	Decoction	Leaf decoction: cold, cough and antipyretic. Decoction with honey: tuberculosis	___________

	India			(Joshi et al., 2016)	
N. elliptica	Uttarakhand Cemmu, Keşmir, India	Seed, Shoot, Leaf	Infusion	Digestive disorders, Food (Joshi et al., 2016) (Bhattacharjee, 2005)	Antifungal (Kumar et al., 2014)
N. eriostachys	Uttarakhand, Himachal Pradesh, India	Leaf, Whole plant	Unspecified	Antipyretic, Eye ailments (Joshi et al., 2016)	___________
N. flavida	Turkey	Aerial part	Unspecified	Flu, bronchitis and colds (Demirci, Ozhatay, 2012)	Antioxidant Herbicidal (Tepe et al., 2007; Bozok, 2019; Shakeri et al., 2016)
N. floccosa	Ladakh, India	Leaf	Decoction	Treat cough, cold and fever (Joshi et al., 2016)	Antioxidant (Ali et al., 2015)
N. glomerulosa	India	Whole plant	Unspecified	Treat itching, digestive problems and pneumonia (Nadkarni, 1976)	Antibacterial Hypnotic Effect Morphine Withdrawal Syndrome (Nezhadali et al., 2013) (Hosseini et al., 2016) (Hosseinzadeh, Ziaee, 2006)
N. glutinosa	Ladakh, India	Leaf	Decoction	Treat fever, pneumonia, and diarrhea (Joshi et al., 2016)	___________
N. govaniana	Himachal Pradesh, India	Whole plant	Decoction	Treat menstrual cramps, flu, insomnia, cold and diarrhea, Sore throat (Joshi et al., 2016)	Cytotoxicity (Dar et al., 2014)
N. hindostana	India	Whole plant	Decoction	Relieve sore throat, ear and toothach and fever (Nadkarni, 1976)	Effective against myocardial necrosis (provides endothelial mediator relaxation), sedative, tonic, dissolving, hepatotonic, antipyretic, lowers blood cholesterol level. Antiinflammatory Antidiabetic Antimicrobial Antioxidant Antiplatelet Dyslipidemia (Ashraf et al 1999) (Kumar et al 1998; Ahmad et al 1981; Joshi et al., 2021; Pandey et al., 2015; Siddique et al., 2018; Ansari et al., 2016; Devi, Singh, 2016; Devi, Singh, 2018)
N. italica	Turkey (Göller Bölgesi-Yenişarbademli Yöresi/Konya, Pertek/Tunceli, Manisa,	Aerial part, Leaf	Infusion	In addition to being used as a spice, it is used against colds, stomach flu and hair loss. As spice, As tea , Tummy ache, Common cold (Demirci, Ozhatay, 2012; Doğan, Tuzlacı, 2015; Özaydın et al.,	Analgesic Antioxidant Antimicrobial (Aydin et al 1999; Emre et al., 2011; Hasimi et al., 2015)

	Çermik/Diyarbakır)			2005; Doğanoğlu et al., 2006; Başer et al., 2006; Özdemir, Alpınar, 2015)	
N. laevigata	Pakistan, Keşmir Ladakh, India (Uttarakhand)	Seed, whole plant	Infusion	Dysentery, fever, colds and headaches, sore throat (Bhattacharjee, 2005)	Antioxidant Antimicrobial (Joshi, 2014; Shinwari et al., 2013)
N. lagopsis	Pakistan	Whole plant	İncineration (ash) and/or mist	Yara iyileştirici (Rehman et al., 2015)	___________
N. leucophylla	Baglund district, Nepal	Root juice, Leaf	Root juice, Paste	Cure fever (Root juice), Malaria (Paste) (Joshi et al., 2016)	Antifungal Antioxidant (Saxena, Mathela, 1996; Singh, Dhaliwal, 2018; Sharma et al., 2018; Sharma, Cannoo, 2016)
N. longibracteata	Ladakh, India	Whole plant	Unspecified	Stomach ailments (Joshi et al., 2016)	Antimicrobial (Avasthi et al., 2017)
N. menthoides	Iranian	Unspecified	Unspecified	Febrifuge and sedative, antidepressant and anxiolytic, Carminative (Amin, 1991)	Antimicrobial Anticholinesterase Cytotoxic Anti-Inflammatory Antinociceptive Neuroprotective Memory enhancing Antioxidant (Kahkeshani et al., 2017; Ghandchi, Jamzad, 2015; Memariani et al., 2019; Sonboli et al., 2009; Süntar et al., 2018)
N. nuda subsp. *albiflora*	Turkey (Pertek/Tunceli)	Leaf	Unspecified	As tea (Doğan, Tuzlacı, 2015)	Antioxidant Antimicrobial (Alim et al., 2009; Mancini et al., 2009; Teber, Bursal, 2020)
N. nuda subsp. *lydia*	Turkey (Bingöl)	Aerial parts, Leaves	Infusion	Common cold, used as tea (Kılıç, 2016)	___________
N. nuda subsp. *glandulifera*	Turkey (Çivril/ Denizli)	Unspecified	Unspecified	Tummy ache (Özaydın et al., 2005)	Antioxidant Antidiabetic (Sarikurkcu et al., 2018) (Al-Kahraman et al., 2012)
N. racemosa	Turkey (Erzurum)	Aerial parts	Infusion	As tea (Aksakal, Kaya, 2018)	Antimicrobial Antioxidant Anti-plasmodial (Lungoci et al., 2023; Afshar et al., 2021; Zazharskyi et al., 2020)
N. septemcrenata	Egypt, Israel, Iraq, Syria and Jordan	Unspecified	Unspecified	Cardiotonic, sedative and sore throat (Tachholm, 1974)	Antimicrobial Toxicity Antipyretic Antiinflammatory Analgestic (El-Moaty, 2010; El-Hamouly, El-Hela, 2004; Moustafa et al., 2015)

N. trachonitica	Turkey (Pertek/Tunceli)	Aerial part	Unspecified	As tea (Doğan, Tuzlacı, 2015)	Antimicrobial Antioxidant (Köksal et al., 2017; Gökbulut, Yılmaz, 2020; Köksal et al., 2017)
N. bracteata	Iranian	Unspecified	Unspecified	Febrifuge and sedative, antidepressant and anxiolytic, Carminative (Amin, 1991)	Antibacterial Anti-proliferative Antiinflammatory (Süntar et al., 2018; Zhang et al., 2021)

2. Results and discussion

Continually, plant taxa have long been regarded as possessing the principal ingredients used in widely disseminated ethnomedical and pharmacological practices. Many studies have revealed that the traditional medicinal and aromatic plant taxa utilized by the local people to treat various illnesses, have not been sufficiently examined for their therapeutic/preventive potential, pharmacological, ethnobotanical and phytochemical aspects. Traditional medicinal plant taxa provide a renewable and natural source of secondary metabolites that can be exploited to create novel medications and cure a variety of human illnesses.

Many members of the Lamiaceae (Labiatae) family are widely planted for their economical qualities. *Nepeta* is among the mosy known genus of Lamiaceae family, include more than 285 taxa that are significant to humans as culinary, aesthetic, and medicinal plants; many Nepeta taxa are widely used in traditional medicine and in ethnobotany. Among many aromatic and medicinal plants, taxa belonging to the genus *Nepeta* L. are widely used in traditional medicine and have different important effects in respect to human health. Therapeutic impacts of the *Nepeta* taxa are also due to the high contents of secondary metabolites; especially flavonoids and essentials. According to the *Nepeta* taxa essential oil composition, there exist two main essential oil chemotypes (nepetolactone and 1,8-cineole and/or linalool).

Many *Nepeta* taxa have pharmacological and biological effects as sedative, antimicrobial, cytotoxic acticities and anticancerous activities, apoptotic induction antioxidant, anti-inflammatory and antinociceptive effects, antidepressive, cholesterol lowering, vermifuge, antifungal, antiasthmatic, carminative, antidiabetes, acetylcholinesterase inhibition, analgesic, diuretic, diaphoretic, febrifuge, neuropharmacological activity, herbicidal, insecticidal, cardioprotective effects, angiotensin-converting enzyme inhibitory activity and insect repellent.

3. Conlusion

Due to the important effects of *Nepeta* taxa on improving the complications of various diseases, ethnobotanical and pharmacological effects the need for doing more comprehensive clinical trials for the use of *Nepeta* taxa.

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