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# Antigenotoxic Effects of *Stachys viscosa* (Lamiaceae), a potential medicinal plant in *Drosophila melanogaster*

Aygül KILIÇ KARABULUT[1]✍, Mikail AÇAR[2]
[1]Munzur University, Tunceli Vocational School, Plant and Animal Production Department, Tunceli, Türkiye, [2]Munzur University, Tunceli Vocational School, Department of Medical Services and Techniques Tunceli, Türkiye
[1]https://orcid.org/0000-0003-3452-8885, [2]https://orcid.org/ 0000-0003-3848-5798
✉: aygulkarabulut@munzur.edu.tr

## ABSTRACT
This research aimed to examine the anti-genotoxic properties of *Stachys viscosa*, a plant of the Lamiaceae family, which has medicinal and aromatic properties and is widely used in cosmetics, food, and pharmaceutical industries. The *Drosophila* wing somatic mutation and recombination test (SMART), an *in vivo* tool for evaluating somatic mutation and recombination, was employed. The anti-genotoxic effect of the *S. viscosa* plant against mitomycin C (MMC) mutagen was investigated. The study evaluated doses of 5 mg, 15 mg, 45 mg, and 60 mg of *S. viscosa*, concluding that doses of 45 mg and 60 mg effectively mitigated DNA damage induced by MMC. At doses of 45 mg and 65 mg, the total number of spots caused by MMC was suppressed by 8.21% and 13.17%, respectively. The data collected indicate that the *S. viscosa* plant possesses certain anti-genotoxic properties.

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## Potansiyel tıbbi bir bitki olan *Stachys viscosa*'nın (Lamiaceae) *Drosophila melanogaster*'da Antigenotoksik Etkileri

## ÖZET
Bu araştırmada tıbbi ve aromatik özelliklere sahip olan, kozmetik, gıda ve ilaç endüstrilerinde yaygın olarak kullanılan Lamiaceae familyasına ait bir bitki olan *Stachys viscosa*'nın anti-genotoksik özelliklerinin incelenmesi amaçlanmıştır. Somatik mutasyon ve rekombinasyonu değerlendirmek için *in vivo* bir test olan *Drosophila* kanat somatik mutasyon ve rekombinasyon testi (SMART) kullanıldı. Yapılan çalışmada, *S. viscosa* bitkisinin Mitomisin C (MMC) mutajenine karşı anti-genotoksik etkisi araştırılmıştır. Çalışmada *S. viscosa*'nın 5 mg, 15 mg, 45 mg ve 60 mg'lık dozları değerlendirildi ve 45 mg ve 60 mg'lık dozların MMC'nin neden olduğu DNA hasarını etkili bir şekilde azalttığı saptandı. Araştırma neticesinde 45 mg ve 65 mg'lık dozlarda, MMC'nin neden olduğu toplam benek sayısının sırasıyla %8,21 ve %13,17 oranında baskılandığı tespit edilmiştir. Elde edilen veriler, *S. viscosa* bitkisinin belirli anti-genotoksik özelliklere sahip olduğunu göstermektedir.

**Genetik**

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## INTRODUCTION

Mutations are defined as spontaneous or induced alterations in genetic material, whereas mutagens are the physical or chemical agents that trigger these mutations. These mutagens are vital because they trigger processes that lead to somatic cell damage, such as the transmission of genetic damage to subsequent generations and cancer development.

The genotoxic effect, defined as damage to DNA, is the main subject of genetic toxicology as it is a cancer-initiating process and the emergence of diseases associated with DNA damage (Sumer et al., 2009).

Many medicinal plants used for traditional purposes are essential in discovering new drugs. Many compounds are obtained from different parts of these plants. These include pectin, starch, flavonoids, coumarin, tannin, asparagine, and many amino acids (Şeker, 2019). Interest in these plants' therapeutic and anti-genotoxic effects, which have many metabolites with proven efficacy is increasing (Shabab et al., 2021). Therefore, the genotoxic effect caused by various mutagens may be reduced due to the anti-genotoxic effect of medicinal plants. Many plants are significant regarding their anti-genotoxic effect (Önen et al., 2017).

The Lamiaceae family attracts much attention due to its medicinal and aromatic character. They are widely used in the cosmetic, food, and pharmaceutical sectors, mainly thanks to the essential oils contained in the plant content. The biological and pharmacological activities of plants in the Lamiaceae family, which is a family wealthy in essential oil components, are being tried to be determined, and the essential oils in their content constitute an area of use in phytotherapy (Nilofar et al., 2024).

Turkey is acknowledged as a crucial center of biodiversity for the Lamiaceae family. The country hosts 603 species and 782 taxa (346 endemic) within this family. Extracts and essential oils from specific species of the Lamiaceae family have been utilized in traditional medicine to address various ailments, provide nourishment, and function as food preservatives for millennia. Species of *Stachys* L. are among those employed for such uses. *Stachys*, a notable genus in the Lamiaceae (Labiatae) family, exhibits significant taxonomic diversity and complexity. As a sub-cosmopolitan genus, *Stachys* demonstrates extensive distribution across the Mediterranean and Southwest Asia, subsequently extending to North and South America and North Africa. Nonetheless, it is absent in New Zealand and Australia. The genus has around 435 taxa and 370 species worldwide. The genus *Stachys* in Turkey includes 118 taxa and 91 species, of which 57 taxa are endemic, yielding an endemism rate of 48%. In Mediterranean locations, these plants have been employed in alternative medicine as herbal treatments and are ingested as wild tea, generally referred to as mountain tea. A multitude of chemical investigations have been performed on the volatile components of *Stachys* taxa. The volatile oil composition of these species is an important determinant in their use as tea in Anatolian ethnobotany. These species also comprise polyphenols, saponins, phenolic acids, glycosides, tannins, diterpenoids, flavonoids, essential oils, monoterpenes, and sesquiterpenes. The synergistic effects of the constituent compounds are believed to be the principal cause for the use of *Stachys* flowers and aerial parts as tea for therapeutic purposes in Anatolian culture. Some representatives of the genus have been recorded for their application as antibacterial and anti-inflammatory agents. Furthermore, studies suggest their capacity to offer antianxiety, antioxidant, and antinephritic effects (Satıl & Açar, 2020).

The ethnobotanical applications of 38 taxa of *Stachys*, including 29 species, have been recorded in Turkey, with *S. lavandulifolia* Vahl and *S. cretica* L. being the most commonly utilized species. In Turkey, *Stachys* species are frequently utilized as medical herbal infusions. Additionally, they are utilized as a powder for treating animal diseases, as a gargle for sore throat, and in the form of handkerchiefs and hair accessories (derived from leaves) for children. Research has identified approximately 40 different diseases and symptoms for which *Stachys* taxa are employed in treatment, with notable applications including addressing stomach issues, colds, coughs, and diabetes (Satıl & Açar, 2020).

*Stachys* species are widely employed in Anatolia and Iran for herbal therapy, frequently ingested as tea. *Stachys* taxa, commonly known as Mountain tea (above-ground parts in the form of infusion and decoction), are considered to have antibacterial and antifungal properties, as well as being used as a tonic for gastrointestinal disorders. The literature indicates their role in pain and inflammation inhibition, exhibiting anxiolytic properties, and serving as antibacterial, antinephritic, anticancer, anti-Helicobacter pylori, and antioxidant agents. Examples are *S. recta* L., utilized for wound healing, and *S. lavandulifolia*, applied for digestive issues. *S. officinalis* (L.) Trevis., *S. sylvatica* L., *S. recta,* and *S. palustris* L. are utilized in Hungarian folk medicine for their anti-inflammatory, anti-rheumatic, and antibacterial attributes. These plants are utilized as antiphlogistics, spasmolytics, diuretics, sedatives, and for the treatment of neoplastic illnesses. *Stachys* taxa are abundant in secondary metabolites, particularly diterpenoids, which demonstrate antibacterial, antifungal, antimycobacterial, and anti-Alzheimer properties (Satıl & Açar, 2020).

Many species in the genus *Stachys* are well known for treating a wide range of illnesses in traditional medicine across various cultures. In Italy, for example, *Stachys recta*, also known as "yellow woundwort," is called "erba della paura," a reference to its use in herbal teas for anxiety treatment. *S. lavandulifolia*, also called "Chaaye Koohi," and other *Stachys* species are widely used in Iran to treat gastrointestinal disorders, skin irritation, and stress. Although this common term may cause confusion with other herbal medicines from *Sideritis* species, herbal teas derived from *Stachys* species, commonly referred to as "mountain tea," are also widely used for treating skin and stomach disorders.

While *Stachys geobombycis* C.Y.Wu, also known as Dong Chong Xia Cao, is used as a tonic in Asia and Europe, *Stachys affinis* Fresen. is utilized in Chinese traditional medicine for a variety of ailments, such as colds, heart disease, antioxidant qualities, and brain abnormalities. Species such as *S. acerosa* Boiss., *S. fruticulose* M.Bieb., *S. byzantine* K.Koch , and *S. lavandulifolia* have a variety of purposes in Iranian traditional medicine, including the usage of *S. sylvatica* to treat polycystic ovarian syndrome (PCOS). Furthermore, species like *S. cretica*, *S. lavandulifolia*, and *S. sylvatica* are used in Turkish traditional medicine to treat stomach and respiratory conditions; some species are also used to treat cardiac problems.

Infusions and decoctions of *Stachys* species are used in Greek and Italian traditional medicine to treat gastrointestinal issues, headaches, rheumatic pain, and neuralgia. Some species are even used in food; for instance, *S. palustris* is used in European cuisine as "mayday flour" in bread additions, and *S. affinis* tubers are consumed in China and Japan as "Chinese artichokes." There have also been documented veterinary use for *S. germanica* and *S. officinalis* (Tomou et al., 2020)

*S. viscosa* Montbret & Aucher ex Benth the native range of this species is N. & E. Türkiye to W. Transcaucasus. It is a subshrub and grows primarily in the temperate biome. It is utilized by the public as a nectar source for bees, an infusion for tea, forage, and for alleviating colds and intestinal issues (Satıl & Açar,2020).

Anti-genotoxic effects of the *Stachys* genus and Lamiaceae family members have been revealed in some studies (Rencuzogullari et al., 2012; Sevindik & Rencuzogullari, 2013; Kilic et al., 2018; Rasgele et al., 2021). In addition, the main subject of the study was a plant formerly called *S. laetivirens*, now classified as a synonym of *S. viscosa*. In a previous study, Sixty-one compounds were identified in the essential oil extracted from the aerial components of *S. laetivirens*, and the oil composition was found to contain 2.0% oxygenated monoterpenes, 12.9% sesquiterpene hydrocarbons, 18.6% diterpenes, 8.2% oxygenated sesquiterpenes, and 43.7% other components. The highest components were found to be nonacosan (23.1%) and phytol (17.9%). While sesquiterpenes are generally found in significant amounts in *Stachys* species, some may accumulate monoterpenes. However, the composition of *S. laetivirens* contains abundant straight-chain alkanes such as nonacosan and phytol (Duman et al., 2005).

Since the existence of mankind, the first area he turned to in order to solve his problems was nature itself. Ethnobotany, defined as the relationship between nature and plants, the most important part of nature, is the basic asset used today to solve problems, especially various diseases. Recently, diseases and problems such as genetic disorders and cancer have been occupying our day. The examination of these problems in various ways continues to increase. Mutagens that affect genetic structure are among the subjects of this research. It is one of the basic research materials in the field of genetics, as in many studies on medicinal plants.

Notwithstanding its therapeutic efficacy, *S. viscosa* has yet to be evaluated for its antimutagenic characteristics. *Drosophila melanogaster* (vinegar fly), a eukaryotic organism used in this study, is used in the determination of mutagenic, genotoxic, carcinogenic, and anti-genotoxic effects of many substances due to its easy and economical production and its genetically diverse lineages (Öz et al., 2023). Among the tests that use *Drosophila* as a model organism, one that has become quite popular in recent years is the Somatic Mutation and Recombination Test (SMART), which allows the recognition of a wide range of genetic issues such as deletions and point mutations, as well as the exact types of chromosomal errors such as mitotic recombination and gene conversion (Çetinkaya & Yurtsever, 2021; Çelik & Uysal, 2023). SMART is a superior method in that it provides more accurate results in genetically measuring the mutation caused by various substances in somatic cells. Compared to other tests, SMART has the advantage of being faster, more reliable, and more economical (Sarıkaya & Çakır, 2005; Yalçın et al., 2024).

The similar genetic characteristics of humans and *Drosophila* make *Drosophila* especially advantageous for such studies. Many substances that are carcinogenic to humans also give positive results in *Drosophila* tests. In addition, there is no need for metabolic activation to test for promutagens and procarcinogens (Rincon & Graf, 1995).

This research sought to examine the anti-genotoxic properties of *S. viscosa*, which has potential medicinal value, against the mitomycin-C (MMC)-induced genotoxic effect of *Drosophila* SMART.

## MATERIAL and METHOD

### Plant material

The aerial components of *S. viscosa* were collected from its habitat during the flowering season. The plant was desiccated in the shade for extraction research and stored in the Herbarium of Munzur University for identification and preservation purposes. MA 2045: *S. viscosa*, roadside limestone rocks around 5th km between Tunceli Merkez and Ovacık, May 2020. B7, Tunceli Merkez (Türkiye).

### Plant extraction

The above-ground parts of *S. viscosa* were dried in the shade and ground in a mortar and pestle. Weighed 4 g of the samples obtained, and 40 mL of methanol (1/10 w/v) was added. They were kept in an incubator (Elekto-mag M 5040 P, Turkey) at 40 °C for 24 hours. The resulting solutions were centrifuged (Universal320 R) at 9,000 rpm. The solvent was removed with the help of an evaporator. After determining the amounts of the extracts obtained, methanol extracts were obtained. The extracts were stored at +4 °C until analyzed (Soldamlı, 2016).

Figure 1 *S. viscosa* general appearance in nature
*Şekil 1. S. viscosa doğadaki genel görünümü*

### *Drosophila* Strains

Two genetically different strains of *Drosophil*a were used in the study. The *mwh/mwh* and *flare-3 strains* of *D. melanogaster* were utilized in the research (Rincon & Graf, 1995).

### Anti-genotoxic Application

MMC (CAS No. 50-07-7), which has known genotoxic effects, was used as a positive control group in the study. In addition, the study utilized dosages of 5 mg, 15 mg, 45 mg, and 60 mg to assess the genotoxic and anti-genotoxic effects of *S. viscosa*.

To assess the anti-genotoxic effects of these dosages against MMC, a concentration of 0.05 mM MMC was employed. For this purpose, 5 mg, 15 mg, 45 mg, and 60 mg of powdered *S. viscosa* pieces were added to 0.5 g of prepared medium (Formula 4-24; Carolina Biological Supply) in sterile test tubes.

### Implementation Procedure

The diagnostic technique was executed in accordance with a precise protocol, albeit with certain alterations (Graf et al., 1984). 72±4 h larvae developing from eggs obtained after 8 h of crossing of *mwh* males and *flr³* virgin females were collected using 17% sodium chloride solution. These larvae were counted and placed in tubes containing group-specific medium. In this way, distilled water was the negative control, MMC was the positive control, and *S. viscosa* and MMC + *S. viscosa* groups were also formed.

### Preparation and Microscopic Analysis of Wing Preparations

For microscopic analysis, only trans-heterozygous (*mwh flr+/mwh+flr³*) individuals were used from larvae to adults in test tubes. The wings of adult flies were clipped and placed on slides on which Faure's solution (30 g of gum arabic, 20 ml of glycerol, 50 g of chloralhydrate, and 50 ml of distilled water) was added. The surfaces of the positioned wings were analyzed using a light microscope at 400X magnification. The observed spot types were documented as single spots and double spots (Rincon & Graf, 1995).

### Statistical Analysis

The spots observed by microscopic scanning were recorded as large single spots, small single spots, and double spots. The single-type clones observed in the SMART test are formed by point mutation, deletion, translocation, chromosome loss or chromosome non-separation, and mitotic recombination in the DNA, while twin clones are formed only by mitotic recombination. For statistical analysis, the number of spots on each wing was compared with those in the control groups. The MICROSTA package program was used to evaluate the results, and a one-way Kastenbaum-Bowman test was performed. The percentage inhibition of wing spot frequency of *S. viscosa* by MMC was calculated using the following formula (Idaomar et al., 2002).

$$\frac{100(a-b)}{a}$$

According to the formula above, a- shows the spot frequency caused by MMC, and b- shows the spot frequency caused by MMC as a result of *S. viscosa* application.

## RESULTS and DISCUSSION

In the study, 5 mg, 15 mg, 45 mg, and 60 mg doses of *S. viscosa* were used. Doses of 0.025mM, 0.05mM, and 0.1mM of MMC, which has antibacterial and antitumor fungal effects and is classified as an alkylating agent, were used as the positive control group. The MMC was directly dissolved in distilled water and used in the study. As a result of the statistical evaluations, while the genotoxic effect of MMC in *Drosophila* was detected, no significant difference was observed in all tested doses of *S. viscosa* compared to the control group (distilled water) for all spots. In the literature, many studies show that MMC, an antibiotic obtained from *Streptomyces caespitosus*, causes genotoxic effects in *Drosophila* (Niikawa & Nagase, 2007; Karabulut & Yesilada, 2014; El-Hefny et al., 2020). In the study, survival percentages were also calculated for each treatment group. All findings and statistical evaluations are presented in Table 1 and Table 2.

Table 1. SMART findings and statistical analysis results of MMC application groups
*Çizelge 1. MMC uygulama gruplarına ait SMART bulguları ve istatistiki analiz sonuçları*

| | | | Statistical analysis of the number of spots per wing * | | | |
|---|---|---|---|---|---|---|
| **Test Groups** | **Survival rate (%)** | **Number of Wings Inspected** | **Small single spot (1-2 cells) (m=2)** | **Large single spot (>2 cells) (m=5)** | **Twin spot (m=5)** | **Total spot Number of (m=2)** |
| **Distilled Water** | 98 | 110 | 0.14 (16) | 0.02 (2) | 0 | 0.16 (18) |
| **MMC (mM)** | | | | | | |
| 0.025 | 60 | 75 | 3.24 (243) + | 3.39 (254) + | 2.10 (158)+ | 8.73 (655)+ |
| 0.05 | 54 | 66 | 6.23 (411) + | 7.17 (473) + | 2.92 (193)+ | 16.32(1077)+ |
| 0.1 | 43 | 64 | 8.81 (564) + | 9.05 (579) + | 3.22 (206)+ | 21.08(1349)+ |

* One-way Kastenbaum-Bowman Test, +: positive (genotoxic), -: negative (not genotoxic), i: insufficient, m: multivariate factor, α=β=0.05, Distilled water are negative control, MMC is a positive control.

Table 2. SMART findings and statistical analysis results of S. viscosa application groups
*Çizelge 2. S.viscosa uygulama gruplarına ait SMART bulguları ve istatistiki analiz sonuçları*

| | | | Statistical analysis of the number of spots per wing * | | | |
|---|---|---|---|---|---|---|
| **Test Groups** | **Survival rate (%)** | **Number of Wings Inspected** | **Small single spot (1-2 cells) (m=2)** | **Large single spot (>2 cells) (m=5)** | **Twin spot (m=5)** | **Total spot Number of (m=2)** |
| **Distilled Water** | 98 | 110 | 0.14 (16) | 0.02 (2) | 0.009(1) | 0.17 (19) |
| ***S. viscosa* (mg)** | | | | | | |
| 5 | 97 | 104 | 0.13 (14) i | 0.02 (2) i | 0.009(1) i | 0.16(17) i |
| 15 | 93 | 97 | 0.12 (12) i | 0.01 (1) i | 0.00 (0) i | 0.13(13) i |
| 45 | 85 | 90 | 0.11(10) i | 0.02 (2) i | 0.01(1) i | 0.14(13) i |
| 60 | 70 | 84 | 0.12 (10) i | 0.01 (1) i | 0.01 (1) i | 0.14 (12) i |

* One-way Kastenbaum-Bowman Test, +: positive (genotoxic), -: negative (not genotoxic), i: insufficient, m: multivariate factor, α=β=0.05, Distilled water are negative control.

In order to determine the anti-genotoxic effect of *S. viscosa* against MMC, 5 mg, 15 mg, 45 mg, and 60 mg doses of *S. viscosa* were added to the prepared medium containing 0.05 mM MMC. In all groups, wings were scanned for the presence of spots. When spot numbers were examined, it was observed that all spot numbers decreased in the 45 mg and 60 mg MMC+ S. viscosa groups compared to the MMC groups. Except for the double spots observed in the 45 mg treatment group, these decreases had a statistically negative effect. In addition, the percentage of inhibition of the number of spots caused by MMC in *S. viscosa* was calculated by the simultaneous application of 45 mg and 65 mg doses of *S. viscosa* and 0.05 mM MMC. The administration of 45 mg and 60 mg doses of *S. viscosa* resulted in a reduction of 8.21% and 13.17%, respectively, in the total number of spots generated by MMC. The outcomes derived from the wing spot test are presented in Table 3.

Table 3. SMART findings and statistical analysis results of MMC+ S. viscosa application groups
*Çizelge 3. MMC+ S. viscosa uygulama gruplarına ait SMART bulguları ve istatistiki analiz sonuçları*

| **Test Groups** | **Survival rate (%)** | **Number of Wings Inspected** | **Statistical analysis of the number of spots per wing *** | | | | |
|---|---|---|---|---|---|---|---|
| | | | **Small single spot (1-2 cells) (m=2)** | **Large single spot (>2 cells) (m=5)** | **Twin spot (m=5)** | **Total spot Number of (m=2)** | **Inh. %** |
| **MMC (0,05mM)** | 54 | 66 | 6.23 (411) | 7.17 (473) | 2.92 (193) | 16.32(1077) | |
| **MMC+*S. viscosa* (mg)** | | | | | | | |
| 5 | 55 | 64 | 6.33(405) i | 7.29(466) i | 3.11(199) i | 16.72(1070) i | |
| 15 | 54 | 61 | 6.34(387) i | 7.51(458) i | 3.11(190) i | 16.97(1035) i | |
| 45 | 55 | 64 | 5.51(353) - | 6.80(435) - | 2.70(171) i | 14.98(959) - | 8.21 |
| 60 | 57 | 66 | 5.12 (338) - | 6.53(431) - | 2.51(166) - | 14.17 (935) - | 13.17 |

* One-way Kastenbaum-Bowman Test, +: positive (genotoxic), -: negative (not genotoxic), i: insufficient, m: multivariate factor, α=β=0.05, MMC (0.05mM) is a positive control.

It is known that many plants that we frequently use in our daily lives are used in the treatment of many types of cancer and other somatic mutation-related diseases and show anti-genotoxic activity thanks to their components. The mutagenic effect due to the effect of various mutagens is reduced due to the anti-genotoxic effect of the components of these plants (Boldbaatar et al., 2014; Zor and Aslan 2020). Secondary metabolites found in the structure of organs such as leaves stems, and roots of plants are widely used in the protection and maintenance of the health of living things and the treatment of diseases due to their various biological activities. Many studies have shown that plant secondary metabolite products have protective effects in preventing genetic damage caused by various damaging factors, especially free radicals. Phytochemicals, natural substances contained in plants, are molecules used to produce plant-based drugs in drug development. Phytochemicals are found in medicinal and aromatic plants, vegetables and fruits, roots, leaves, and flowers. Phytochemicals, which are not the main food source consumed by humans, are natural compounds that give plants taste, color, and aroma (Vasanthi et al., 2012). This study examined the genotoxic and anti-genotoxic effects of *S. viscosa*, a potentially significant medicinal plant from the Lamiaceae family utilized in many cosmetic, culinary, and pharmaceutical applications, on *D. melanogaster* by the *Drosophila* wing spot test. Numerous studies investigate the antimutagenic properties of several plant extracts, utilizing *Drosophila* as a model organism (Radak & Andjelkovic, 2016). This work is the initial investigation of the anti-genotoxic impact of *S. viscosa* on *Drosophila* utilizing the wing spot test.

It has been shown in different test systems that the negative effects of MMC and promutagens that can be genotoxic as a result of metabolic activation can be prevented with various synthetic or natural molecules. These effects are considered to be antigenotoxic by preventing them from binding to DNA by inducing repair mechanisms, binding to genotoxins, or blocking their metabolism by inhibiting enzyme activities, and molecules that exhibit these activities are considered to be antigenotoxic agents or antimutagens (Laohavechvanich et al., 2006). In this context, we can say that *Stachys* species, which contain various biopolymers that are medically important, prevent breaks in DNA strands that occur due to the effects of various mutagens such as MMC and can also prevent point mutations that develop in parallel. In a study conducted with cell culture, it was shown that the cytotoxic effect of the essential oil contained in a species belonging to the Lamiaceae family on colorectal cancer cell lines was higher than its effect on healthy cell lines. In addition, as a result of apoptosis analysis, it was shown that the essential oil showed a high apoptosis effect and induced apoptosis. As a result, it was reported that this species has the potential to be a therapeutic agent against colorectal cancer (Yadollahi, 2024). The anti-cancer properties of essential oils obtained from some Lamiaceae species against human cancer cells have been investigated. Studies have reported that the tested members of this species have anticancer, antioxidant, and antimutagenic properties (Kolumbayeva et al., 2022; Gezici et al., 2024). Additionally, in a study investigating the antigenotoxic effect of *Salvia verticillata* L. belonging to the Lamiaceae family using the Cytokinesis Block MicroNucleus (CBMN) assay, it was reported that *Salvia* showed a statistically significant antigenotoxic effect against MMC, a mutagenic agent. It can be said that the phenolic acids, flavonoids, and terpenes contained in the plant contribute to this effect (Stavropoulou et al., 2024).

## CONCLUSIONS

This study determined that *S. viscosa* did not cause any genotoxic effect in *D. melanogaster*. In addition, statistical evaluations determined that 45 mg and 60 mg of *S. viscosa* showed anti-genotoxic effects by suppressing DNA damage induced by MMC in *Drosophila*. Accordingly, it can be said that the plant contains some anti-genotoxic factor(s). Members of the Lamiaceae family are extensively utilized for medicinal and aromatic purposes. The family showing aromatic properties has rich secondary metabolites. It also contains many species with antibacterial, anti-fungal, and antioxidant properties. In addition, studies on genotoxic effects are at the beginning level. Many different model organisms are used in genotoxicity and antigenotoxicity studies, especially in the field of Mendelian genetics. Among these organisms, *Drosophila* is the most widely used. With this *in vivo* study with *Drosophila*, one of the most commonly used model organisms in experimental studies due to its genetic characteristics, the anti-genotoxic activity of *S. viscosa* was investigated for the first time on *D. melanogaster*. In this context, we think the study should be evaluated in terms of public health. In order to better elucidate the subject of the study, support our findings, and clarify the mechanism of anti-genotoxicity, further studies such as different extractions and evaluation of different parts of the plant may be recommended. As a result, the pioneering of effective research on the evaluation and characterization of components obtained from the Lamiaceae family and having antigenotoxic effects makes it possible to apply these components to human health. Additionally, it may be recommended to conduct new studies with different *in vivo* and *in vitro* test systems that work with different mechanisms and different model organisms to elucidate the mechanism of the antigenotoxic effect of *S. viscosa* on *Drosophila*.

### Contribution Rate Statement Summary of Researchers

The authors declare that they have contributed equally to the article.

### Conflict of Interest

The authors have declared no conflict of interest.

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