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Evaluation of *Elaeagnus angustifolia* in Campus Landscaping from a Smellscape Perspective: The Case of Kastamonu University Campus

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Smells are a power that surrounds us but can follow us from our mood to our physical health. Despite being a feeling of difficulty in measuring, with the increasing importance of current sensory design, sensory walks, observations, surveys and sensitive measuring devices can be evaluated. The most important value that smell and landscape contain is the order of the ecological cycle as well as the sensory effects on people. This study examines the place of *Eleagnus angustifolia*, which shows smell properties, in the perception of young people. Especially when the importance of the view of university students outside of education is taken into consideration, the effects of this species used in the cycle in terms of the technological and visual contributions used in the spinning look as well as the therapeutic effects are investigated and suggestions are presented.

KEYWORDS
Eleagnus angustifolia, smellscape, fragrant plants, sensory design

Kampüs Peyzajında *Eleagnus angustifolia* Türünün Kokusal Peyzaj Açısından Değerlendirilmesi: Kastamonu Üniversitesi Kampüsü Örneği

Kokular etrafımızı saran görünmesi güç ancak ruh halimizden fiziksel sağlığımıza kadar bizi etkileyen bir unsurdur. Ölçülmesi güç bir duyu olmasına rağmen günümüzde duyusal tasarımın daha çok önem kazanmasıyla birlikte duyusal yürüyüşler, gözlemler, anketler ve belirli ölçüm cihazları ile değerlendirilebilmektedir. Kokulu bitkilerin peyzajda sıklıkla kullanılmasına karşın mekân ile ilişkileri hala ucu açık bir konudur. Bu çalışma koku özelliği gösteren Eleagnus angustifolia türünün gençlerin algısındaki yerini incelemektedir. Özellikle üniversite kampüs peyzajı öğrenciler için eğitim faaliyetleri dışında boş vakitlerini geçirdikleri önemli bir açık yeşil alandır. Bu açık yeşil alanlardaki bitki varlığının ekolojik ve görsel katkılarının yanında terapik etkileri de göz önünde bulundurulduğunda kampüste kullanılan bu bitki türünün mekân ile ilişkisinde kokusunun etkisi araştırılmış ve öneriler sunulmuştur.

ANAHTAR KELİMELER
Eleagnus angustifolia, kokusal peyzaj, kokulu bitkiler, duyusal tasarım

1. INTRODUCTION

According to the European Landscape Convention, the term "landscape" is defined as an area whose character, as perceived by humans, is the result of the action and interaction of natural or human elements (European Landscape Convention, 2000). This definition underscores the growing emphasis on examining the effects of other senses on individuals beyond visual perception. Indeed, approaches that appeal to all perceptions are increasingly included in landscape aesthetics. The concept of an auditory landscape has been a seminal starting point, and it has been followed by the exploration of relationships with other senses, culminating in the development of the smellscape concept over the past decade.

In this regard, Kramsch (2014) underscores the influence of social, linguistic, and cultural values on the nexus between space and human communication. Similarly, Pennycook and Otsuji (2015) state that movement is facilitated in the relationship between space and behavior, leveraging the associative nature of smell. In the context of this relationship, contemporary urban spaces are designed by associating odor with plant elements in accordance with specific principles. The sense of smell, as an integral component of landscape design, exerts a substantial influence on humans. However, its intangibility renders it challenging to evaluate design criteria due to its volatility and the associated difficulties in quantifying it (Ruggles, 2017).

Despite the intricacies involved in measuring smell, it can be assessed through sensory walks, observations, surveys, and specialized measurement devices, underscoring the growing significance of sensory design in contemporary landscape architecture. The odor perception is shaped by the hedonic tone formed by factors such as intensity, duration, and frequency (Curren, 2012; Invernizzi et al., 2017). The olfactory sense is a phenomenon of social life that exerts a profound influence on human behavior, attitudes, and even physical well-being (Synnott, 1991).

Aromatherapy studies (Tabatabaeichehr & Mortazavi, 2020) show that aromatic oils have a positive effect on mood (Diego et al., 1998; Fox, 2009; Kritsidima et al., 2010; Olfactory Research Fund, 2014; Goto et. al., 2014; Vilapana &Yamanaka, 2015; Liang et al., 2024; Ab et al., 2024; Winarsih et al., 2024;) and play an important role in psychophysiological functions (Ali et al., 2015). Xiong et al. (2023) found jasmine to positively affect personal mood while Son et al. (2024) reached the same conclusion with lavender (*Lavandula* sp.), rosemary (*Rosmarinus officinalis* L.), sage (*Salvia microphylla* Kunth), apple mint (*Mentha suaveolens*), and geranium (*Pelargonium graveolens*). The presence of both human activity and natural odors in urban landscapes has been identified as a complementary element of the urban environment. The density of natural vegetation has been identified as a significant indicator of the smellscape (He et al., 2022).

The use of odors in the garden art of many civilizations from the past to the present has been demonstrated with plants. In the context of ancient Greek civilization, plants were selected for their medicinal and aromatic properties, as evidenced by their presence in botanical gardens (Hill, 1915). In monastery gardens, attention was directed towards these plants, underscoring their significance in both horticultural practices and spiritual traditions. In the classical gardens of China in the Far East, the focus on fragrant plants was evident, as documented by Chen and Yuan (2018). Similarly, in European painting, the depiction of fragrant plants became a subject of note, as highlighted by Boynukalın (2020). Song and Wu (2022) reported that odor concentration and diffusion are directly related to plant density, height, receptive location, and spatial configuration. It was further argued that these factors also affect other perceptual elements of the space in which they are located, focusing on different plants (magnolia, peony, lilac, osmanthus) with sensory walks. Zhong et al. (2023) examined the relationship between visual and olfactory factors in sound environments, concluding that smell is more effective in enhancing the auditory environment than visual stimuli. Xiong et al. (2023) conducted a sensory evaluation based on the aroma of pine, asserting that the

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congruence between visual and olfactory stimuli enhances the sensory experience and contributes positively to mental well-being.

The Osmanthus plant (*Osmanthus fragrans*) has been shown to have a positive impact on the human central nervous system, underscoring the significance of odor landscapes in public health (Zhang & Zhang, 2024). In a medical study conducted in the garden of a rehabilitation center, Pálsdóttir et al. (2021) found that patients who spent time in a greenhouse where geranium (*Pelargonium* sp.), rosemary (*Rosmarinus officinalis* L.), lavender (Lavandula sp.), verbena (*Aloysia* sp.), and ground cherry (*Physalis* sp.) were cultivated in a greenhouse exhibited positive perceptions of the odors and reported a reduction in stress levels (Pálsdóttir et al., 2021). In a separate study conducted in Poland, the public's perception of the frequency of occurrence and rarity of certain Lavandula, Salvia, and Hyssopus species was assessed. The findings indicated that while commonly encountered plants in urban parks were perceived as positive odors by the public, rarely observed species such as Hyssopus were neither pleasant nor unpleasant. In the evaluation made on 97 different plant taxa specifically for Ankara, regarding the use of plant species with scent properties in spatial design for visually impaired individuals, *Tilia spp*. was evaluated on road axes, *Lavandula* spp. around bus stops and *Rosa* spp. in seating areas (Kaya & Çorbacı, 2025). It was observed that species evoking relaxing and sweet memories through their odors particularly bring joy to city dwellers. In addition, the study draws attention to the changing plant species in the urban environment due to climate change and emphasizes the importance of sensory gardens in city parks and emphasizes the inclusion of plant species with more intense smell characteristics (Krzeptowska-Moszkowicz et al., 2022).

In the context of examining the utility of odors in various fields, including medicine and art, the present study explores the relationship between plants, as living elements of the landscape, and the utilization of space within (Çorbacı et al., 2017; Hassamancıoğlu et al., 2025) a university campus environment. Considering that scented plants in Türkiye should be placed more in the open green space system rather than in scented gardens (Karaşah, 2025) this study aims to investigate the spatial relations of aromatherapy, contingent on its odor properties, and the way it intersects with space.

It is acknowledged that various species of plants in Türkiye possess olfactory characteristics, and that the presence of drought-resistant species is crucial in the context of effective water usage and climate change. *Eleagnus angustifolia*, a species of particular interest, was observed to be a frequent component of the Kastamonu University campus landscape.

Elaeagnus angustifolia, a member of the Elaeagnaceae family, is a deciduous, small tree or large multi-stemmed shrub (Great Plains Flora Association 1977). The bark is reddish and occasionally shredding, and the branches can possess sharp spines. Fragrant yellow flowers are produced in spring and are pollinated by insects. The fruits, which are oval, measure between 1 and 1.5 centimeters in length and contain a single, relatively large seed (Katz & Shafroth, 2003; Gülcü & Uysal, 2010).

Historically, this plant has been utilized as an herbal remedy for various ailments, including pain management, fever reduction, and diuresis (Hamidpour et al., 2017). Recent pharmacological studies have demonstrated that *E. angustifolia L.* possesses anti-inflammatory, antimicrobial, antioxidant, and other health benefits, making it a potential candidate for the treatment of various disorders (Tehranizadeh et al., 2016). *Eleagnus angustifolia* is regarded as an edible landscape value with its fruits, which are more frequently used as windbreaks and dune breaks in landscaping (Ermeydan et al., 2011; Karademir Çelik, 2015), and which exhibit fragrance properties with its flowering in May-June. Huang et al. (2009) have stated that, in addition to its economic and ecological importance, this species is a plant preferred by users due to its volatile aroma concentrate with high tolerance to soil drought and aerosol salt.

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In this context, the present study aims to explore the perception of *Eleagnus angustifolia* among students in a campus environment, with a focus on the impact of its olfactory properties, the preferred locations for its odor, and the determination of odor intensity.

2. MATERIAL AND METHOD

2.1. Study Area

The present study was conducted at Kastamonu University Kuzeykent Campus, which is in the city center of Kastamonu. The campus is a developing university campus with a total area of 962.781.01 m^2 and 832.458.11 m^2 of open area, and it currently has a total of 13.419 students. The campus features pine groves, which are notable for their presence in the area surrounding the faculty buildings, central dining hall, library, and social facilities (Figure 1). However, there is a paucity of planting designs around the buildings. Due to the prevailing continental climate, the campus is characterized by a preponderance of evergreen coniferous species, particularly *Tilia tomentosa* and *Eleagnus angustifolia*, which contribute to the smellscape. Among these two fragrant species, the flowering period of the silver berry species was preferred because it occurred earlier than the flowering period of the Linden species, which coincided with the students' academic year.

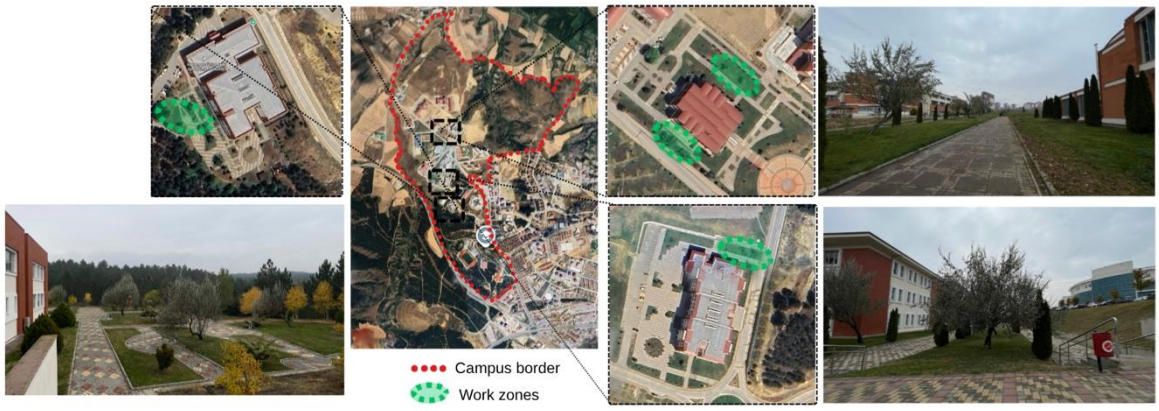


Figure 1. *Kastamonu University campus*

In line with the purpose of the study, the odor perception was measured by the survey method and panelist method, which are frequently used in literature to measure the effect of smell on humans (Figure 2). The study was conducted on days when the temperature was high and the wind speed was low, depending on the influence of climatic factors on odor perception (Badach et al., 2018; Ayan Çeven, 2020; Jia et al., 2021; Allen, 2023; Cai et al., 2022).

2.2. Odor Perception (Survey)

This study employed a questionnaire to determine the relationship between odor and behavior, with the objective of examining the effects of the odor of *Eleagnus angustifolia* on the user. The study population comprised 13.419 students from Kastamonu University's Kuzeykent Campus, and the sample size was calculated as n=73, with an error percentage of 0.05 at a 95% confidence interval. As stated in the study's purpose, the investigation was meticulously structured into two phases to determine the users' perceptions of the Silver berry tree odor, odor, and space preferences.

The questionnaire phase of the study entailed the administration of a survey to voluntary students from diverse faculties to assess their cognizance of the Silver berry tree odor. The initial questionnaire was designed to evaluate the respondents' familiarity with the distinctive odor characteristics of the Silver berry tree. The second questionnaire study was conducted in June with the students who participated in the first questionnaire study in the vicinity of the Silver berry tree by

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being exposed to the plant's odor. The second questionnaire consists of three parts: in the first part, the socio-demographic status of the voluntary participants is collected; in the second part, the odor and space preferences in relation to the plant is evaluated with the semantic difference method through adjective pairs. The semantic differential method (Acar et al., 2003), a reliable and effective tool for measuring subjective perceptions of external stimuli (Zhang & Zhang, 2024), was used to evaluate responses to odors.

The semantic differential technique, developed by Osgood et al. (1957), is expressed by a scale consisting of pairs of opposite adjectives. The selection and grouping of these adjective pairs was conducted by Dalton (2000) and Ayan Çeven (2021), respectively. The study evaluated silver berry odor preferences in the seating area, food and beverage area, study area, and sports area, which can be used for different activities on campus, in the relationship between odor and space. In this context, the adjective pairs employed include: stable/undecided, excited/calm, happy/sad, banal/pleasing, tiring/relaxing, appetizing/intimidating, distracting/distracting, depressing/refreshing, hot/cold, heavy/light, strong/weak, new/old, light/dark, distinct/vague, sharp /blunt, healthy/unhealthy, tense/relaxed, pleasant/unpleasant, dynamic/static, fresh/old, dangerous/safe, characteristic/common, interesting/boring, clean/dirty, simple/complex, relaxing/stimulating, bitter/sweet, strong/weak, harmonious/discordant, plain/colorful, caustic/freezing. The participants were asked to evaluate each adjective pair by assigning one of the scores "-2, -1, 0, 1, 2" for each adjective pair on the questionnaire form for four different categories. The values of "-2, -1, 0, 1, 2" were then converted to "1; very, 2; somewhat, 3; neutral, 4; somewhat, 5; very" to facilitate the evaluation process in the computerization of the questionnaires. In the evaluation phase, the scores given by each subject for each adjective pair were averaged. In the second part of the questionnaire, the quality of the odor (Henshaw, 2013, McLean, 2019; Ayan Çeven, 2021) was also measured with a 5-point Likert scale. The character of the odor was assessed using the criteria of value (pleasant-unpleasant), duration (intermittent-continuous), and intensity (low-high) as the participants were situated near the silver berry plant. The final section of the questionnaire incorporated an open-ended inquiry to determine the relationship between odor and memory.

2.3. Measuring the Distribution of Silver Berry Odor (Panelist)

The study used sensory measurement to determine the character of the odor. Sensory measurement is a frequently used method for subjective odor intensity assessment. The study was conducted with voluntarily selected students who had previously experienced the odor of oleaster, but were not sensitive to odor beforehand. Considering that temperature, wind and humidity are important factors in the perception of odors at this stage of the study (Ayan Çeven, 2021), the field study with the panelists was carried out in May, when the temperature was above 250, the wind was below 10 km/h and the humidity was above 40%. Five selected students (panelists) evaluated the odor intensity, duration, frequency, and distribution under existing oleaster trees using a 7-point Likert scale. To assess the spatial distribution of the odor, the perceptibility of the odor was measured using the methods of Song and Wu (2022) around the tree at distances of 1m, 2m, 3m, and 5m, with a 5-minute waiting period at each point. The primary objective was to determine the extent and direction of the wind-driven distribution of the odor (Figure 2).

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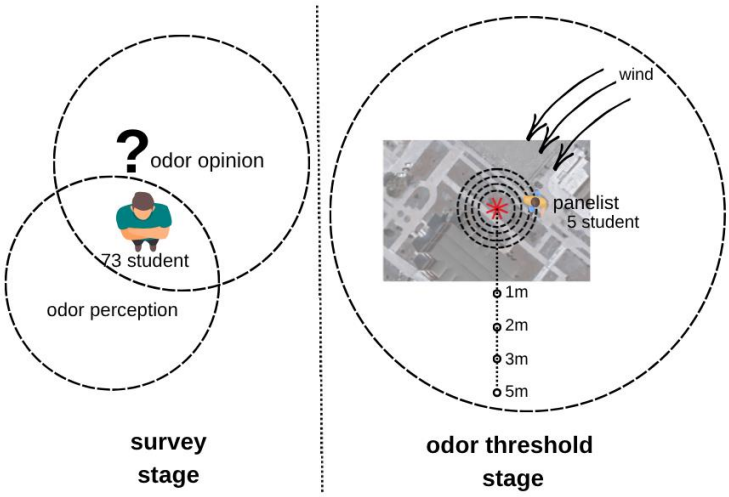


Figure 2. *Methodology summary*

2.4. Analysis

The collected data were then subjected to factor analysis (Kaiser, 1958; Akdeniz, 1991) using the SPSS software program, with the goal of identifying effective adjective pairs that could explain the variations in the data. The results obtained from the odor distribution data, which were collected with the assistance of panelists, were then digitized and visualized using the Photoshop software program. This process enabled the mapping of the distinctive olfactory characteristics of the silver berry trees on the university campus.

3. RESULTS AND DISCUSSION

3.1. Participant Demographics

In the initial stage of the study, students from various faculties participated in the first questionnaire study, during which they evaluated the odor of silver berry trees. The study revealed that 74% of the participants were female, 26% were male, 23% fell within the 18-20 age range, and 77% were 20 years and older. 50% of the students participating in the study are engineering and architecture faculty students. Most of the participants (93%) exhibited no difficulty in odor perception, and 63.01% demonstrated no odor sensitivity.

3.2. Olfactory Awareness and Its Structure

An analysis of the participants' outdoor activities on campus revealed that 38% visited the area once daily, 58% spent between 15 and 20 minutes there, and 43% utilized it for eating and drinking activities. In the initial stage of the study, the participants' familiarity with the odor of silver berry was assessed. It was found that 34% of the students were unaware of the odor, 42.4% described it as pleasant, 13.6% as refreshing, and 10.6% as unpleasant.

In the subsequent phase of the questionnaire, the olfactory characteristics of silver berry odor in various locations were assessed based on criteria of continuity, value, and intensity. The results indicated that 74.66% of the participants reported perceiving silver berry odor in the food and beverage area (mean 11.2), with the sports area exhibiting the least perception of the odor (see Table 1).

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Table 1. *Findings on odor character by location*

	Duration		Value		Intensity		Frequency	
place	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**
sitting	3.5	70	4	80	3.6	72	11.1	74
eating	3.5	70	4	80	3.7	74	11.2	74.6
sports	3.5	70	3	60	2	40	8.5	56.6

In the final stage of the study, the arithmetic mean results according to the semantic differentiation scale of the preference of silver berry odor according to the place where it is located were examined. According to Figure 3, which expresses negative values to positive values, it was determined that silver berry odor has no effect on the emotional state of the participants in the dining and seating area. However, silver berry odor around the dining area was found to be associated with happiness. In the seating area, silver berry was found to elicit sensations of sweetness, clarity, attention, refreshment, understanding, dynamism, and freshness.

Conversely, in the sports areas, the prevailing sentiment was one of monotony and pessimism, characterized by an aged and somber atmosphere. However, the presence of silver berry odor induced contrasting emotional responses, including calmness, happiness, pleasure, appetite, and a sense of dynamism, concurrent with monotony and pessimism. As illustrated in Figure 3, the subjects expressed a negative sentiment regarding the presence of silver berry odor in the seating and dining areas. Conversely, they exhibited a preference for the odor in the sports field.

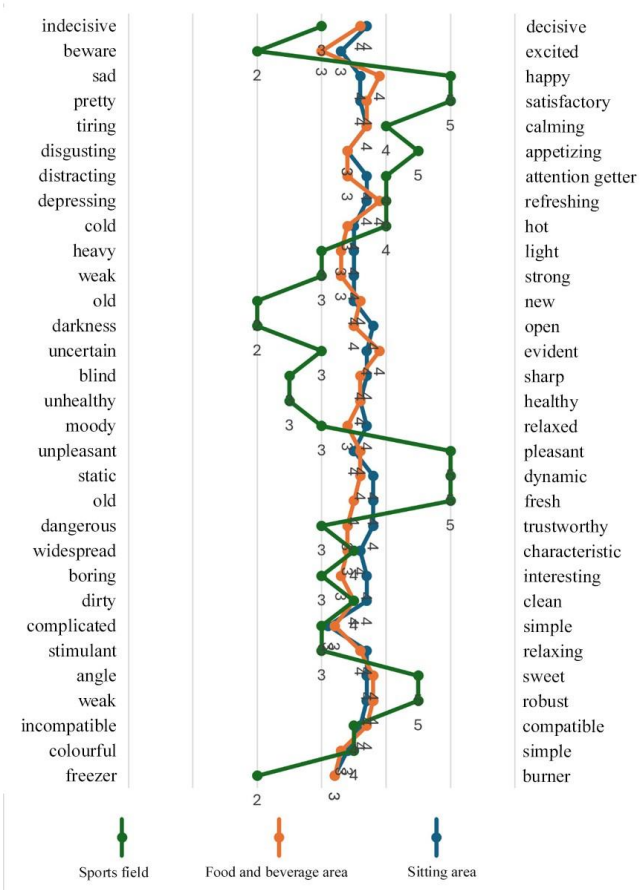


Figure 3. *Semantic differentiation of the odor character according to spaces*

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3.3. Odor Character and Its Distribution

In the panelist method for the perception of silver berry odors in the study, five volunteers without odor sensitivity were selected for the application, which was carried out under suitable climatic conditions where the odor could be perceived during the flower season (May) of the silver berry trees on the campus. After explaining the procedure of the application, the participants filled out the form regarding odor perception by walking around the tree one meter from the silver berry tree. As a result of the applications, it was determined that the odor perception of the 5 panelists gradually decreased with distance. At this stage, the results of the panelists' odor perception during the full rotation of the panelists around the plant in a circle were evaluated. It was found that silver berry odor was perceived most in the southwest direction (37%) and least in the northeast direction (15%) (Figure 4). The odor was perceived more strongly in the warmer views, while the odor perception in the north direction was the lowest. The odor distribution map, which illustrates the spatial distribution of the odor based on the location of the plants on the campus, is presented in Figure 4. Meteorological data showed that the prevailing wind was blowing from the southwest. Panelist evaluations revealed that odor perception was greater (37%) in the prevailing wind direction than in other directions, depending on the distance from the odor source. It is seen that the measured oleaster trees are located between the structures in terms of their spatial location but are exposed to the winds (Figure 4).

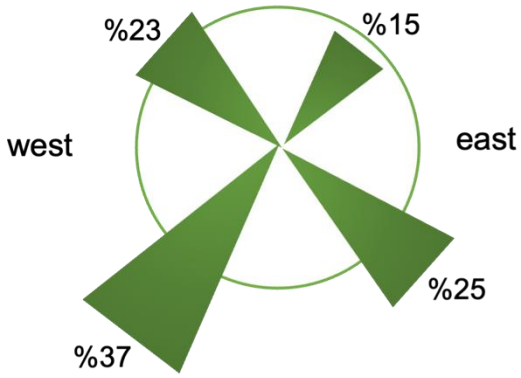


Figure 4. *Directional distribution of odor*

4. CONCLUSION AND RECOMMENDATIONS

This study was conducted to evaluate the effect of the odor of silverberry on university students. The results demonstrate that the odor of the silver berry tree can be perceived and appreciated. Song and Wu (2022) argue that odor diffusion will enrich dynamic sensory experience in the future and draw attention to the fact that odor perception, which is evaluated with a subjective approach, should be included more in urban landscapes. Additionally, the significance of olfactory experiences in facilitating spiritual healing in environments resembling naturalness has emerged as a crucial topic of concern (Bratman et al., 2024). The study's findings indicate that the plants not employed for any specific design purpose in the campus landscape are not optimally positioned in terms of their visual, ecological, and olfactory characteristics. Song and Wu (2022), in evaluating the scent landscape, state that scent intensity and spread vary depending on factors such as plant density, tree height, receptor location and spatial range, and that other plants in the environment, landscape architecture, rocks and water are also important factors affecting scent spread. A subsequent examination of the built environment on campus, encompassing diverse functional areas, revealed a deficiency in the integration of plant elements. This deficiency can be attributed to the absence of comprehensive design principles in the existing plant selection. Consequently, the absence of diversity in the relationship between plant odors and space underscores the study's limitations.

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The evaluation of the silver berry odor, based on space preferences, revealed an emotional neutrality in the students' eating and drinking spaces. The following suggestions were made in the present study:

- The participants indicated that the presence of silver berry trees in seating areas has the potential to enhance the environment's aesthetic appeal and promote mental well-being. This assertion is supported by research that demonstrates the positive impact of scents on cognitive function and academic performance (Ilmberger et al., 2001; Michael et al., 2005; Rodionova & Minor, 2017). Considering these findings, the strategic placement of silver berry trees within the seating areas of the campus library could potentially optimize the learning environment.

- Considering the findings from the study, it can be suggested that silver berry trees could be utilized in conjunction with aromatherapy plants that possess calming properties in places where sports activities are carried out to minimize the health problems arising from the increase in blood circulation due to intense tempo to promote calming, happy emotional states.

The study yielded several notable results. First, it was determined that the perception of odor varies depending on the direction of wind, with changes occurring more significantly in the southwestern direction. This finding underscores the importance of considering odor distribution when designing smellscapes, emphasizing the need to establish a relationship between plant species and their placement within the space to ensure optimal olfactory experiences.

This study, specifically focusing on the species *Eleagnus angustifolia*, examines user-centered spatial changes and their evaluation based on wind direction in smellscapes within campus open spaces. The limited number of studies on smellscape and on user perception of these species makes this research valuable. The results also show that oleaster has distinctive scent qualities and is a familiar and beloved fragrance for many. This suggests that this species is considered a landscape asset not only for its ecological and design benefits but also for its microclimatic and spatial orientation. Olfactory perception, which varies with environmental conditions, offers opportunities to develop sensory design strategies in landscape architecture. Highlighting odor distribution and scent corridors on campus, this study enables the consideration of olfactory focal points in planting designs, extending beyond aesthetics to foster orientation, meaning, and awareness within spatial organization. Future research will offer examples for assessing the effects of combining plant species with different scents on user perception.

Author Declarations and CRediT Roles

There is no conflict of interest. No funding was received. Generative artificial intelligence was not used. It has not been previously presented or published. Data are presented within the article.

Ethical approval is required and obtained. Approving institution/organization: Kastamonu University Science and Engineering Sciences Scientific Research and Publication Ethics Board. Date of approval: 25.11.2022. Approval no: 2200128673.

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