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ul. Jana Heweliusza14
10-718 Olsztyn-Kortowo, Poland
tel.: +48 89 523-36-61
fax: +48 89 523-34-38
e-mail: wydawca@uwm.edu.pl

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RESEARCH MARKETING STANDARDS FOR CHICKEN EGG QUALITY PARAMETERS INTENDED FOR CONSUMPTION

***Mergim Mestani*[1], *Ibrahim Mehmeti*[2], *Medin Zeqiri*[3]**

[1–3]Faculty of Food Science and Biotechnology
UBT – Higher Education Institution, Kalabria, Prishtina, Kosovo
[1]ORCID: 0000-0001-6427-7824
[2]ORCID: 0000-0001-5653-2418
[3]ORCID: 0000-0001-6062-8754

Key words: chicken eggs, quality of chicken eggs, fresh eggs, market eggs, physical parameters, standards of eggs.

Abstract

Egg quality is a critical factor influencing consumer preference and market value, primarily affected by freshness, storage conditions, and production practices. This study compared the quality parameters of fresh and market chicken eggs. A total of 2000 eggs (both market and fresh) were analyzed following USDA Egg Grading Manual protocols. Parameters evaluated included egg weight, eggshell weight, yolk and egg white weight, specific gravity, Haugh units (HU), air cell size, yolk color (RYCF), eggshell thickness, length, and width. Results revealed significant differences, with fresh eggs demonstrating superior quality across multiple parameters. The results revealed significant differences, with fresh eggs exhibiting superior quality across several parameters. Fresh eggs had a higher mean weight (65.89 g vs. 62.30 g; $P = 0.0001$) and shell weight (7.97 g vs. 7.35 g; $P = 0.0186$), although no significant difference was observed in shell thickness ($P = 0.1626$). Fresh eggs also showed higher yolk weight (15.31 g vs. 14.37 g; $P = 0.021$) and more intense yolk color (RYCF: 12.35 vs. 11.45; $P = 0.0259$). Notably, Haugh unit values were significantly higher in fresh eggs (88.46) compared to market eggs (76.57; $P = 0.0006$), indicating better freshness. The air cell size was smaller in fresh eggs (3.47 mm vs. 4.78 mm; $P = 0.0044$), qualifying them as "extra" class under quality standards. Based on the findings, fresh eggs met the criteria for superior quality, being classified as "L" class based on weight and "extra" class due to their smaller air cell size. Conversely, market eggs tended to fall into lower quality classes, such as "M" class, due to their lower weight and larger air cell size. However, both types of eggs are deemed suitable for consumption according to established guidelines. Continuous research is essential to refine egg quality standards and align with consumer expectations.

Address: Medin Zeqiri, UBT-Higher Education Institution, Kalabria, str. Rexhep Krasniqi Nr. 56, Prishtina 10000, Kosovo, e-mail: medin.zeqiri@ubt-uni.net

Introduction

The production and consumption of chicken eggs are constantly increasing, with eggs serving as a significant source of protein and essential nutrients for billions of people worldwide (DILAWAR et al. 2021, FAOSTAT 2022, KOCETKOVS et al. 2022, KUANG et al 2018, MIRANDA et al. 2015, PAL and MOLNAR 2021, PAPANIKOLAOU and FULGONI 2021, RATH et al. 2015). A significant portion of this production is used in the secondary processing industry (AHMAD et al., 2021). Kosovo's poultry industry saw significant growth in 2020, with 366 million eggs produced, meeting 99% of demand, though per capita consumption lags a little behind the EU average (MAFRD 2021, HORNE 2018).

Ensuring high physical quality parameters of chicken eggs is crucial for meeting consumer expectations and regulatory standards. Consumers prioritize freshness and nutritional value when assessing egg quality (GRASHORN et al. 2016, HARNSOONGNOEN and JAROENSUK 2021, RATH et al. 2015). Consumer preferences are influenced by intrinsic and extrinsic characteristics, as well as socio-cultural factors (RONDONI et al. 2020, ZAHEER 2015).

Numerous studies have investigated egg quality, elucidating factors that influence it, such as environmental and genetic influences, dietary supplements, chicken age, stress levels, temperature, lighting conditions, medications, diseases, management practices, and growth systems (ADAMSKI et al. 2017, DILAWAR et al. 2021, HARNSOONGNOEN and JAROENSUK 2021, KOCETKOVS et al. 2022, RATH et al. 2015, SOKOŁOWICZ et al. 2018, SENBETA et al. 2015). A study by RODRÍGUEZ-HERNÁNDEZ et al. (2024) found that hens from cage-free housing systems yield eggs of higher quality, with improvements in albumen height, egg weight, yolk color, eggshell thickness, and Haugh units. While, GRASHORN et al. (2016) emphasized genetic factors' influence on albumin quality, with minimal influence from nutrition, while adding calcium, phosphorus, and vitamin D to hen diets improved shell resistance. Stable storage conditions, as highlighted by RATH et al. (2015) and GRASHORN et al. (2016), enhance egg quality, underscoring the importance of production practices.

Size uniformity is a crucial aspect of egg marketing standards. Regulatory bodies in Kosovo, such as Ministry of Agriculture, Forestry and Rural Development (MAFRD, have set guidelines (AD Nr. 17/2008) for classifying and labeling eggs based on factors like size and shell cleanliness. This ensures transparency for consumers and consistency in packaging. Based on these standards, eggs are categorized into size groups, ranging from small to large.

This study aims to assess a number of exterior and internal quality parameters of fresh and market chicken eggs, such as egg weight, eggshell weight, yolk and white weight, specific gravity, Haugh units (HU), air cell size, yolk color (RYCF), eggshell thickness, length and width. The results will be compared with the standards and guidelines outlined in Administrative Directive AD No. 17/2008, which defines the criteria for evaluating the external and internal quality of chicken eggs in Kosovo. For the benefit of both producers and consumers, regular monitoring of these variables is essential to preserving the safety and freshness of eggs. To improve egg quality standards and deepen our understanding, this sector requires ongoing research.

Materials and Methods

In this study, a total of 2,000 eggs were collected from various municipalities in Kosovo (Ferizaj, Gjilan, Prizren, Gjakovë, Istog, Lipjan, Podujevë, and Prishtinë). In the supermarkets of the municipalities of Ferizaj, Gjilan, Gjakovë, Istog, Lipjan, and Podujevë, a total of 200 eggs were collected from two different local producers (100 eggs from each producer). Meanwhile, in the municipality of Prizren, 300 eggs were collected from three different producers (100 eggs from each producer). In the municipality of Prishtina, 400 eggs were collected from four different producers (100 eggs from each producer). Additionally, 100 fresh eggs were collected as control samples from a farm in the Pristina region. Based on the label information, the eggs found on the market were classified as "Class A" eggs intended for consumption. The results of all samples were compared with the standards and guidelines specified in Administrative Instruction UA No. 17/2008, which sets criteria for assessing the external and internal quality of chicken eggs in Kosovo. According to this administrative instruction, eggs are classified into two groups to determine their quality for consumption: fresh class "A" eggs and class "B" eggs intended for industrial processing. Class "A" eggs are further divided and labeled as follows: "XL" – very large eggs weighing 73 g and above, "L" – large eggs weighing between 63 g and 73 g, "M" – medium-sized eggs weighing between 53 g and 63 g, and "S" – small eggs weighing less than 53 g. For class "A" eggs, the air cell should not exceed 6 mm, while for extra class eggs, the air cell should not exceed 4 mm, as specified in the same Administrative Instruction. Various criteria were used to evaluate egg quality, including egg weight, eggshell weight, egg yolk weight, egg white weight, specific gravity, Haugh units (HU), air cell size, intensity of yolk color (RYCF), eggshell thickness, egg length, and egg width. The weights of eggs, along with their shells, yolks, and egg whites, were measured using

the Electronic Analytical Balances, BA-W2004 Series, China. The air cell size was determined using the official egg air cell gauge FORM PY-35 (5-1-74), following USDA Egg Grading Manual. Specific gravity (SW) was calculated by immersing the eggs in saline solutions until they reached their floating point. Various NaCl solutions with specific weights ranging from 1.050 to 1.100 in increments of 0.005 g/cm^3 were created in order to ascertain the specific weight of the eggs (Hydrometer precision, 1.000 to 1.100 g/cm^3, Greiner-Glasinstrumente, Germany). Haugh Units (HU) were measured with a Haugh meter (Haugh unit micrometer, B C Ames Co, Waltham, Massachusetts, USA), following USDA Egg Grading Manual. Yolk color density was visually assessed using a Yolk Color Fan 1–15 scales (Roche & Company Ltd., Switzerland), following the methodology outlined by JOUBRANE et al. (2019). Eggshell thickness, length, and width were evaluated using a Digital Traceable Calipers, model 3415CC (Webster-Texas, USA). This meticulous approach ensured a robust assessment of egg quality, providing valuable insights into the characteristics of eggs available in the market from various regions and producers in Kosovo.

Statistical analysis. Descriptive statistics were conducted using the Statistical Package for the Social Sciences (SPSS) (IBM Version 28.0, Armonk, NY). The t-test was utilized to determine if there was a significant difference between the means of various parameters. A P-value of ≤ 0.05 was considered statistically significant, indicating a notable difference between the means of the parameters.

Study limitations. Research primarily focuses on the physical characteristics of hens' eggs, overlooking other factors affecting egg quality like breed, feeding, production techniques, storage temperature and genetics. Additionally, the study's limited sample size and geographic scope in Kosovo may hinder generalization. It fails to consider varied chicken housing systems (caged or free-range), which can influence egg quality. Furthermore, the research neglects to examine the impact of handling practices, hygiene, transport, and specific storage conditions on egg quality.

Results and Discussions

Table 1 presents a comparative analysis of various characteristics of chicken eggs, specifically comparing market eggs with fresh (control) eggs. The descriptive statistics provide insights into parameters such as egg weight, eggshell weight, egg yolk weight, egg white weight, specific gravity, Haugh unit (HU), air cell size, intensity of yolk color (RYCF), eggshell thickness, egg length, and egg width. These parameters are crucial in evaluating the quality and nutritional content of eggs.

Table 1

Comparative analysis of chicken egg characteristics:
Market vs. Fresh eggs (descriptive statistics)

Specification		Egg weight [g]	Eggshell weight [g]	Egg yolk weight [g]	Egg white weight [g]	Specific gravity [g/cm^3]	Haugh unit [HU]	Air cell [mm]	Intensity of yolk color [RYCF]	Eggshell thickness [μm]	Egg length [mm]	Egg width [mm]
Market chicken eggs	min	56.97	6.75	13.40	36.82	1.06	62.90	3.44	9.44	0.38	49.10	38.10
	max	66.90	7.97	15.30	43.63	1.09	91.20	6.21	12.70	0.44	57.40	44.80
	mean	62.30	7.35	14.37	40.58	1.07	76.57	4.78	11.45	0.41	53.97	41.99
	SEM	1.41	0.20	0.27	0.96	0.00	3.86	0.43	0.52	0.01	1.18	0.98
	STDEV	3.44	0.49	0.66	2.34	0.01	9.45	1.04	1.26	0.03	2.88	2.40
Fresh chicken eggs (control)	min	59.58	5.88	11.84	36.76	1.07	75.50	3.20	9.00	0.32	45.77	33.77
	max	76.85	10.83	18.26	54.39	1.10	115.00	4.80	15.00	0.56	61.54	48.46
	mean	65.89	7.97	15.31	43.53	1.09	88.46	3.47	12.35	0.43	56.26	43.68
	SEM	0.64	0.16	0.29	0.71	0.00	1.34	0.10	0.23	0.01	0.48	0.40
	STDEV	3.71	0.95	1.68	4.14	0.01	7.83	0.58	1.37	0.05	2.82	2.33
P-value	–	**0.0001**	**0.0186**	**0.021**	**0.0164**	**0.0001**	**0.0006**	**0.0044**	**0.0259**	**0.1626**	**0.0124**	0.0137

Note: The statistics include minimum, maximum, mean, standard error of the mean (SEM), and standard deviation (STDEV) values for egg weight, eggshell weight, egg yolk weight, egg white weight, specific gravity, Haugh unit (HU), air cell size, intensity of yolk color (Roche Yolk Color Fan), eggshell thickness, egg length, and egg width. *P*-values indicate the level of significance for differences between the two groups, with values less than 0.05 considered statistically significant

Egg weight is a fundamental characteristic affecting marketability and consumer preference. The mean egg weight for market eggs (62.30 g) is slightly lower than that of fresh eggs (65.89 g), indicating potential differences in egg size between the two groups. Notably, market eggs have a narrower range of weights (56.97 g to 66.90 g) compared to fresh eggs (59.58 g to 76.85 g), suggesting more consistency in size among market eggs. The difference in mean egg weight between the two groups is statistically significant ($P = 0.0001$), indicating a meaningful disparity. From this we conclude that fresh eggs, which were stored at controlled temperatures, had a higher weight compared to market eggs, where the storage temperature was not controlled. The average market egg weight in the research follows the standard range (58 to 62 g) reported by RATH et al. (2015), while fresh eggs exceed the reported averages. Factors influencing egg weight, such as feed, chicken weight, genetics, environment, storage conditions, and sanitary conditions in farms, are reported by various authors (HARNSOONGNOEN and JAROENSUK 2021, KOCETKOVS et al. 2022, RATH et al. 2015, SOKOŁOWICZ et al. 2018).

Eggshell weight and thickness are critical for shell integrity and protection of the eggs contents. Market eggs exhibit a mean eggshell weight of 7.35 g, whereas fresh eggs have a slightly higher mean weight of 7.97 g. However, fresh eggs demonstrate a wider range of eggshell weights, indicating greater variability in shell thickness compared to market eggs. This variation could influence egg quality and susceptibility to breakage. The difference in mean eggshell weight between the two groups is statistically significant ($P = 0.0186$). In terms of eggshell characteristics, market eggs tend to have a slightly thinner eggshell, as evidenced by the mean eggshell thickness of 0.41 μm, compared to 0.43 μm for fresh eggs. However, this difference may not be statistically significant, as indicated by the *P*-value (0.1626). The results of our research align with findings from other authors regarding eggshell characteristics and influencing factors (KOCETKOVS et al. 2022, RATH et al. 2015, SOKOŁOWICZ et al. 2018). A study by RODRÍGUEZ-HERNÁNDEZ et al. (2024) concluded that cage-free housing systems yield higher quality eggs with thicker shells. Additionally, GRASHORN et al. (2016) stressed the significance of chicken diet in enhancing shell resistance. Stable storage conditions, as emphasized by RATH et al. (2015) and GRASHORN et al. (2016), contribute to improved egg quality, underscoring the importance of production practices.

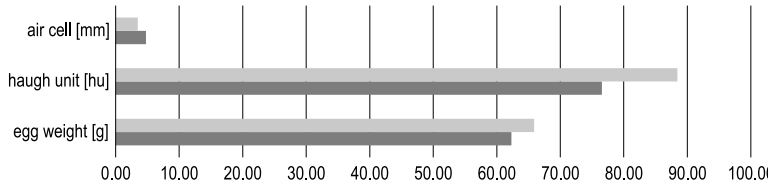
Egg yolk weight and color intensity are essential indicators of nutritional value and visual appeal. Fresh eggs exhibit a marginally higher mean yolk weight (15.31 g) compared to market eggs (14.37 g), suggesting potentially richer nutritional content in fresh eggs. The difference in mean yolk weight between the two groups is statistically significant ($P = 0.021$). Furthermore,

the intensity of yolk color, measured by the Roche Yolk Color Fan (RYCF), is significantly higher in fresh eggs (mean RYCF of 12.35) than in market eggs (mean RYCF of 11.45), indicating a deeper, more vibrant yolk color in fresh eggs. The difference in mean RYCF is statistically significant ($P = 0.0259$). Higher values of yolk weight, color index, and factors influencing weight loss have been reported by previous authors (DILAWAR et al. 2021, KOCETKOVS et al. 2022, RATH et al. 2015, SOKOŁOWICZ et al. 2018). A recent study by RODRÍGUEZ-HERNÁNDEZ et al. (2024) found that cage-free housing systems produce eggs of higher quality and weight, with a more intense yolk color.

Haugh unit (HU) values reflect the freshness and quality of eggs, with higher values indicating fresher eggs. Fresh eggs have a substantially higher mean HU value (88.46) compared to market eggs (76.57), indicating fresher and potentially higher-quality eggs in the fresh group. This discrepancy is further supported by the significant difference in air cell size between the two groups, with fresh eggs having a smaller mean air cell size (3.47 mm) compared to market eggs (4.78 mm), signifying less air infiltration and better egg freshness. The differences in mean HU and air cell size are statistically significant ($P = 0.0006$ and $P = 0.0044$, respectively). We have observed that smaller Haugh Units correlate with larger air chambers and vice versa. Previous studies have shown that the Haugh unit depends on albumen height but not on egg weight (INCA et al. 2020, JANG 2022, RAFEA 2019). Both lower and higher values of air cell in eggs, and the factors affecting the deterioration of this important parameter for egg quality in consumption and food industry use, have been discussed by previous authors (HARNSOONGNOEN and JAROENSUK 2021, RATH et. al. 2015). A recent study by RODRÍGUEZ-HERNÁNDEZ et al. (2024) found that cage-free housing systems produce higher quality eggs, with improvements in albumen height and Haugh units. Additionally, GRASHORN et al. (2016) emphasized the influence of genetic factors on albumin quality, with minimal impact from nutrition. Overall, the comparative analysis highlights significant differences in various egg characteristics between market and fresh eggs, with some parameters showing statistically significant disparities while others do not. These findings underscore the importance of considering multiple factors when assessing egg quality and consumer preferences.

Figure 1 compares egg weight, Haugh unit, and air cell size between market and fresh chicken eggs.

Fresh eggs surpass market eggs in several aspects: they have higher egg weight (fresh: 65.89 g, market: 62.30 g) and Haugh unit (fresh: 88.46, market: 76.57). Moreover, fresh eggs display a smaller air cell compared to market eggs (fresh: 3.47 mm, market: 4.78 mm). The mean weight of fresh eggs (65.89 g) classifies them in the large egg category according to Administrative Instruction No. 17/2008, which stipulates that eggs with a mean weight



	Egg weight [g]	Haugh unit [hu]	Air cell [mm]
fresh chicken eggs (control) mean	65.89	88.46	3.47
market chicken eggs mean	62.30	76.57	4.78

fresh chicken eggs (control) mean market chicken eggs mean

Fig. 1. Comparison of mean egg characteristics, key quality parameters, between Market and Fresh chicken eggs

of 63–73 g are classified as large class "L" eggs. On the other hand, market eggs with a mean weight of 62.30 g fall into the medium egg category "M" (53–63 g). However, according to this administrative instruction, both fresh and market eggs are categorized as "A" class eggs, which are suitable for consumption. Regarding the air cell measurements from the study, both groups of eggs fall into the "A" class. However, fresh eggs are classified as "extra" because they do not exceed the 4 mm limit set in the administrative guidelines for this parameter. The administrative instructions stipulate that the air cell should not exceed 6 mm, and eggs classified as "extra" should

Table 2

Percentage change in chicken egg characteristics compared to mean values: Fresh eggs vs. Market

Parameters	Fresh chicken eggs (control)	Market chicken eggs	Percentage difference [%]
Egg weight [g]	65.89	62.30	-5.76
Eggshell weight [g]	7.97	7.34	-8.58
Egg yolk weight [g]	15.31	14.37	-6.54
Egg white weight [g]	43.53	40.57	-7.30
Specific gravity [g/cm^3]	1.090	1.073	-1.58
Haugh unit [HU]	88.46	76.56	-15.54
Air cell [mm]	3.47	4.78	27.41
Intensity of yolk color (Roche yolk color fan)	12.35	11.45	-7.86
Egg shell thickness [μm]	0.43	0.41	-4.88
Egg length [mm]	56.26	53.96	-4.26
Egg width [mm]	43.68	41.99	-4.02

Note: Negative values in the Percentage Difference [%] column indicate a decrease in the measured parameter for Market compared to Fresh Chicken Eggs

have an air cell size not exceeding 4 mm. These disparities imply superior quality and freshness in fresh eggs, possibly influenced by factors like storage temperature, diet, and handling. Further investigation is required to fully comprehend the implications of these distinctions.

Fresh eggs, serving as the control group, demonstrate significant advantages over market eggs in several key parameters. Firstly, fresh eggs exhibit a higher egg weight by 5.76% compared to market eggs. This weight disparity suggests potential differences in nutritional content and overall egg quality. Secondly, fresh eggs display an 8.58% increase in eggshell weight compared to market eggs. A thicker eggshell often correlates with better egg protection and durability. Furthermore, fresh eggs boast a higher Haugh unit (HU), indicating superior freshness and quality. The Haugh unit is a vital metric in assessing egg quality, with higher values indicating fresher eggs. Additionally, fresh eggs have a substantially smaller air cell size, with a 27.41% decrease compared to market eggs. A smaller air cell suggests fresher eggs, as air cell size increases with egg aging. In summary, the comparison underscores the superiority of fresh eggs over market eggs in terms of weight, eggshell thickness, Haugh unit, and air cell size. These differences are crucial for consumers and egg producers alike, emphasizing the importance of considering egg freshness and quality when making purchasing decisions. Loss of egg weight, significant decline in albumen height and HU, as well as yolk index, has been documented by various authors. Additionally, degradation in shell characteristics such as thickness, width, and height has been observed. Factors influencing these changes include storage duration and temperature, chicken age, diet, and eggshell attributes (GRASHORN et al. 2016, HARNSOONGNOEN and JAROENSUK 2021, KOCETKOVS et al. 2022, RATH et al. 2015)

Conclusion

This study provides a comprehensive evaluation of the external and internal quality parameters of chicken eggs available in the market compared to fresh eggs sourced directly from farms. The findings highlight significant differences in key external quality parameters, such weight, shell thickness, Haugh Unit, and air cell size. Fresh eggs consistently outperformed market eggs in these metrics, emphasizing their superior quality. When compared to the criteria outlined in Administrative Instruction UA No. 17/2008, which sets standards for assessing the external and internal quality of chicken eggs in Kosovo, both market and fresh eggs meet the basic requirements for consumer safety and marketability. However, the superior performance of fresh eggs suggests that stricter adherence to storage and production

practices could further enhance the quality of market eggs. Future studies should consider expanding the sample size and geographic scope, alongside exploring factors such as chicken breed, diet, housing systems, and storage conditions. Such efforts are essential for refining marketing standards and aligning them with evolving consumer expectations. By doing so, stakeholders can improve product quality, increase market competitiveness, and support informed consumer choices.

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INFLUENCE OF IMPROPER PLAY WITH THE CAT ON THE FREQUENCY OF AGGRESSIVE BEHAVIOUR

***Justyna Wojtaś*[1], *Aleksandra Garbiec*[2], *Karolina Kaleta*[3], *Martyna Decowska*[4], *Joanna Kapustka*[5]**

[1]ORCID: 0000-0002-1275-3240
[2]ORCID: 0000-0001-8430-0729
[3]ORCID: 0009-0004-8853-9568
[4]ORCID: 0009-0000-5391-4197
[5]ORCID : 0000-0001-8175-7299
[1,2,5]Department of Animal Ethology and Wildlife Management
[3,4]Felinology Student Scientific Circle
University of Life Sciences in Lublin, Lublin, Poland

Key words: cat, aggression, cat-human relationship, behavior.

Abstract

This study aimed to assess the relationship between improperly conducted play and the frequency of aggressive behaviour in cats. The research was conducted using an anonymous survey. Three thousand five hundred respondents with cats took part in the study. Among the animals, 58.9% were aged 1 to 5 years, 24.4% were cats aged 6–15 years, under 14.4% and senior cats over 15 years of age 2.3%. The results were analyzed using the Statistica 13.1 program. Almost half of the respondents confirmed playing with the cat with their hands (42.3%). Aggressive behaviours most often mentioned by caretakers were scratching (62.6%), biting (46.8%), attacking hands/legs (43.2%) and attacking other animals (35.0%). Significant correlations were observed between the occurrence of aggressive behaviour and the way of ending play with the cat. The least aggressive behaviour towards other animals occurred when playing more than three times a day.

Introduction

This increase in the popularity of cats may be due to the false belief that they are easy to care for, a belief that has been present for many years (ZASLOFF and KIDD 1994). Due to their relatively small size, cats are more willingly chosen pets by people living in small apartments. In addition, the rapid adaptation of cats to new environments, new caregivers and even in foster programs (VITALE et al. 2022) underscores the flexible nature

Address: Joanna Kapustka, University of Life Sciences in Lublin, ul. Akademicka 13, 20-950 Lublin, Poland, e-mail: joanna.kapustka@up.lublin.pl

of cats, including their ability to be socially self-sufficient, they exhibit less stressful behaviors. Cats are able to be alone for more extended periods (compared to dogs), and more willing to accept care from strangers such as a neighbor or friend of the owner (MEROLA et al. 2015). Cats also require less effort and are less demanding than dogs, which is essential from the point of view of the elderly, disabled or tired of caring for others (ROCHLITZ 2007).

Play is a crucial resource for cats, especially indoor cats and it's often considered an indicator of welfare, and when done correctly, it can facilitate the relationship between cats and humans (HENNING et al. 2023). The absence of hunting cycle may result in the cat's frustration and cause behavioural problems, such as aggression. Many pets are abandoned or euthanized yearly, and behavioural problems, including aggression, are cited as one of the leading disposals causes (SALMAN et al. 2000).

Cats are predators and hunt on small mammals and birds. The researchers indicate that cats, especially free-ranging and feral, have impact of wildlife population (CROWLEY et al. 2019). The evolutionary process has not significantly affected the feline hunting chain. This inherited pattern is very hardcoded in the predator's brain. Most domestic cats do not need to forage for food on their own. Despite this, implementing the hunting sequence is crucial in their lives. Home conditions do not allow hunting for live-moving prey, so the accumulated emotions should be redirected to various types of toys. At the sight of a potential victim, a sequence of behaviours is triggered consisting of the following stages (Figure 1): hunting, catching, playing, killing, eating, grooming and resting.

Aggression can take many forms, active or passive. The active state is more frequent and more easily recognized by owners. It is manifested by clear signals such as scratching, biting, bristling, growling, and hissing. In contrast, the passive form is more challenging to recognize. It involves intensely staring at the victim, preventing from accessing essential resources. In the case of passive aggression directed at the other cat, it may be manifested by interfering with the other individual in playing, eating, using bedding, driving away from the owner, etc. (CROWELL-DAVIS et al. 2004). Cat aggression is a severe and prevalent behavioural problem that causes injury to other pets and humans. Aggression directed at other cats tends to occur in households with multiple cats, and in homes with one cat, the owners become frequent targets (CROWELL-DAVIS 2007).

The type of aggression can be determined by the aggressive cat's posture, vocalization, facial expressions, and the context in which the aggressive behaviour occurs. In addition, certain types of aggressive behaviour are more likely to occur in cats of a certain age or gender. The types of aggression commonly recognized in cats can be classified as territorial aggression, gender aggression, fear aggression (in defence), play aggression, and redirected

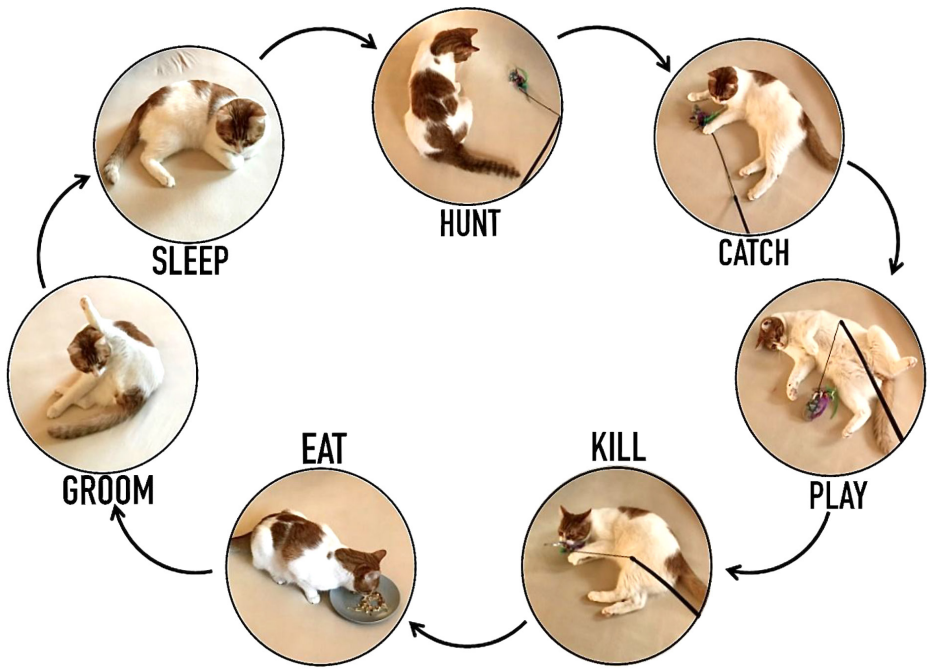

Fig. 1. Cat's hunting cycle

attack. In addition, mothers with kittens may show maternal aggression (CURTIS 2008). This functional classification emphasizes that aggressive behaviour is normal for a cat in many circumstances. Furthermore, it makes understanding the motivations and stimuli that trigger aggressive behaviour easier and helps identify ways to change or avoid it (CHAPMAN 1991).

Aggression in play is most common in healthy young kittens but can occur at any age, regardless of gender (CURTIS 2008). For young kittens whose claws are still soft and short, caregivers encourage kittens to attack their hands or feet, thinking it is a "funny" kind of play. Unfortunately, this is how they teach their cats that human hands and feet are prey that can be attacked. Such play later leads to many dangerous situations, which the owners no longer consider fun because they suffer many serious injuries (CROWELL-DAVIS 2007).

Play-motivated aggression can usually, but not necessarily, be directed at the people chosen by cats. It is not clear why certain people are selected (CURTIS 2008). The diagnosis of aggression in play is based on the behaviour and attitude of the cat. The cat follows the owner, stares at him, hides behind furniture or doors with his tail between his legs, and then runs out and attacks. In mild cases, the cat may run past the owner and paw at the leg, while in the most severe cases, the cat may jump on the owner, biting and

scratching. Although the aggressor is motivated by fun, this aggression often has a dangerous course. Owners of such cats may have many scars and scratches from "play" attacks and may be afraid of their pets (CURTIS 2008).

The study aimed to assess the impact of the caretaker's improper play with the cat on the frequency of aggressive behaviour.

Material and Methods

The study was carried out using the diagnostic survey method. The research technique was a self-developed anonymous questionnaire via Google Forms. Informed consent was obtained from all study participants. Cat owners were informed that the questionnaire responses would be used for research and information provided will remain confidential.

The questionnaire was made available online, on a social networking site to a group of cat owners. It included general questions concerning basic information about the owner and the animal, course of play and the presence of aggressive behaviour (the owners provided information on what their play with the cat looks like, how long it lasts, how often it is repeated, what type of toys they use (the respondents could choose more than one answer in this question) and how it is finished (the respondents could choose more than one answer in this question), frequency of aggressive behaviour (scratching, biting and attacking the hands and feet of the caretaker as well as attacking other animals).

Statistical analysis

The results are presented as descriptive statistics with a mean (X) and standard deviation (SD). The number and percentage of respondents of each group and answers in each question were calculated. In questions regarding aggressive behaviour in cats, the answer YES was defined as 1, and NO as 0. To determine relationships between the variables, the Pearson $\chi 2$ test was performed. The normality of the distribution was checked with the Shapiro-Wilk test. Differences between variables with a normal distribution were determined using Student's t-test, while those not showing a normal distribution were determined with the Mann-Whitney U test. Significance level $p < 0.05$.

Results

Research group – owners

The study was conducted on a group of 3,500 respondents who own cats. The majority (3.381) were women, and 119 were men. The largest group were respondents aged 21–40 (57% of respondents) and 41–60 years old – 32.9%. There were 6% of people under 20, and the smallest group of recipients were owners of cats over 61. More than half of the respondents had higher education (59%). 34.6% of the respondents live in large cities, 24.4% in medium-sized cities, 24.5% in small towns and 16.5% in villages.

Research group – cats

Among cats, 58.9% were individuals aged 1 to 5 years. 24.4% were from 6 to 15 years old, 14.4% were under one year old, and only 2.3% of senior cats were over 15. The exact origin of more than half of the cats is unknown – 53.5% were found or adopted, and 25.9% were adopted from shelters, pro-animal associations or foster homes. 20.6% of animals come from legal breeding. 49.1% of respondents had males, and 50.9% of females. Most cats (88%) had previously undergone castration or sterilization.

As for the frequency of playing with the cat, 72.2% of the respondents declared that they do it daily. The percentage of respondents' answers is presented in the Figure 2a.One session playing with a cat lasted for 43.4% of respondents until the animal had had enough and 7% until the owner had enough. For 28.8% of the respondents, playing with the cat lasted from 5 to 10 minutes, 15.3% for more than 10 minutes, and 5.5% for less than 5 minutes.

The most frequently chosen toys were a fishing rod with feathers, mice, balls , strings and ribbons, and papers and hair ties. The number of respondents who indicated that they play with a specific type of toy is given in Figure 2b.

A significant relationship was observed between the occurrence of aggressive behaviour and playing with the cat with mice and balls ($\chi 2 = 19.765$ P<0.001), papers and hair ties ($\chi 2 = 23.395$, $P < 0.001$) and the owner's hands ($\chi 2 = 95.745$, $P < 0.001$). In addition, a significant effect of playing with hands on the frequency of various types of aggressive behaviour in cats was observed (Table 1). Toys that reduce aggressive behaviour have been observed to be olfactory mats ($\chi 2 = 13.669$, $P = 0.008$), valerian/catnip toys ($\chi 2 = 15.973$, $P = 0.003$) and ball tracks ($\chi 2 = 8.792$, $P = 0.067$). The way of ending the game with a cat and the number

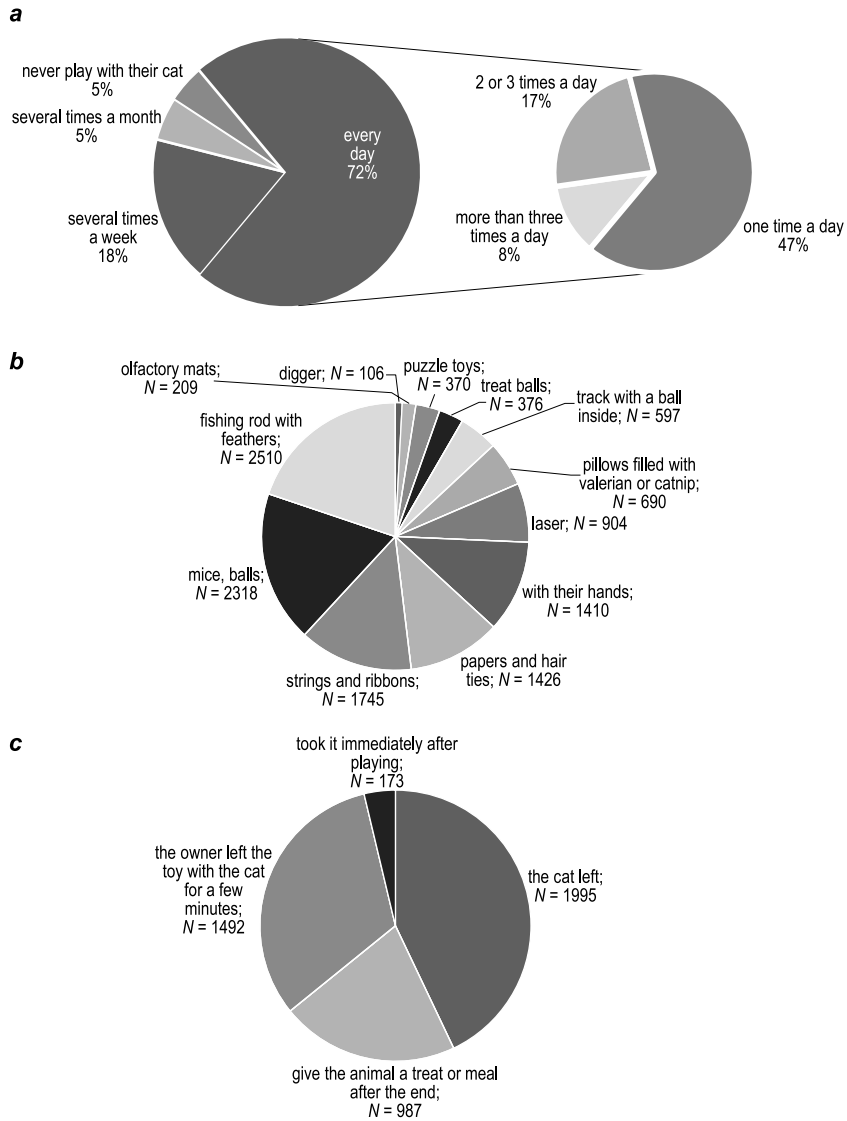

Fig. 2. The number and percentage distribution of given answers in questions: *a*) How often do you play with your cat? *b*) What type of toys do you play with your cat? *c*) How do you end a play with your cat?

distribution of answers to this question is given in Figure 2c. More than half of cat owners (62.6%) declared that there was a situation in which their cat scratched them. Among them, 5.4% had such incidents daily, 12.6% several times a week, 21.7% several times a month, 32.7 times a year, and 27.7% a one-off event. In contrast, 37.4% did not experience a cat scratch. Bites by cats occurred in 46.8% of respondents. Among them, such behaviour was

Table 1

The occurrence of aggressive behaviour in cats depending on the play with the hands of the owner

Aggressive behaviour	Owners playing with the cat with their own hands $N = 1410$		Owners not playing with the cat with their own hands $N = 2089$		*P*-value
	$\bar{x}$	SD	$\bar{x}$	SD	
Scratch	0.67	0.47	0.60	0.49	$P < 0.001$
Bite	0.50	0.50	0.44	0.50	0.003
Attacking hands/legs	0.56	0.50	0.35	0.48	$P < 0.001$
Attacking other animals	0.38	0.49	0.33	0.47	0.006
The sum of aggressive behaviours	1.72	1.20	2.11	1.23	$P < 0.001$

most often recorded several times a year, i.e. in 29.3%. It occurred several times a month in 21.3% and as a one-time incident in 24.9% of respondents. 15.9% were bitten several times a week, and 8.6% were bitten daily.

In contrast, 53.2% of cats have never bitten their owner. Behaviour such as attacking the owner's hands and feet occurred in 43.2% of the handlers. In this group, 30.3% of owners experienced it several times a month, 27.7% experienced it several times a week, and 18.6% experienced it several times a year. In addition, 17.7% of cats attacked the arms and legs of their owners daily, and 5.7% of the cases were one-time incidents. However, 56.8% of the study participants did not encounter such behaviour.

A significant effect of the frequency of playing with the cat on the occurrence of aggressive behaviour was found (Figure 3). The sum of aggressive behaviours was highest when the owner played with the cat 2–3 times a day ($\bar{x} = 1.97 \pm 1.18$), while minor behaviours occurred when the cat was not playing ($\bar{x} = 1.54 \pm 1.22$, $P < 0.001$). Furthermore, the frequency of all aggressive behaviours (Figure 2), except for aggression towards other animals, was significantly lower in cats that did not play with their owners compared to those that played with them very often: more than three times a day ($0.000 < P < 0.042$), 2–3 times a day ($0.000 < P < 0.003$) and when playing once a day ($0.000 < P < 0.008$).

It was observed that the more often the owner played with the cat, the less aggressive behaviour the cat showed towards other animals (Figure 4). The least aggressive behaviour towards other animals occurred when playing more than three times a day ($\bar{x} = 0.24 \pm 0.43$), and the most when playing several times a month ($\bar{x} = 0.52 \pm 0.5$, $P < 0.001$), with no play with a cat, the average the number of aggressive behaviours towards other animals was 0.49 (SD = 0.5, $P < 0.001$). The most common aggressive behavior was

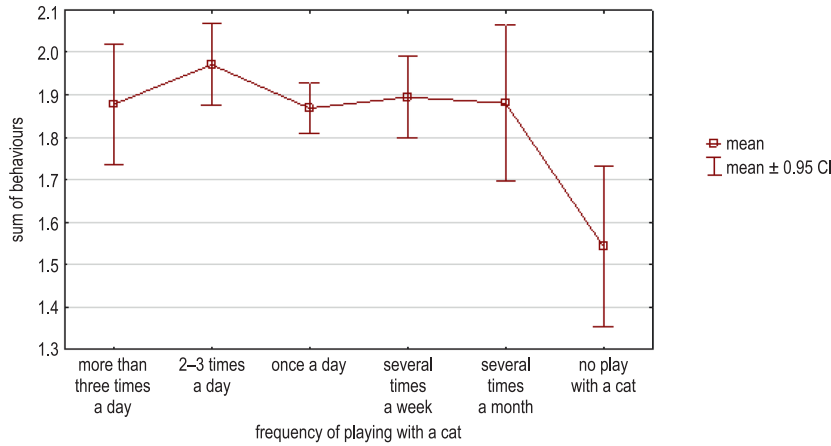

Fig. 3. Boxplot of the sum of aggressive behaviours depending on the frequency of playing with the cat

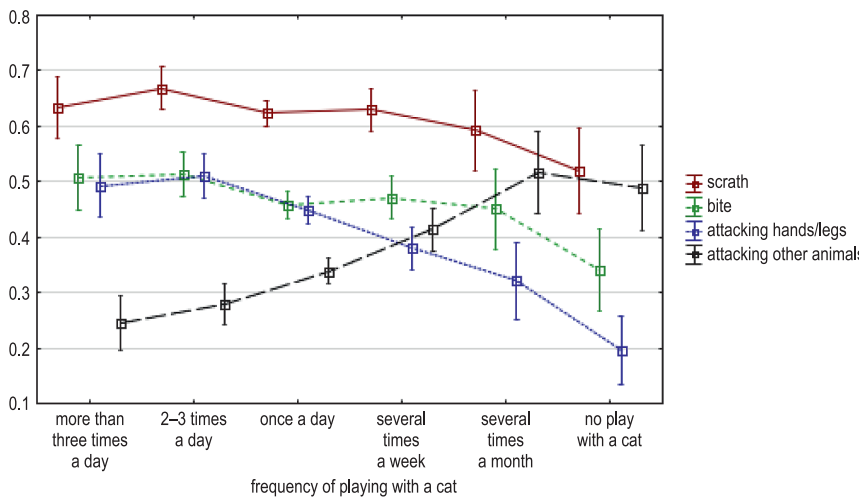

Fig. 4. Boxplot of specific aggressive behaviours depending on the frequency of the owner playing with the cat

scratching the owner, on average from 0.68 ±0.47 when playing 2–3 times a day to 0.52 ±0.5 when not playing with the cat (p = 0.003). The other differences were not statically significant.

Significant correlations were observed between the occurrence of aggressive behaviour and the way of ending play with the cat. There was a significant effect of ending play by leaving a toy for a few minutes on the occurrence of scratching ($\chi 2$ = 8.697; P = 0.003), attacking arms/legs ($\chi 2$ = 14.547; P < 0.001) and the total number of aggressive behaviours

($\chi 2 = 12.611$; $P = 0.013$). Feeding after play affected the occurrence of biting ($\chi 2 = 6.155$; $P = 0.013$) and attacking other animals ($\chi 2 = 29.854$; $P < 0.001$). In the group of cats whose owners took away the toy after the end of the play, the total number of aggressive behaviours was the lowest among the selected ways of ending play (taking away the toy: $\bar{x} = 1.78 \pm 1.27$; leaving the toy: $\bar{x} = 1.94 \pm 1.20$; serving the meal: $\bar{x} = 1.85 \pm 1.19$; the cat leaves on its own: $\bar{x} = 1.91 \pm 1.25$) – Table 2.

Table 2

The average frequency of aggressive behaviours regarding the type of ending a game with cat

The type of end a game		Took away toy after the end of the play		Leaving a toy for a few minutes		Feeding a cat		Cat leaves on its own	
		X	*P*-value	*X*	*P*-value	*X*	*P*-value	*X*	*P*-value
Scratch	yes	0.60	0.472	0.65	0.013*	0.64	0.270	0.63	0.689
	no	0.63		0.61		0.62		0.62	
Bite	yes	0.47	0.999	0.47	0.927	0.50	0.032*	0.48	0.155
	no	0.47		0.47		0.46		0.45	
Attacking arms/ legs	yes	0.40	0.437	0.47	0.001*	0.42	0.741	0.44	0.175
	no	0.43		0.40		0.44		0.42	
Attacking other animals	yes	0.32	0.455	0.35	0.940	0.28	<0.001*	0.36	0.175
	no	0.35		0.35		0.38		0.33	
Sum of aggressive behaviours	yes	1.78	0.280	1.94	0.013*	1.85	0.473	1.91	0.039*
	no	1.88		1.83		1.89		1.83	

**P*-value <0.05 are considered significant

Discussion

According to research, cat owners who play with their own hands with their cats are particularly exposed to scratching and other aggressive behaviour. But, of course, playing with your hands is just one of the factors that can trigger aggressive behaviour. For example, AHOLA et al. (2017) found a predisposition for aggression in early-weaned cats. They discovered that the late-weaned cats were less likely to behave aggressively and display stereotypically. Although the tendency to aggressive behaviour towards the caregiver may also be inherited (SALONEN et al. 2019), it may depend on sex or coat colour (STELOW et al. 2016).

A crucial aspect when playing with a cat is to fulfil the hunting chain. The collected research revealed that most animals during this activity stare

at the target, chasing it and catching and biting it. After playing, most respondents leave the toy for a few minutes. An element that should not be omitted is serving a meal or a treat after the end of the "hunt". The predator will feel fulfilled thanks to this action because the hunt was successful (CECCHETTI et al. 2021). However, our study observed that providing a meal increased the risk of bites to the owner but minimized attacks on other animals. It is possible that the keepers fed the cat a meal at the wrong time in the hunting cycle.

Failure to meet hunting needs causes the accumulation of emotions and the inability to channel them. Growing frustration may cause or increase the frequency of inappropriately aggressive behaviour, such as biting and attacking hands and feet (STRICKLER and SHULL 2013). In our study, 17.7% of cats attacked the arms and legs of their owners daily. A typical situation in homes is a cat that lurks behind furniture and jumps out of hiding at a passing owner, attacking him. The lack of stimuli makes the owner's moving legs a desirable target for the cat. Such behaviours should be redirected to toys, regular active play should be introduced into the cat's life and attempts to attack the caregiver should be consistently stopped (FRANK and DEHASSE 2004). An alternative solution is introducing a second cat of similar character and age. This activity is less involved for the owner because the cats play together (BEAVER 2004). However, on the other hand, play between adult animals (except dogs) is described as rare (MILLS 2008). If aggression occurs in play between cats, the cats should be separated, and the attacking cat should be redirected to a toy or play with the owner (MOESTA and CROWELL-DAVIS 2011).

An inappropriate toy selection can also affect the frequency of aggressive behaviour in a cat. Each animal has its preferences when choosing toys, but the most common are small, easy-to-move, toss-and-grab objects that resemble natural prey. Playing with hands and incorrect laser play should be avoided, as the cat cannot catch and complete the hunting cycle, which leads to frustration (AMAT and MANTECA 2019). In our study, some caregivers indicated playing with their pets using a laser. It is not the best choice because the cat cannot catch the light and complete the hunting cycle. Nevertheless, you can use this toy, under certain conditions, to start an activity. And then redirect the animal to a physically accessible item (KOGAN and GRIGG 2021).

STRICKLER and SHULL (2013) found no significant relationship between the frequency of play and the total number of cats behavioural problems in their studies. However, our study observed that the less the owner played with the cat, the less aggressive the cat showed towards the owner. The result is surprising because the quality of the cat-caretaker relationship is usually significantly related to the amount of daily play (HENNING et al. 2023). In the case of improper play with a cat, the phenomenon of redirected aggression

may occur, described in detail in the studies of many scientists, including STELOW (2022) and ALVAREZ BUENO (2020). Based on the study, it can be concluded that the way and frequency of playing with a cat significantly impacts aggressive behaviour. The obtained results may help minimize frustration in the cat, thus reducing aggression directed at the owner or other animals. The toy choice and the way of playing should be selected individually for a cat. The results help understand the cat's needs and build a positive relationship between the owner and the cat. Properly conducted activity in a cat helps maintain a satisfactory well-being level.

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THE WEED FLORA OF THE RECREATION AREAS OF CENTRAL DISTRICTS IN ŞANLIURFA (TÜRKIYE)

***Ömer Faruk Kaya*[1], *Ahmet Hamdi Çiçek*[2], *Hatice Tosyagülü Çelik*[3]**

[1]ORCID: 0000-0003-3969-8939
[2]ORCID: 0009-0009-2672-8423
[3]ORCID: 0000-0003-2739-7047
[1]Faculty of Arts and Sciences, Department of Biology
[2]Graduate School of Natural and Applied Sciences
Harran University, 63290, Şanlıurfa, Türkiye
[3]Health Services Vocational School, Plant and Animal Production Department
Ankara Yıldırım Beyazıt University, 06760, Ankara, Türkiye

K e y w o r d s: recreation area, weed, flora, Şanlıurfa, Türkiye.

A b s t r a c t

The aim of this study was to determine the weed flora of recreation areas within borders of Eyyübiye, Haliliye and Karaköprü central districts of Şanlıurfa. A field study was carried out in 34 recreation areas within these districts. As a result of the study, 134 plants belonging to 27 families were identified. There were 82 were species, 31 were subspecies and 21 were varieties from these taxa. 109 of them are dicotyledonous and 25 are monocotyledonous. When evaluated in terms of life form, 1 is a phanerophyte, 1 is a chamaephyte, 30 are hemicryptophyte, 2 are cryptophyte (geophyte) and 100 are therophyte. The distribution rates according to phytogeographical regions are as follows: Irano-Turanian elements 13% (17), Mediterranean elements 7% (10), Euro-Siberian elements 5% (7), Eastern Mediterranean elements 4% (5) and unknown elements 71% (95). Considering the number of identified taxa, the first five families are Fabaceae (29), Poaceae (24), Asteraceae (23), Brassicaceace (6), Plantaginaceae (6), Apiaceae (5) and Caryophyllaceae (5).

Introduction

The term recreation is a combination of the Latin words “re-repeat, again” and “create-creation, renewal” (KALEM 2001). Recreation, as the equivalent of the verb “re-create”, which means to renew something or to regain lost opportunities, includes the meanings of renewal of strength

Address: Ömer Faruk Kaya, Harran University, 63290, Şanlıurfa, Türkiye, e-mail: phytosociologist@gmail.com

or spirit, revitalization, regeneration, rest, fun and play (JENSEN and NAYLOR 2000, RÜZGAR 2016). Based on the fact that the word recreation comes from the Latin word "recreatio", that is, to regain health, in the historical process of defining recreation, it has also been considered as an activity that prepares people for working life. While some definitions refer to recreation as restoration, that is, renewal or improvement, most focus on it as a form of activity (TORKILDSEN 2005). In fact, recreation is an experience of "renewal"; a refreshing change from work and daily routine. The deeper meaning of recreation goes beyond entertainment and hobby. It includes activities of the highest creative, cultural and civil values that enrich our lives and raise the tone of society (JENSEN and NAYLOR 2000). Recreation areas where recreation activities are carried out increase the value of cities and make them livable. Many developed societies consider recreation areas in their urban planning (KARA et al. 2008).

In recent years, public institutions (especially municipalities) have been increasingly trying to create a large number of recreation areas (parks, gardens, recreation areas, sports complexes, etc.) in the city or in the immediate vicinity of the city for urban people to relax, have fun or do various sports activities, etc. During landscaping in recreation areas, ornamental plants, which can relax people with their appearance or sometimes with their scent and give peace of mind, are used. These plants are usually woody plants preferred for their general appearance or other plant parts (flowers, fruits, leaves, etc.). In addition to these perennial woody plants, different ornamental annual herbaceous plants are planted in recreation areas according to the season. However, in these recreation areas, weeds are also seen that disrupt the appearance of the landscape and can also negatively affect the plants in the area.

A weed is generally a plant that is undesirable in a given situation, or in other words "a plant in the wrong place". For example, they are unwanted plants in human-controlled environments such as farm fields, gardens, lawns and parks. The term weed is also used for any plant that grows or reproduces aggressively or is invasive outside of its natural habitat (RAHMAN and AL MAMUN 2017). Among these weeds, those that can cause problems for human health or cause damage by creating various economical or ecological problems, are called invasive alien species (ÖNEN 2015). Weeds generally have a large number of seeds and these seeds maintain their vitality for a long time. They can also reproduce with their vegetative parts (rhizomes, stolons, etc.). Parts such as wings and feathers in the morphological structure of the seeds enable them to be transported over long distances (YILDIRIM and EKIM 2003).

Various methods such as mowing, manual removal, herbicides are used to control these weeds, which have high ecological adaptation and tolerance. The main factor in the success of these methods is the identification of the weed species to be controlled. Thus, the method of combating weeds that cause various problems can be determined.

In this study, it was tried to determine the weed flora in recreation areas of at least 20 decares or more in Eyyübiye, Haliliye and Karaköprü, the central districts of Şanlıurfa. Information on the current taxonomic status, life forms, phytogeographic regions and worldwide distribution of the plants were given.

Material and Method

In order to identify the foreign weed flora in the recreation areas of the central districts of Eyyübiye, Haliliye, and Karaköprü in Şanlıurfa, periodic visits were made to the recreation areas every month throughout the year. During these visits, the recreation areas were scanned, and at least three samples were collected from plants in the generative stage (flowering-fruiting). The collected plant samples were pressed, dried, and preserved as herbarium samples. These plant samples are stored in the personal herbarium of the second author. Flora of Turkey (DAVIS 1965–1985, DAVIS et al. 1988, GÜNER et al. 2000) was used as the main source for plant identification. In addition, AKIL and KAYA (2013), KAYA et al. (2020) were also utilized.

The taxa identified during the study were listed in alphabetical order. The plant list was created by following the order of family, genus and species name and (if available) subspecies taxon name and author name. BRUMMITT and POWELL (1992) was taken into consideration for the abbreviations of the authors of the taxa. For the current taxonomic status of the plants, GÜNER et al. (2012) was used. Life forms of the plants were determined according to RAUNKIAER (1934).

The field study was conducted in recreation areas of at least 20 acres or more in Eyyübiye, Haliliye and Karaköprü districts. The districts where the recreation areas are located and the list of the areas they cover are given in Table 1.

Table 1

List of recreation areas within the scope of the study

District	Number	Recreation areas name	Area [m^2]
Eyyübiye	1.	Osmanlı Picnic Area	125 021
	2.	Karabakh brotherhood park	106 230
	3.	Akabe Picnic Area	104 831
	4.	Balıklıgöl Plateau	70 000
	5.	Eyyüp Cenap Gülpınar Park	43 390
	6.	Kale Eteği Park	40 078
	7.	Karakoyun Park	36 335
	8.	Urfa Sport Complex (Futball World)	35 000
	9.	Mahmutoğlu Kule Park	32 000
	10.	Makam Karşısı Çamlık Park	29 581
	11.	Osmanlı 4th Stage Park	24 464
Haliliye	12.	GAP Valley 3rd Stage	224 084
	13.	Cumhuriyet Park	122 914
	14.	Haliliye Nation Garden	120 000
	15.	GAP Vadisi 5th Stage	108 829
	16.	GAP Vadisi 4th Stage	75 495
	17.	Selahaddin Eyyubi Park	60 563
	18.	Fatih Sultan Mehmet Park	60 427
	19.	GAP Vadisi 2nd Stage	43 036
	20.	Turgut Özal Park	41 643
	21.	Süleymaniye Streamside	35 581
	22.	Karşıyaka Park	34 937
	23.	Hızmalı Park	28 519
	24.	Necmettin Erbakan Park	22 782
	25.	Şehitlik Çamlık Park	20 450
Karaköprü	26.	Halil-ür Rahman City Forest	1 300 000
	27.	Maşuk 2nd Stage Park	40 000
	28.	Traffic Education Park	30 000
	29.	Mehmetçik Park	30 000
	30.	Children's Play World	30 000
	31.	Akpınar Streamside 1st Stage	25 583
	32.	Akpınar Streamside 7th Stage	22 000
	33.	Akpınar Streamside 4th Stage	20 592
	34.	Maşuk 1st Stage	20 000
Total			3 164 565

Findings and Discussion

This study was conducted in 34 recreation areas of at least 20 acres or more in Eyyübiye (11), Haliliye (14) and Karaköprü (9) districts (Figure 1).

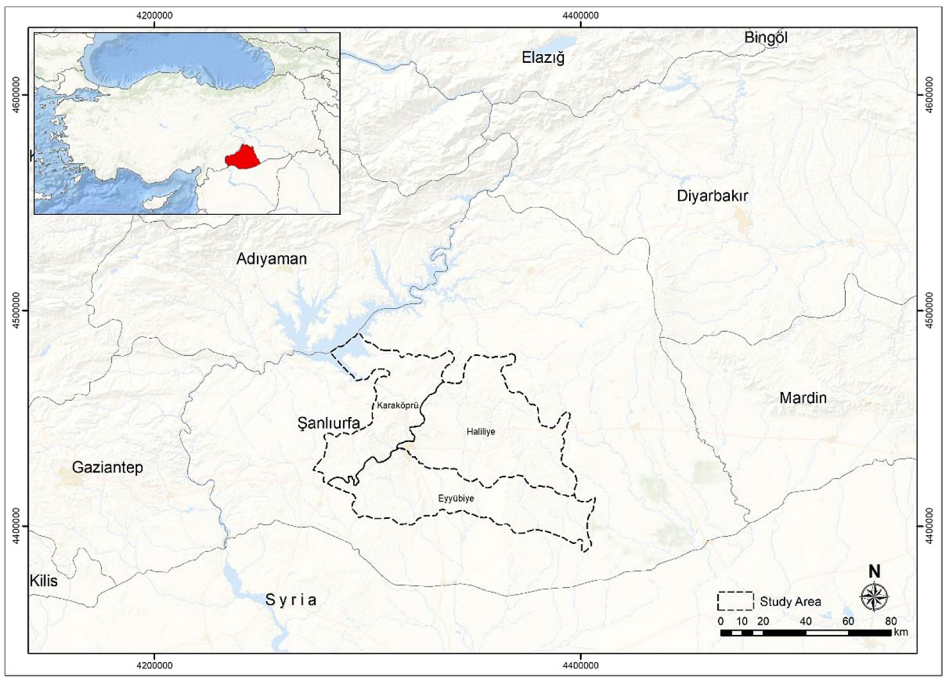

Fig. 1. Study area

As a result of the study, 134 taxa (82 species, 31 subspecies and 21 varieties) belonging to 27 families were identified as natural weeds. According to Önen (2015), *Amaranthus retroflexus*, *Xanthium strumarium* and *Erigeron bonariensis* are considered as invasive weeds. The list of weeds identified in recreation areas is given in Table 2. DAVIS (1965–1985), DAVIS et al. (1988) and GÜNER et al. (2000) were used for life span, life form and flowering periods of the plants.

Table 2

List of plants identified in the study

Taxon name	Collector number	Recreation areas (see Table 1 for number)	LF	Phytogeo-graphical region	Pheno-logical periods	General distribution
1	2	3	4	5	6	7
Amaranthaceae						
Amaranthus albus L.	AHÇ 21	1, 2, 3, 16, 18, 22, 27, 33, 34	Th	–	Spr.	N. & C. America
**Amaranthus retroflexus* L.	AHÇ 71	1, 10, 11, 12, 13, 19, 20, 21, 22, 23, 24	Th	–	Spr.	N. America
Salsola kali L.	AHÇ 286	3, 13, 34	Th	–	Aut.-Win.	Europe, N. Africa, Asia
Apiaceae						
Artedia squamata L.	AHÇ 76	2, 12, 13, 19, 24, 33	Th	–	Sum.	Georgia, W. & C. Iran, N. Iraq, W. Syria, Syrian Desert, Cyprus
Eryngium creticum Lam.	AHÇ 118	1, 2, 3, 13, 24, 25, 29	H	E. Medit.	Sum.	Balkans, W. Syria, Syrian Desert, N. Iraq, Cyprus, N. Egypt
Scandix pecten-veneris L.	AHÇ 140	12, 13, 29, 34	Th	–	Sum.	W., C. & S. Europe, Mediterranean area, S.W. Asia
Scandix stellata Banks & Sol.	AHÇ 3	1, 2, 13, 29	Th	–	Spr.	France, S. Spain, Balkans, N. Africa, Crimea, S.W. Asia
Tordylium aegyptiacum (L.) Lam.	AHÇ 127	12, 16	Th	E. Medit.	Sum.-Aut.	Cyprus, W. Syria, Syrian Desert, N. Iraq, Egypt
Araceae						
Eminium spiculatum (Blume) Schott	AHÇ 49	3, 13	Cr (G)	Ir.-Tur.	Spr.	Egypt to Iraq
Asteraceae						
Anthemis arvensis L.	AHÇ 178	1, 2, 3, 13, 34	Th	Euro-Sib.	Sum.-Aut.	Europe, Caucasus, Iran, N. & S. America, Australia, New Zealand
Carduus pycnocephalus L. subsp. *albidus* (M. Bieb.) Kazmi	AHÇ 82	1, 2, 13, 18, 29	Th	–	Spr.-Sum.	Greece, Crimea, Cyrenaica, N. Egypt, and S.W. Asia eastwards to C. Asia
Centaurea balsamita Lam.	AHÇ 33	29	Th	Ir.-Tur.	Spr.	Anti-Lebanon, Transcaucasia, Iran, Turkestan
Centaurea hyalolepis Boiss.	AHÇ 9	3, 13, 34	H	Ir.-Tur.	Spr.	Cyprus, W. Syria, Syrian Desert, S. Iran

cont. Table 2

1	2	3	4	5	6	7
Centaurea iberica Spreng.	AHÇ 35	1, 27	H	–	Spr.	Balkans, Crimea, S.W. & C. Asia
Centaurea solstitialis L. subsp. *solstitialis*	AHÇ 88	1, 2, 8, 13	H	–	Sum.	S. Europe, S. Russia, Crimea, Caucasia, Lebanon, Iran
Centaurea virgata Lam.	AHÇ 89	3	H	Ir.-Tur.	Sum.	Bulgaria, Lebanon, Anti-Lebanon, Transcaucasia, N. Iraq, Iran, Afghanistan, Turkestan
Chardinia orientalis (L.) Kuntze	AHÇ 168	2, 13, 19	Th	Ir.-Tur.	Sum.-Aut.	Palestine, Lebanon, Syrian Desert, Transcaucasia, N., N.W. & W. Iran, Transcaspia
Cichorium intybus L.	AHÇ 153	1, 2, 3, 10, 17, 25, 30	H	–	Sum.-Aut.	Europe, W. Asia, N. Africa
Cota altissima (L.) J. Gay	AHÇ 11	3, 13, 34	Th	–	Spr.	S. Europe, Crimea, Caucasia, C. Asia
Crepis foetida L. subsp. *foetida*	AHÇ 172	1, 2, 3, 6, 7, 21, 23, 31, 32	Th	–	Sum.-Aut.	W., C. & S. Europe, Cyprus, S. Russia, Caucasia, Iran, W. Syria
Crepis pulchra L. subsp. *pulchra*	AHÇ 96	4, 9, 10, 13, 26, 28	Th	–	Sum.	C. & S. Europe, N. Africa, Cyprus, Caucasia, Iran, W. Syria, Syrian Desert
Crupina crupinastrum (Moris) Vis.	AHÇ 129	13, 16	Th	–	Sum.-Aut.	Mediterranean area, Caucasia, Iran
**Erigeron bonariensis* L.	AHÇ 86	9, 13, 18, 24, 33	Th	–	Spr.-Sum.	Temperate regions
Lactuca serriola L.	AHÇ 146	1, 2, 12, 13, 34	Th	Euro-Sib.	Sum.	Eurasia & N. Africa
Notobasis syriaca (L.) Cass.	AHÇ 108	13	Th	Medit.	Spr.-Sum.	Mediterranean area, N. Iraq, N.W. Iran, Azerbaijan
Picnomon acarna (L.) Cass.	AHÇ 160	13, 15	Th	Medit.	Sum.-Aut.	Mediterranean area, Caucasia, Iraq, Iran, Afghanistan
Senecio vernalis Waldst. & Kit.	AHÇ 198	13	Th	–	Aut.-Win.	C. & E. Europe, Balkans, S. Russia, Crimea, S.W. & C. Asia
Senecio vulgaris L.	AHÇ 40	1, 10, 13, 19	Th	–	Spr.	Europe, N. Africa, Asia
Silybum marianum (L.) Gaertn. subsp. *marianum*	AHÇ 116	13	Th	Medit.	Sum.	Mediterranean area, S. & E. Iraq, Iran, Afghanistan

cont. Table 2

1	2	3	4	5	6	7
Sonchus asper (L.) Hill subsp. *glaucescens* (Jord.) Ball	AHÇ 104	1, 2, 3, 13, 17, 18, 20, 32, 33	Th	–	Spr.-Sum.	Europe except far north, N. Africa, N. & W. Asia
Taraxacum aleppicum Dahlst.	AHÇ 265	1, 2, 3,4, 6, 7, 9, 10, 22, 23, 25, 26, 28	H	E. Medit.	Aut.-Win.	Greece, Crete, Cyprus, W. Syria, Syrian Desert
**Xanthium strumarium* L. subsp. *strumarium*	AHÇ 211	13	Th	-	Aut.-Win.	World-wide
Boraginaceae						
Anchusa azurea Mill. var. *azurea*	AHÇ 149	13, 16	H	–	Sum.	Eurasia
Heliotropium circinatum Griseb.	AHÇ 120	29	Th	Ir.-Tur.	Sum.	N. Iraq, N. Iran
Brassicaceae						
Capsella bursa-pastoris (L.) Medik	AHÇ 208	1, 2, 8, 9, 11, 13, 14, 22, 28	Th	–	Aut.-Win.	Temperate regions
Isatis lusitanica L.	AHÇ 47	13	Th	–	Spr.	W. Syria, Syrian Desert, Palestine, N. Iraq, Iran, Afghanistan, Greece, N.W. Africa
Raphanus raphanistrum L. subsp. *raphanistrum*	AHÇ 61	13, 16	Th	–	Spr.	Europe, N. Africa, S.W. & C. Asia
Sinapis alba L. subsp. *alba*	AHÇ 92	1	Th	–	Spr.-Sum.	W., C. & S. Europe, Cyprus, W. Syria, N. Iraq, W. Iran, N. Africa
Sinapis arvensis L.	AHÇ 57	1, 13	Th	–	Spr.	W., C. & S. Europe, N. Africa, S.W. Asia
Sisymbrium irio L.	AHÇ 272	1, 13, 21	Th	–	Aut.-Win.	Europe, S.W. Asia and N. Africa
Caprifoliaceae						
Scabiosa rotata M. Bieb.	AHÇ 294	13, 15	Th	Ir.-Tur.	Aut.-Win.	N. Balkans, Crimea, C. & N. Iran, N. Iraq, Khorassan, Transcaucasia
Valerianella vesicaria (L.) Moench	AHÇ 155	13, 19	Th	–	Sum.-Aut.	S. France, Italy, Aegean, Iran, N. Iraq, Palestine, Lebanon, Anti-Lebanon, Syria, Cyprus, C. Asia, Algeria

cont. Table 2

1	2	3	4	5	6	7
Caryophyllaceae						
Cerastium dichotomum L. subsp. *dichotomum*	AHÇ 187	13, 15, 16	Th	–	Aut.-Win.	Spain, N.W. Africa, Greece, Cyprus, W. Syria, Caucasia, Iran, Syrian Desert, Turkestan, Arabia
Holosteum umbellatum L. subsp. *umbellatum*	AHÇ 19	13, 19, 29	Th	–	Spr.	Iran, Afghanistan, W. Syria, Syrian Desert, Cyprus
Polycarpon tetraphyllum (L.) L.	AHÇ 58	13	Th	–	Spr.-Sum.	W. & C. Europe, Mediterranean area, Georgia, Syrian Desert, N. Iran, Arabia, Sinai
Spergularia rubra (L.) J. Presl & C. Presl	AHÇ 125	13	Th	–	Sum.-Aut.	Widespread in North hemisphere, Australia
Stellaria media (L.) Vill. subsp. *media*	AHÇ 27	1, 2, 5, 6, 8, 9, 13, 14, 17, 26, 28	Th	–	Spr.	W. Syria, Syrian Desert
Convolvulaceae						
Calystegia sepium (L.) R. Br. subsp. *sepium*	AHÇ 42	13	H	–	Spr.-Sum.	N. & S. hemispheres (temperate parts)
Convolvulus arvensis L.	AHÇ 50	13, 30, 32, 33	H	–	Spr.	Temperate and Subtropical regions
Euphorbiaceae						
Chrozophora tinctoria (L.) A. Juss.	AHÇ 165	13, 16	Th	–	Sum.-Aut.	Mediterranean area, Socotra, S.W. & C. Asia
Euphorbia aleppica L.	AHÇ 220	3, 29, 34	Th	–	Aut.-Win.	Mediterranean area, Crimea, Caucasia, N. Iraq, W. lran
Euphorbia helioscopia L. subsp. *helioscopia*	AHÇ 169	21, 33	Th	–	Sum.-Aut.	Europe, N. Africa & Asia
Fabaceae						
Alhagi maurorum Medik. subsp. *maurorum*	AHÇ 219	13	Th	Ir.-Tur.	Aut.-Win.	W. Caucasia, W. Siberia, N. Iran, C. & E. Asia
Astragalus asterias Steven	AHÇ 121	13	Th	Ir.-Tur.	Sum.-Aut.	Armenia, Azerbaijan, Caucasus, C. Asia, Iran, N. Iraq, Syrian Desert, W. Syria, Arabia, N. Africa
Astragalus guttatus Banks & Sol.	AHÇ 81	13, 20	Th	Ir.-Tur.	Sum.	Syrian Desert, W. Iran

cont. Table 2

1	2	3	4	5	6	7
Astragalus hamosus L.	AHÇ 62	13, 18, 20	Th	–	Spr.	Mediterranean area, S. Russia, Crimea, Caucasus, Syrian Desert, N. & N.W. Iran, Arabia
Coronilla scorpioides (L.) W.D.J. Koch	AHÇ 54	13, 20	Th	–	Spr.	C. & S. Europe, Caucasia, N. Africa, W. Syria, S. Iran
Cullen jaubertianum (Fenzl) C.H. Stirt.	AHÇ 80	32	H	Ir.-Tur.	Sum.	Syrian Desert
Hippocrepis unisiliquosa L. subsp. *unisiliquosa*	AHÇ 223	1, 13	Th	–	Aut.-Win.	Mediterranean area, S.W. Asia
Hymenocarpus circinnatus (L.) Savi	AHÇ 6	13	Th	Medit.	Spr.	S. Europe, Cyprus, W. Syria, Syrian Desert, N. Africa
Lathyrus cicera L.	AHÇ 79	13, 15	Th	–	Sum.	Greece, Crimea, N. Africa, Cyprus, W. Syria, Syrian Desert, N. Iraq, N. & N.W. Iran, Transcaucasia, C. Asia
Medicago coronata (L.) Bartal.	AHÇ 29	13	Th	Medit.	Spr.	S. Europe, N. Africa, Cyprus, W. Syria, Syrian Desert, N. Iraq, Azerbaijan
Medicago polymorpha L. var. *polymorpha*	AHÇ 46	13, 23, 25	Th	–	Spr.-Sum.	Old World
Medicago lupulina L.	AHÇ 226	13, 22	H	–	Aut.-Win.	Europe, N., N.W. & W. Iran, W. Syria, Caucasia, Turkestan
Medicago minima (L.) L. var. *minima*	AHÇ 68	13	Th	–	Spr.-Sum.	Europe (except the North), Asia, N. Africa, Macaronesia & the Cape, America
Medicago radiata L.	AHÇ 295	13, 24	Th	Ir.-Tur.	Aut.-Win.	S. Russia, Palestine, Iran, N. Iraq, Armenia, Turkestan
Medicago rigidula (L.) All. var. *rigidula*	AHÇ 99	13	Th	–	Sum.	S. Europe, N.W. Africa, S.W. Asia eastwards to Afghanistan
Medicago sativa L. subsp. *sativa*	AHÇ 193	13	H	–	Aut.-Win.	Europe to C. Asia, N. Africa
Melilotus indicus (L.) All.	AHÇ 292		Th	–	Aut.-Win.	Eurasia

cont. Table 2

1	2	3	4	5	6	7
Pisum sativum L. subsp. *elatius* (M. Bieb.) Asch. & Graebn. var. *elatius*	AHÇ 102	1, 2, 21	Th	Medit.	Sum.	S. Europe, Crimea, N. Africa, Cyprus, W. Syria, Caucasia, N. Iran
Prosopis farcta (Banks & Sol.) J.F. Macbr.	AHÇ 269	13	Ch	–	Aut.-Win.	Arabia, Egypt, Sinai, Cyprus, Iran, Syrian Desert, TransCaucasia, Afghanistan, C. Asia
Scorpiurus subvillosus L. var. *subvillosus*	AHÇ 43	13	Th	Medit.	Spr.	Mediterranean area, Crimea, Transcaucasia, Syrian Desert, N. Iraq, S. Iran, E. Africa
Trifolium campestre Schreb. subsp. *campestre* var. *campestre*	AHÇ 156	9, 10, 12, 13, 18, 25	Th	–	Sum.-Aut.	Europe, Mediterranean area, N. Iraq, Caucasia, Iran
Trifolium repens L. var. *repens*	AHÇ 98	1, 10, 13, 18, 23, 30, 31, 32	H	–	Sum.	Temperate Eurasia
Trifolium resupinatum L. var. *resupinatum*	AHÇ 131	1, 2, 18, 20	Th	–	Sum.-Aut.	W. Syria N. Iraq, W. Iran, Egypt.
Trifolium stellatum L. var. *stellatum*	AHÇ 90	13	Th	–	Sum.	W. Europe, Mediterranean area, N. lraq, W. Syria, W. Iran
Trifolium tomentosum L. var. *tomentosum*	AHÇ 143	13	Th	–	Sum.	S. Europe, W. Syria, Cyprus, Egypt, N. Iran
Trigonella caelesyriaca Boiss.	AHÇ 87	13, 15	Th	Ir.-Tur.	Spr.-Sum.	W. Syria, Syrian Desert, N. Iraq
Trigonella spruneriana Boiss.	AHÇ 77	13, 16	Th	Ir.-Tur.	Spr.-Sum.	Greece, W. Syria, Iraq, N.W. & W. Iran, Transcaucasia
Vicia monantha Retz. subsp. *monantha*	AHÇ 221	13	Th	–	Aut.-Win.	Mediterranean area, S.W. Asia
Vicia sativa L. subsp. *nigra* (L.) Ehrh. var. *nigra*	AHÇ 159	2, 13, 31	Th	–	Sum.-Aut.	Cosmopolitan
Geraniaceae						
Erodium ciconium (L.) L'Hér.	AHÇ 130	13	Th	–	Sum.	Mediterranean area, N. Africa, C. & S. Russia, Crimea, Cyprus, W. Syria, Syrian Desert, N. Iraq, Iran, Afghanistan

cont. Table 2

1	2	3	4	5	6	7
Erodium cicutarium (L.) L'Hér. subsp. *cicutarium*	AHÇ 284	13, 29	Th	–	Aut.-Win.	Europe, N. Africa, S.W. Asia
Geranium libanoticum Schenk	AHÇ 70	13, 19	H	–	Spr.	Lebanon, Iran
Geranium rotundifolium L.	AHÇ 85	13	Th	–	Sum.	Eurasia (except N), N. Africa
Lamiaceae						
Lamium amplexicaule L. subsp. *amplexicaule*	AHÇ 66	5, 13, 25	Th	Euro-Sib.	Spr.	Temperate Eurasia
Marrubium vulgare L.	AHÇ 254	13	H	–	Aut.-Win.	Eurasia, N. Africa
Malvaceae						
Malva neglecta Wallr.	AHÇ 53	1, 2, 7, 21, 31 ,32	Th	–	Spr.-Sum.	Europe, N.W. Africa, S.W. Asia
Malvella sherardiana (L.) Jaub. & Spach	AHÇ 163	13	H	–	Aut.-Win.	Greece, Bulgaria, Spain, Crimea, Caucasia, W. Syria, Syrian Desert, N. Iran, Cyprus
Oxalidaceae						
Oxalis corniculata L.	AHÇ 36	17, 21	H	–	Spr.	Cosmopolitan
Papaveraceae						
Fumaria asepala Boiss.	AHÇ 117	34	Th	Ir.-Tur.	Sum.	Armenia, N., W. & C. Iran, W. Syria, Syrian Desert
Hypecoum pseudograndiflorum Petrovič	AHÇ 133	13	Th	–	Sum.-Aut.	Albania, Bulgaria, Greece, Serbia, Kosova
Phyllanthaceae						
Andrachne telephioides L.	AHÇ 195	13, 34	H	–	Aut.-Win.	Mediterranean area, S. to Somalia, S.W. Asia, E. to N.W. India
Plantaginaceae						
Linaria chalepensis (L.) Mill. var. *chalepensis*	AHÇ 106	13	Th	E. Medit.	Sum.	S. Europe (from France eastwards), S.W. Asia, Egypt
Plantago lanceolata L.	AHÇ 65	1, 2, 13, 24	H	–	Spr.-Sum.	Europe, N. Africa, Asia

cont. Table 2

1	2	3	4	5	6	7
Plantago major L. subsp. *major*	AHÇ 103	1, 2, 13, 15, 16	H	–	Spr.-Sum.	Temperate Eurasia & N. America
Veronica anagalloides Guss. subsp. *anagalloides*	AHÇ 51	1, 13, 21	Th	–	Spr.-Sum.	Europe, N. Africa, Caucasia, Iran, Afghanistan, C. Asia
Veronica persica Poir.	AHÇ 135	13	Th	–	Sum.	Caucasia, S.W. Asia, Europe, N. Africa, C. Asia, Japan, America, New Zealand
Veronica polita Fr.	AHÇ 185	13	Th	–	Aut.-Win.	Temperate Eurasia, N. Africa
Poaceae						
Aegilops triuncialis L. subsp. *triuncialis*	AHÇ 114	13	Th	–	Sum.	S. Europe & N. Africa, S.W. Asia eastwards to Transcaucasia
Alopecurus arundinaceus Poir.	AHÇ 139	1, 2	H	Euro-Sib.	Sum.	Temperate Eurasia
Alopecurus myosuroides Huds. var. *myosuroides*	AHÇ 148	1, 5, 13,	Th	Euro-Sib.	Sum.-Aut.	Eurasia, N. Africa
Avena sterilis L. subsp. *sterilis*	AHÇ 128	13, 16	Th	–	Sum.-Aut.	C. Europe, S. Russia, Crimea, Caucasia, Mediterranean area, S.W. & E. Asia
Bromus japonicus Thunb. subsp. *japonicus*	AHÇ 230	13	Th	–	Aut.-Win.	Eurasia, N. Africa
Catabrosa aquatica (L.) P. Beauv.	AHÇ 136	1	H	–	Sum.-Aut.	Temperate Eurasia, N. America
Chrysopogon gryllus (L.) Trin. subsp. *gryllus*	AHÇ 44	1	H	–	Spr.-Sum.	S. Europe, Crimea, W. Syria, Caucasia, N. Iraq, Iran
Cornucopiae cucullatum L.	AHÇ 122	1, 3	Th	E. Medit.	Sum.-Aut.	Italy, Sicily, Greece, Aegean, W. Syria, Syrian Desert, N. Iraq
Cynodon dactylon (L.) Pers. var. *dactylon*	AHÇ 48	1, 2, 7, 9, 18, 20, 29, 34	H	–	Spr.-Sum.	Africa, Asia, Europe
Echinaria capitata (L.) Desf.	AHÇ 275	13,	Th	–	Aut.-Win.	S. Europe, Cyprus, W. Syria, Transcaucasia, Iraq, N., N.W & W. Iran, N.W. Africa, C. Asia
Echinochloa crus-galli (L.) P. Beauv.	AHÇ 112	1, 13	Th	–	Sum.	Mediterranean area, Caucasia, S.W., C. & E. Asia, N. America

cont. Table 2

1	2	3	4	5	6	7
Hordeum murinum L. subsp. *leporinum* (Link) Arcang.	AHÇ 94	1, 2, 13	Th	–	Sum.	Europe
Lolium persicum Boiss. & Hohen.	AHÇ 151	1, 2, 3, 12, 13, 25	Th	Ir.-Tur.	Sum.-Aut.	Caucasia, Iran, Iraq, Afghanistan, Baluchistan, England, N. America, N.W. China
Lolium perenne L.	AHÇ 78	1, 2, 3, 15, 16, 34	H	Euro-Sib.	Spr.-Sum.	Temperate Eurasia
Phalaris paradoxa L.	AHÇ 52	1, 13	Th	Medit.	Spr.	Mediterranean area, S.W. Asia
Phleum exaratum Griseb. subsp. *exaratum*	AHÇ 18	1, 13	Th	–	Spr.	Italy, Balkans, W. Syria, N; Iraq, Iran, Transcaspia
Phragmites australis (Cav.) Steud.	AHÇ 38	1	H	Euro-Sib.	Spr.	Temperate Eurasia
Poa annua L.	AHÇ 150	1, 2, 12, 13, 19, 27	Th	–	Sum.	Cosmopolitan
Polypogon monspeliensis (L.) Desf.	AHÇ 84	1, 13	Th	–	Sum.	W. Europe, Mediterranean area, Caucasia, Asia
Rostraria cristata (L.) Tzvelev var. *cristata*	AHÇ 60	13	Th	–	Spr.-Sum.	Mediterranean area, Crimea, Caucasia, N. Iraq, N. Iran, Arabia, Afghanistan, W. Pakistan
Setaria glauca (L.) P. Beauv.	AHÇ 152	13	Th	–	Sum.-Aut.	S. & southern C. Europe, Mediterranean area, Caucasia, S.W., C. & E. Asia, N. America
Sorghum halepense (L.) Pers. var. *alepense*	AHÇ 1	13	H	–	Spr.	Mediterranean area, S.W. & C. Asia
Taeniatherum caput-medusae (L.) Nevski subsp. *crinitum* (Schreb.) Melderis	AHÇ 75	13	Th	Ir.-Tur.	Spr.-Sum.	Balkans, N. Africa, Transcaucasia, Crimea, Iran, Iraq, Cyprus, W. Syria, Afghanistan, C. Asia, W. Pakistan
Vulpia myuros (L.) C.C. Gmel.	AHÇ 69	1	Th	–	Spr.-Sum.	Mediterranean area, W. & C. Europe, S. Russia, Caucasia, S.W. Asia eastwards to Pakistan

cont. Table 2

1	2	3	4	5	6	7
Polygonaceae						
Polygonum aviculare L.	AHÇ 176	1, 13, 20	Th	–	Sum.-Aut.	Cosmopolitan
Rumex pulcher L. subsp. *pulcher*	AHÇ 95	1, 2, 13	H	–	Spr.-Sum.	Most of Europe, N. Africa, Syrian Desert, N. & N.W. Iran, Arabia
Portulacaceae						
Portulaca oleracea L.	AHÇ 144	13	Th	–	Sum.-Aut.	Europe, S.W. Asia
Ranunculaceae						
Ranunculus arvensis L.	AHÇ 232	1, 13	Th	–	Aut.-Win.	Europe, S.W. Asia, N. Africa, Turkestan
Ranunculus millefolius Banks & Sol. subsp. *millefolius*	AHÇ 174	1	Cr (G)	–	Sum.-Aut.	N. Iraq, Syrian Desert, Cyprus; N.W. Iran
Rubiaceae						
Galium aparine L.	AHÇ 74	1	Th	–	Spr.	Europe, N., W. & C. Asia, N. America
Galium tricornutum Dandy	AHÇ 64	1, 2, 13	Th	Medit.	Spr.	S.-W. & C. Europe, Caucasia, Iraq, Iran, C. Asia to Kashmir, Tibet
Tamaricaceae						
Tamarix smyrnensis Bunge	AHÇ 134	1	Ph	–	Sum.-Aut.	Caucasia, Iran, N. Iraq, Transcaspia, Afghanistan, Balkans, W. Syria, Romania, Crimea
Urticaceae						
Urtica pilulifera L.	AHÇ 192	13	Th	Medit.	Aut.-Win.	S. Europe, N. Africa, S.W. Asia
Verbenaceae						
Phyla canescens (Kunth) Greene	AHÇ 210	13	H	–	Aut.-Win.	C. & S. America, Mediterranean Europe, Cyprus, Lebanon, Egypt
Zygophyllaceae						
Tribulus terrestris L.	AHÇ 22	1, 13	Th	–	Spr.	S. Europe, S.W. Asia

Abbreviations: AHÇ – Ahmet Hamdi Çiçek; LF – life form; Ch – Chamaephyte; Cr (G) – Cryptophyte (Geophyte); H – Hemicryptophyte; Ph – Phanerophyte; Th – Therophyte; Ir.-Tur. – Irano-Turanian; Medit. – Mediterranean; E. Medit. – East Mediterranean; Euro-Sib. – Euro-Siberian; Aut. – Autumn; Spr. – Spring; Sum. – Summer; Win. – Winter; * Invasive weed

When the plants are evaluated according to the family they belong to, Fabaceae (29), Poaceae (24), Asteraceae (23), Brassicaceae (6), Plantaginaceae (6), Apiaceae (5) and Caryophyllaceae (5) ranking emerges (Figure 2).

When the plants are evaluated in terms of the phytogeographical region to which they belong, the order is like Irano-Turanian (17), Mediterranean (10), Euro-Siberian (7) and Eastern Mediterranean (5). For the remaining 95 plants, there is no phytogeographical region evaluation (Figure 3).

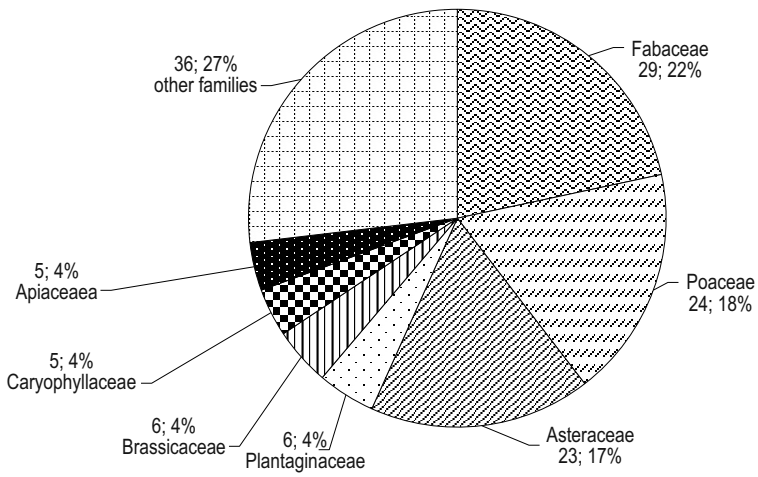

Fig. 2. Distribution of identified plants by families

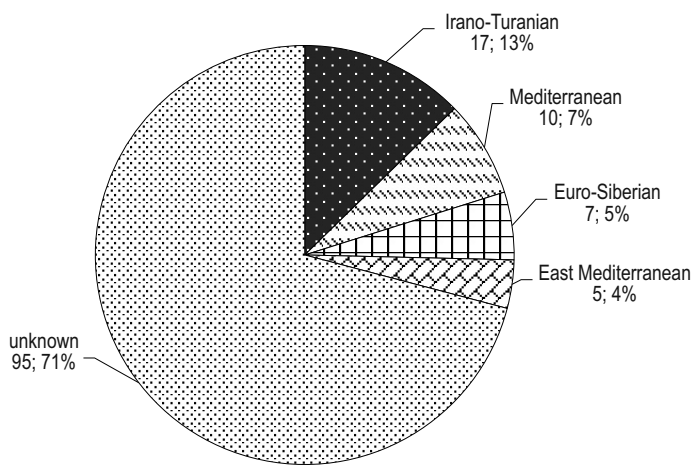

Fig. 3. Distribution of taxa according to phytogeographic regions

When the plants in the recreation areas were evaluated according to RAUNKIAER'S (1934) life forms, 100 of them were therophyte, 30 of them were hemicryptophyte, 1 of them was chamaephyte, 1 of them was phanerophyte and 2 of them were cryptophyte (geophyte) (Figure 4).

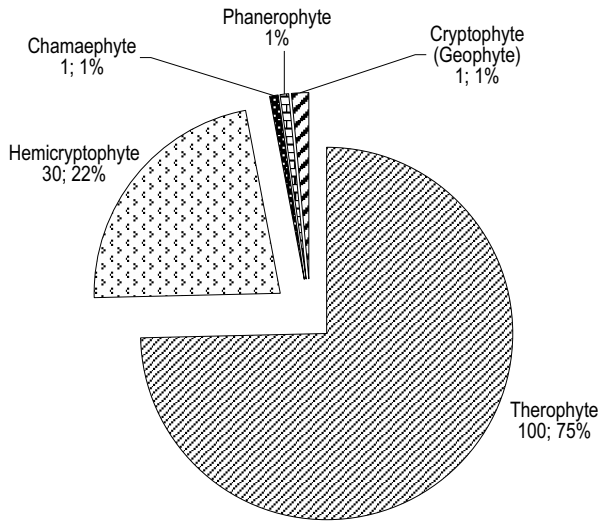

Fig. 4. Distribution of plants according to life forms

When an assessment was made based on the number of species identified in recreational areas, it was observed that Cumhuriyet Park and Ottoman Picnic Area in particular harbored significantly more species than other recreational areas in terms of foreign weeds. One of the most important reasons for this is that both recreational areas are surrounded by natural areas, allowing the diaspora of species in these areas to enter the recreational areas. Additionally, the absence of landscape design or the presence of damaged areas within these recreational areas is another contributing factor. Another reason is that weed control efforts are not being carried out at an adequate level. The low number of species in other recreational areas is generally attributed to their surroundings being enclosed by urban areas and the lack of effective control measures (mowing or removal) against these invasive weeds that disrupt the landscape (Figure 5).

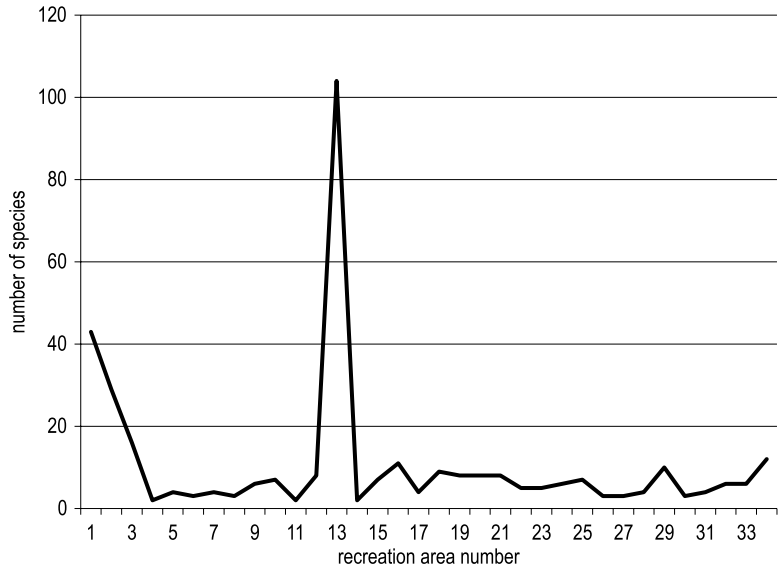

Fig. 5. Comparison of recreational areas in terms of number of types

Conclusion and Suggestions

This study covers the recreation areas located in Eyyübiye, Haliliye and Karaköprü districts, which are the central districts of Şanlıurfa. Some of these recreation areas are completely in the middle of concrete structures in the city centre and there is no ruderal or natural area around them. Some of the recreation areas are located in urban areas with partial construction and still surrounded by ruderal and natural areas.

It was determined that the weeds detected in the recreation areas consisted of plants remaining from the habitat before the areas were transformed into recreation areas and plants that were transported by different means, such as birds, insects, fertilisation, etc. and were identified as in the area.

The natural (rural) areas and constructions around the recreation areas may cause changes in the composition of the weed flora. In the recreation areas located between the buildings in the city centre, the weed composition is composed of ruderal plants and plants which have been transported to the area in various ways. On the other hand, in the recreation areas where there are still natural areas around, it was determined that there are many plants belonging to the steppe vegetation in addition to the plants mentioned above. These steppe plants are seen in the parts bordering the recreation areas, especially around the fences. In addition, these steppe

plants are also found in places where the recreation areas have not yet been organised or organised but deterioration is seen.

In recreation areas, which are urban areas created by humans for various purposes, the recognition of the plants and animals that we live together in the city in general allows the problems that may arise from them to be combated without harming the environment. By using this information, the relevant units of public institutions and organisations will have the opportunity to intervene at an early stage, especially in species that are considered invasive among weeds. This will enable efficient use of resources, i.e. preventing loss of time, labour and budget.

In order to better understand the events that may occur in the context of human and environment and to recognise urban areas in all aspects, such studies should continue increasingly. Obtaining new information will provide important benefits in the management of urban areas. It is hoped that this study will serve as a resource for researchers working on the determination of the ecology of urban areas.

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PROSPECT TO ACHIEVING EQUITABLE URBAN TREE CANOPY DISTRIBUTION IN IBADAN METROPOLIS, OYO STATE, NIGERIA

***Oyinlola Abiodun Fasoro*[1], *Sofiyat Mojisola Salam*[2]**

[1]ORCID: 0000-0003-3438-8579
[1,2]Faculty of Renewable Natural Resources,
Department of Social and Environmental Forestry
University of Ibadan, Ibadan,Oyo State, Nigeria

K e y w o r d s: environmental justice, urban tree, tree distribution, urban policy.

A b s t r a c t

Urban trees' services and disservices have garnered a lot of attention, and many cities are working to expand greenspace and tree canopy to improve the quality of life for residents. However, from an environmental justice perspective, it is vital to examine the distribution of tree canopy cover and who benefits from better quality of life. This study investigates the impact of environmental justice on urban tree canopy distribution in the Ibadan city. Oluyole Estate and Old Bodija communities were purposively selected based on vegetation cover, industry presence, and population growth rates. At 5% sampling intensity, houses were randomly selected. Data were analyzed using descriptive and chi-square statistics, and Normalized Difference Vegetation Index (NDVI) was utilized to assess vegetation density.

The study revealed that vegetation cover increased significantly between 2003 and 2013, and remains at a level of 0.35–0.36 in both of the locations that were studied. Although Oluyole Estate residents believe that tree canopy cover is unevenly distributed, they also believe that there is equal access to vegetation cover. In contrast, Old Bodija residents stated that tree canopy cover is evenly distributed and that access is equitable. A chi-square test indicates that the association between the distribution of urban tree canopy cover and gender, age and education is significantly different. Given the crucial role of urban green spaces in residents' health and well-being, policymakers should prioritise public awareness, education, and environmental justice in urban climate policies.

Introduction

SCHLOSBERG and COLLINS (2014) defined environmental justice (EJ) as the intersection of human rights, public health, safety, and proximity to environmental resources and hazards. In other words, EJ aims to provide

Address: Oyinlola Abiodun Fasoro, University of Ibadan, Ibadan,Oyo State, Nigeria, e-mail: oyinlola4christ@gmail.com

clean, safe places to live, work and play. Promoting equity strengthens a city's ability to respond to climate change by fostering human well-being, social capital, and long-term social and economic urban growth. DANFORD et al. (2014) stated that, in recent decades, EJ research has shifted focus from minimising environmental waste and pollution to ensuring access to environmental and community resources as an indicator of quality of life. Examples of community resources include outdoor recreation and parks, natural areas, right-of-way, private properties such as neighbourhoods and residential zones, public playgrounds, and urban tree cover. These resources offer a wide range of economic, environmental, and social benefits at all levels, from the local to the global (DOBBS et al. 2017, FASORO et al. 2024). NESBITT et al. (2017) reported that proximity to trees reduces stress and anxiety, fosters a welcoming and secure setting for community activities, and cultivates intellectual and emotional well-being. Ecologically, city trees, particularly old ones, help mitigate the consequences of climate change by regulating microclimate temperatures, reducing stormwater runoff and sequestering carbon (GREENE et al. 2011). However, the unequal distribution of the local benefits of parks, green spaces and trees in cities raises concerns about environmental justice.

LYYTIMÄKI (2017) confirmed that, depending on factors such as species composition, location in relation to other trees and built structures, growth patterns, life phase, stress caused by external conditions and the intensity of maintenance activities, urban trees can provide disservices as well as benefits. FASORO and AJEWOLE (2022) found that 60% of resident staff at the University of Ibadan were aware of the potential hazards posed by trees to the university community. The study revealed that fruit and leaves littering the environment can make pedestrian and driver paths slippery, resulting in accidents. Furthermore, respondents stated that some trees are prone to windthrow; weak branches and trees may fall on power lines, causing power outages and accidents. Clearly, trees can cause harm, influencing how people value them in their environment.

According to FASORO et al. (2024), the distribution of trees and access to nature are rarely equitable among Nigerian communities. This injustice and unfairness exist in many cities and is mostly the result of long-standing distributive, procedural and recognitional imbalances. Distributive justice focuses on the fair allocation of green spaces to ensure that all socioeconomic groups benefit from the tree canopy (GRANT et al. 2023). Recognitional justice requires the inclusion and prioritisation of the diverse perspectives, experiences, preferences, values and knowledge of disadvantaged groups, such as those who are racialised or have a low income, and those who are neglected, such as those living in low-canopy neighbourhoods or who have

been historically excluded from decision-making, in urban forest planning, tree-planting and stewardship events (CAMPBELL et al. 2022, GRANT et al. 2022). According to ENGLUND et al. (2021), procedural justice involves equal participation in decision-making processes, including public involvement in the development of plans and initiatives that promote ongoing public participation in city governance, as well as targeted outreach to marginalised groups who are often underrepresented in traditional public engagement processes.

The uneven distribution of urban trees is driven more by socioeconomic factors than ecological ones (LANDRY and CHAKRABORTY 2009). The study also found that the factors impacting the distribution of urban trees are often a combination of current drivers (e.g. where new trees can be planted and maintenance funding) and historical processes (e.g. social stratification and neighbourhood succession). These factors combine to cause contemporary imbalance in tree canopy cover, and researchers discovered that the socioeconomic traits associated with canopy cover differ among cities. Cities are characterised by diverse socioeconomic classes living in close proximity. This diversity is often accompanied by social stratification based on class, caste, gender, profession, race, ethnicity, age and ability. These social categories affect people's and groups' ability to withstand climatic shocks and minimise climate hazards. Differences across social groups often lead to discrimination based on group membership. Poorer people, as well as ethnic and racial minorities, are more likely to live in dangerous, vulnerable and overcrowded urban areas. These conditions make people more susceptible to the effects of climate change, reducing their ability to adapt to and withstand adverse events (RECKIEN et al. 2018).

The most recent study on the environmental justice implications of urban forests found that racialised minorities and poorer communities are more likely to live in neighbourhoods with a lower urban tree canopy (GERRISH and WATKINS 2018, WATKINS and GERRISH 2018). According to FREY (2017) and THRELFALL et al. (2022), two decades of research have demonstrated persistent inequities in access to urban tree canopies in the United States and beyond. These studies demonstrate environmental inequities in access to a key urban environmental amenity.

This study therefore investigates the distribution of urban tree canopy in the Ibadan metropolitan area. Three primary investigations were conducted: tree canopy distribution; the socioeconomic characteristics of residents; and distributive environmental justice. The aim is to recommend to policymakers and key stakeholders that urban climate policies should include equity and environmental justice as primary long-term goals.

Methodology

Study area

Ibadan is Nigeria's third largest metropolitan area. According to the UN Human Settlements Programme (2022), it is Africa's second fastest-growing metropolis. It consists of two distinct seasons: wet and dry. The wet season runs from March to October, while the dry season lasts from November to February. Typical annual rainfall is predicted to be 1,230 mm, with rain falling on around 109 days per year. The average temperature is 26.4°C.

The study was conducted in the Oluyole Estate and Old Bodija communities in Ibadan city. Oluyole Estate is in the Ibadan South-West Local Government Area (LGA), while Old Bodija is in the Ibadan North LGA. Oluyole is situated between latitudes 7° 21′ N and 3° 50′ E, while Old Bodija lies between latitudes 7° 25′ N and 3° 54′ E. The mean annual rainfall is estimated to be 1,230 mm, with rain falling on around 109 days. The mean temperature is 26.4°C. The NBS (2020) reported the population size of the area to be approximately 282,585 and 308,119, respectively. Figure 1 depicts a map of the study area.

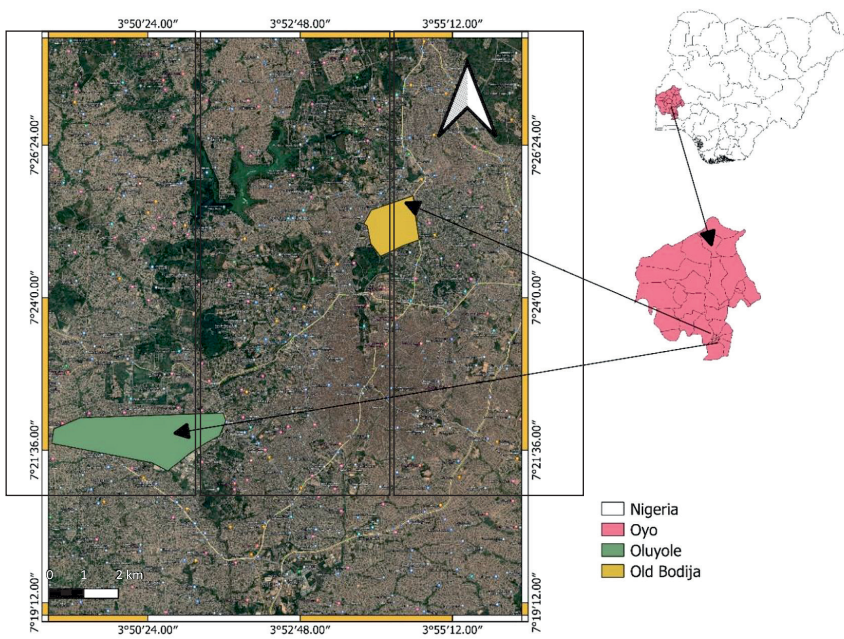

Fig. 1. Map of the study area (Oluyole and Old Bodija)
Source: Author's own study, based on Google Maps

Data collection and sampling procedure

Both primary and secondary data were used for the study. Primary data were collected using structured questionnaires and key informant interviews (KIIs) to validate the respondents' responses. To determine vegetation cover, a Landsat 9 image from 2023 was downloaded and spatial data for the research region was retrieved. Secondary data were gathered from relevant books and journals.

A multi-stage sampling design was employed. The Ibadan metropolis is divided into eleven local government areas, five of which are urban and six of which are peri-urban. The five urban LGAs are Ibadan North, Ibadan North West, Ibadan North East, Ibadan South West and Ibadan South East. Of these, two urban LGAs (Ibadan North and Ibadan South-West) were purposively selected due to their significant economic activities and considerable green space. The Oluyole Estate and Old Bodija communities were then purposively selected based on vegetation cover, the presence of industries and population growth. Based on information provided by community leaders, houses were randomly selected in both communities at a 5% sampling intensity. One respondent was selected from each house. Table 1 shows the sampling technique.

Table 1

Sampling size

Urban LGA	Community	Number of houses	Sampling size (at 5% sampling intensity)
Ibadan North	Oluyole Estate	1059	53
Ibadan South-West	Old Bodija	3261	163
Total	–	–	216

Data analysis

Chi-square test of association. Data were subjected to descriptive and chi-square statistics.

Chi-square test was used to determine whether there is a statistically significant difference between socioeconomic characteristics of respondents and green spaces equity

$$(\chi^2) = \frac{1}{G}\sum \frac{(G(\mathrm{a}i,j) - Si\mathrm{T}j)^2}{Si\mathrm{T}j} \tag{1}$$

where:

χ^2 – Chi-square statistic

G – total number of observations

G(ai,j) – observed value in the cell corresponding to row i and column j.
Si – sum (or marginal total) of row i
Tj – sum (or marginal total) of column j
SiTj – expected value in cell (i, j) under the assumption of independence.

Determination of the level of greenness

Landsat imagery was downloaded from the Global Visualization Viewer (GloVis) on the official website of the United States Geological Survey (USGS): https://glovis.usgs.gov/app/. The collected data was then analysed using ArcMap to extract the Normalised Difference Vegetation Index (NDVI). The NDVI is the most basic and widely used objective measure of vegetation density and is frequently employed in environmental health studies to assess greenness exposure in urban areas (JIMÉNEZ et al. 2022). Ratio values range from −1 to +1. Positive values close to 1 indicate healthy green vegetation, while negative values describe areas without vegetation cover, such as water bodies, snow-covered areas, rocks, and bare soil. Low values around 0 represent sparsely vegetated areas and vegetation that is aged or dead.

The equation for NDVI is:

$$\mathrm{NDVI} = \frac{\mathrm{NIR\ (Band\ 5)} - \mathrm{Red(Band\ 4)}}{\mathrm{NIR\ (Band\ 5)} + \mathrm{Red(Band\ 4)}} \quad (2)$$

where:

NIR (Near-Infrared, Band 5): Vegetation reflects a lot of NIR light, so healthy plants have high values in this band

Red (Band 4): Vegetation absorbs most of the red light for photosynthesis, so healthy plants have low values in this band.

Results

Normalized Difference Vegetation Index (NDVI) of Oluyole Estate

Figure 2 shows the NDVI digital map values for the Oluyole community. The maximum NDVI values for years 2003, 2013 and 2023 were 0.08, 0.36 and 0.32, respectively, while the minimum NDVI values were -0.31, 0.05 and 0.032. From the maximum NDVI values, the results showed that the vegetation cover in the study area increased from 0.08 in 2003 to 0.36 in 2013, but then declined to 0.32 in 2023.

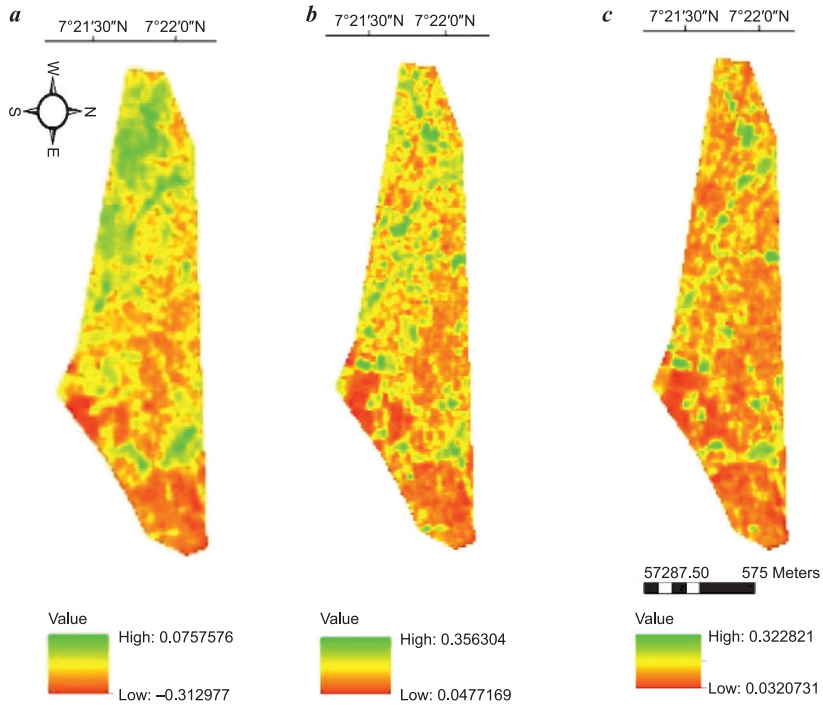

Fig. 2. Oluyole NDVI map in 2003 (*a*); 2013 (*b*) and 2023 (*c*)

Normalized Difference Vegetation Index (NDVI) of Old Bodija Community

NDVI digital map values for Old Bodija community were presented in Figure 3. The maximum NDVI values for years 2003, 2013 and 2023 respectively were 0.11, 0.39 and 0.35 and the minimum NDVI values were

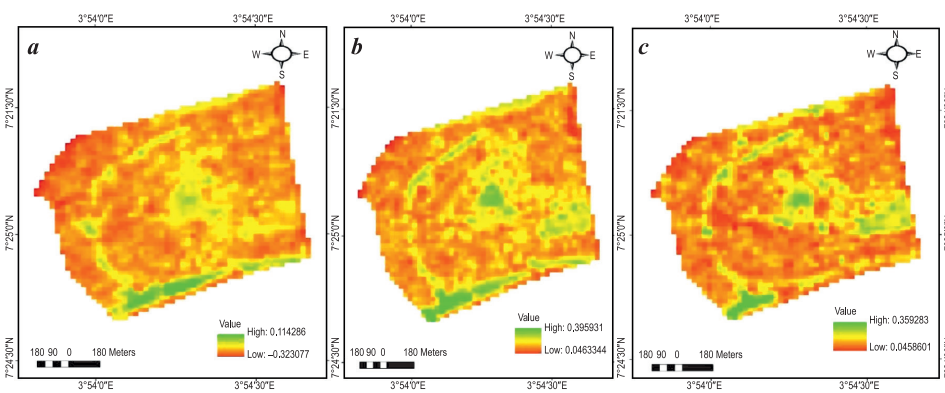

Fig. 3. Old Bodija NDVI Map in: *a* – 2003; *b* – 2013; *c* – 2023

-0.32, 0.046 and 0.045. From the maximum NDVI values, the values revealed that the vegetation cover in the study area increased from 0.11 in year 2003 to 0.39 in year 2013, however it decreased in 2023 to 0.35.

Socio-economic characteristics of residents in Oluyole and Old Bodija

Based on the data presented in Table 2, the socio-economic characteristics of residents in Oluyole Estate and Old Bodija community reveal several similarities and some notable distinctions. In both communities, the majority of respondents were male, accounting for 55.2% in Oluyole and 54.7% in Old Bodija. The dominant age group in both locations was between 20 and 35 years, comprising 55.2% of Oluyole's population and an even higher 62.3% in Old Bodija. Oluyole had a larger proportion of respondents between 36 and 51 years, while Old Bodija had more individuals aged 52 and above.

In terms of marital status, singles constituted the largest group in both areas, with 52.8% in Oluyole and 54.7% in Old Bodija, while married individuals followed closely behind. Widowed respondents were extremely few in both communities. Income distribution indicated that the majority of respondents in both areas earned over ₦ 40,000 monthly, though Oluyole had a slightly higher proportion at 58.3% compared to 49.1% in Old Bodija.

Ethnically, Yoruba was the predominant group, representing 78.5% of Oluyole and 75.5% of Old Bodija, followed by a smaller presence of Igbo individuals and a minimal number of Hausa respondents. Education levels were relatively high across both communities, with 65.6% of Oluyole respondents and 73.6% of Old Bodija respondents having attained tertiary education. In terms of employment status, Oluyole featured a significant number of self-employed individuals, while Old Bodija had a notable proportion of students.

The majority of residents identified as Christians, comprising 75.5% in both communities, while Muslims represented roughly a quarter of the population. Regarding the duration of residency, most individuals had lived in their respective areas for between one and ten years. Lastly, housing status showed that a large portion of residents in both areas rented their homes, with 70.6% in Oluyole and 75.5% in Old Bodija.

Overall, while both communities share many socio-economic traits, nuances in age distribution, income levels, and employment patterns highlight subtle differences in the demographic landscape of Oluyole Estate and Old Bodija.

Table 2

Socioeconomic characteristics of the respondents

Variables		Oluyole		Old Bodija	
		N	[%]	*N*	[%]
Gender	male	90	55.2	29	54.7
	female	73	44.8	24	45.3
Age	<20	10	6.1	2	3.8
	20–35	90	55.2	33	62.3
	36–51	45	27.6	7	13.2
	52–66	10	6.1	8	15.1
	>66	8	4.9	3	5.7
Marital status	married	76	46.6	23	43.4
	single	86	52.8	29	54.7
	widowed	1	.6	1	1.9
Income	<10,000	10	6.1	5	9.4
	10,000–20,000	13	8.0	4	7.5
	20,000–30,000	18	11.0	10	18.9
	30,000–40,000	27	16.6	8	15.1
	>40,000	95	58.3	26	49.1
Ethnicity	Igbo	24	14.7	10	18.9
	Yoruba	128	78.5	40	75.5
	Hausa	4	2.5	0	0.0
	no response	7	4.3	3	5.7
Education	no formal education	1	.6	1	1.9
	primary	9	5.5	1	1.9
	secondary	46	28.2	12	22.6
	tertiary	107	65.6	39	73.6
Religion	christianity	123	75.5	40	75.5
	islam	38	23.3	12	22.6
	no response	2	1.2	1	1.9
Period of occupancy	<1 year	23	14.1	3	5.7
	1–10 years	92	56.4	31	58.5
	11–20 years	23	14.1	15	28.3
	21–30 years	16	9.8	1	1.9
	31–40 years	7	4.3	3	5.7
	>40 years	2	1.2	0	0
House Ownership	rent	115	70.6	40	75.5
	sole ownership	48	29.4	13	24.5
	Total	163	100.0	53	100.0

Residents' awareness of green spaces benefits and the proximity to residents

In Oluyole Estate and Old Bodija community respectively, 71.2% and 60.4% of respondents were aware of the environmental benefits of trees. In contrast, 28.8% and 39.6% were unaware of these benefits in Oluyole Estate and the Old Bodija community, respectively. In Oluyole Estate, 44.2% and 17.8% of respondents said that trees were close to or really close to their homes, while 24.5% and 13.5% said that trees were distant or very far away. In the Old Bodija community, 28.3% and 24.5% of residents said that trees were close and very close to their homes, while 32.1% and 13.2% said that trees were distant and very far away. In Oluyole Estate, 62.0% of residents said that trees were close to them, while 38.0% said that they were far away. In the Old Bodija community, 52.8% of residents reported that trees were nearby, while 47.4% reported that trees were far from their homes.

Types of green spaces in communities

Table 3 shows the types of urban green spaces mentioned by the respondents. Table 3 shows that, in Oluyole Estate, the most commonly identified green infrastructure was street trees (48.5%), followed by household trees (25.8%), gardens (17.2%), and parks (8.6%). In the Old Bodija community, however, most residents (43.4%) reported that street trees dominated the environment, followed by household trees (26.4%), gardens (18.9%) and parks (11.3%).

Table 3

Distribution of available green spaces in the environment

Type of Green space	Oluyole		Bodija	
	N (163)	percentage	*N* (53)	percentage
Street trees	79	48.5	14	26.4
Household trees	42	25.8	23	43.4
Garden	28	17.2	10	18.9
Parks	14	8.6	6	11.3

Perception of residents on tree canopy cover distribution and equitable access

In Oluyole Estate, 25.2% of respondents said that the tree canopy was evenly distributed in the community, while 74.8% said that it was not. In the Old Bodija community, most respondents (69.8%) argued that tree canopy

cover is unevenly distributed, while 30.2% believed that it is distributed equally. At Oluyole Estate, 59.5% of respondents believed that access to vegetation cover was equal, while 40.5% believed that access was unequal. In the Old Bodija community, 69.8% of respondents reported unequal access to vegetation cover, while 30.2% stated equal access.

Relationship between social-economic characteristics of respondents and green space equity

In Table 4, Pearson's chi-square test (χ^2) reveals that gender ($p = 0.041$), age ($p = 0.002$) and education ($p = 0.024$) significantly influence respondents' opinions concerning the distribution of urban green spaces in the study area (Table 4). However, respondents' income (0.182), ethnicity (0.513), occupation (0.177), religion (0.705), length of residence (0.829) and home ownership (0.446) do not significantly affect their perception of the distribution of urban green space.

Table 4

Chi-square test of association results

Variables	Values	Df	Significance
Gender	4.189	1	0.041
Age	16.708	4	0.002
Income	6.245	4	0.182
Ethnicity	2.300	3	0.513
Education	9.393	3	0.024
Occupation	7.647	5	0.177
Religion	0.700	2	0.705
Period of occupancy	1.258	5	0.829
House ownership	0.582	1	0.446

Discussion

The Normalised Difference Vegetation Index (NDVI) is used to assess the greenness of vegetation and understand its density. Historically, Ibadan's urban environments were characterised by a high concentration of trees and green spaces. However, industrialisation has led to a drastic change in the relationship between urban areas and green spaces. Rapid population growth, driven by industrialisation and migration to cities, has put immense pressure on urban environments. As cities expanded, the need for housing, manufacturing and infrastructure led to deforestation and a reduction

in green spaces. The focus shifted towards optimising space for economic activity and accommodating growing urban populations. According to the study, vegetation cover increased in the Old Bodija and Oluyole communities between 2003 and 2013. Oral interviews with community leaders revealed that, during this period, there was an increased awareness of the importance of integrating trees and green spaces into urban areas, prompting many homeowners to plant trees in their gardens. However, rapid urbanisation and migration, coupled with the demand for land to build homes, factories and infrastructure, have resulted in widespread deforestation and a decline in green spaces. This corroborates the findings of AREOLA and IKPORUKPO (2018), who identified the Old Bodija community as one of the least vegetated areas in the Ibadan metropolitan area.

Demographic variables such as race, ethnicity, income level, gender and age of respondents are often associated with varying degrees of exposure to environmental hazards (FOSTER and DUNHAM 2022). LOCKE et al. (2017) reported that residents' socio-economic characteristics can be a significant predictor of tree canopy change in a community. As this study targeted household heads, it is unsurprising that the sampled population in the two communities was dominated by men; a substantial proportion of respondents were middle-aged and married. Middle-aged and married people often have established roots in a community, so they may value access to green spaces that support family wellbeing, community aesthetics and health. This could boost advocacy for fair tree planting and maintenance efforts. In Nigeria, there are three primary ethnic groups: Yoruba, Igbo and Hausa. To ensure equitable implementation, tree canopy planning must take ethnic diversity into account and guarantee the inclusive participation of all ethnic groups, particularly minorities who may be underrepresented. The survey found that the majority of respondents were Yoruba, educated Christians who had lived in the communities for between one and ten years. The dominance of Yoruba respondents reflects the ethnic composition of the study area. Most respondents were aware of the benefits of trees, with a high percentage stating that they lived near trees. In environmental justice studies, people's perception of trees and their benefits is essential, as obtaining justice requires determining whether people know and understand why they are being defended, which supports the Environmental Justice Act. However, RILEY and GARDINER (2020) noted that physical proximity to trees does not imply that people will evaluate their quality in the same way, as people can evaluate a tree's quality in terms of the environmental services it provides. For instance, a tree may be considered high quality if it produces fruit or provides environmental services.

Respondents selected street trees, household trees, gardens, and parks as urban green resources present in their living environments. Parks, gardens

and tree-lined streets all significantly contribute to the health and well-being of urban dwellers. However, access to these resources is often unequally distributed, with some socio-economic groups having greater access than others. This is because, when tree-planting initiatives focus specifically on increasing canopy cover in environmental justice communities, achieving an equitable distribution of urban trees is difficult. These difficulties arise not only from policy and funding issues, but also ecological ones, such as the physical availability of sites for planting trees in environmental justice communities (DANFORD et al. 2014). Understanding residents' perceptions of the distribution of tree canopy cover and equitable access is critical for establishing effective urban greening strategies. Addressing the underlying causes of these perceptions enables policymakers and community leaders to foster fairer and more inclusive urban settings. Respondents reported that the distribution of tree canopy cover is uneven, resulting in differences in access to and benefit from it throughout the communities.

Pearson's chi-square test revealed a relationship between opinions on the equitable distribution of urban green spaces and the residents' socioeconomic characteristics (gender, age and education). This supports the findings of DANFORD et al. (2014) that socioeconomic factors combine to generate inequalities in tree canopy cover and that these factors differ by city. Tree canopy cover is positively correlated with educational attainment, homeownership, employment, housing age, and income. This is because higher-income, educated homeowners are more likely to live in affluent neighbourhoods that invest in urban greening, landscaping and maintenance. However, according to LANDRY and CHAKRABORTY (2009), canopy cover is negatively correlated with rentership, household density, and minority population. This is due to less control over property modifications, such as tree planting or landscaping. Densely populated neighbourhoods are often characterised by smaller plots, less outdoor space, and more hardstanding (e.g. paved areas and apartment blocks), which limits opportunities for planting trees. The negative correlation with minority populations revealed patterns of environmental injustice, with minority communities often living in areas with less public and private investment in green infrastructure.

Conclusion

Pursuing equitable urban tree canopy distribution is an important step in building sustainable, resilient and equitable communities. While many people are aware of the environmental benefits of trees, the study revealed that tree canopy cover is unevenly distributed in some areas and that socioeconomic disparities could be linked to this distribution.

To address these disparities, green spaces must be included in all building and development plans as part of enforced urban planning policies and regulations. In other words, policymakers should draft and implement a national policy requiring all public and private development projects (residential, commercial and institutional) to include designated green spaces, such as trees, lawns, gardens or parks, as an essential component of building approvals. Furthermore, key urban development authorities, such as the Federal Ministries of Environment and Lands, Housing and Urban Development, state planning commissions and municipal councils, would be empowered to oversee implementation and impose fines for non-compliance with green space requirements. It is also crucial to engage residents in the planning and implementation of urban greening initiatives to ensure that tree canopy distribution aligns with community needs and preferences.

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