Research Article

Effects of Indoor Plants on Organic Chemicals Released from Furniture and Decoration Element

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Abstract

Plants have been used for centuries to decorate homes and add a touch of nature to interiors. Beyond their aesthetic appeal, plants have numerous benefits for indoor environments. Research has shown that plants can purify the air, improve indoor air quality and have psychological and physiological benefits. In this research, it aims to figure out the extent of knowing the effects of indoor plants on organic chemicals emitted from furniture and decoration elements. For this purpose, 225 randomly selected people participated in the prepared research questionnaire. According to the results of the survey, it was determined that the 18-25 age group participants and the participants with postgraduate education had a higher level of knowledge about the effects of plants on indoor pollutants compared to the participants in the other age and education groups. On the other hand, no significant difference was found between the evaluations of male and female participants regarding the effects of plants on indoor pollutants. When these results are examined in general, it is seen that the participants do not have enough information about the effects of indoor plants on the organic chemicals emitted from the furniture and decoration elements. As a result, it has been revealed that users should be informed about the effects of indoor plants on organic chemicals and awareness should be raised on this issue. And it has been reported that increasing the level of knowledge on this subject can provide significant contributions to human health.

Keywords: Interior, Plant, Organic Chemical, Equipment, Furniture.

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Araştırma Makalesi

Mobilya ve Dekorasyon Elemanlarından Salınan Organik Kimyasallar Üzerine İç Mekan Bitkilerinin Etkileri

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Özet

Bitkiler yüzyıllardır evleri dekore etmek ve iç mekânlara doğa dokunuşu katmak için kullanılmıştır. Bitkilerin estetik çekiciliğinin ötesinde iç mekânlar için pek çok faydası vardır. Araştırmalarda bitkilerin havayı temizlediği, iç mekân hava kalitesini iyileştirdiği, psikolojik ve fizyolojik açıdan çok sayıda faydalarının olduğu vurgulanmıştır. Bu araştırmada, katılımcıların iç mekân bitkilerinin mobilya ve dekorasyon elemanlarından ortama yayılan organik kimyasallar üzerindeki etkilerini bilme düzeylerinin belirlenmesi amaçlanmaktadır. Bu amaçla hazırlanan araştırma anketine rastgele seçilmiş 225 kişi katılmıştır. Araştırma sonuçlarına göre, 18-25 yaş grubu katılımcılar ile lisansüstü eğitime sahip katılımcıların, diğer yaş ve eğitim grubu katılımcılara göre bitkilerin iç mekân kirleticileri üzerindeki etkilerine ilişkin bilgi düzeylerinin daha yüksek olduğu tespit edilmiştir. Öte yandan kadın ve erkek katılımcıların bitkilerin iç mekân kirleticileri üzerindeki etkilerine ilişkin değerlendirmeleri arasında anlamlı bir farklılık bulunamamıştır. Bu sonuçlara genel olarak bakıldığında, katılımcıların iç mekân bitkilerinin mobilya ve dekorasyon elemanlarından ortama yayılan organik kimyasallar üzerindeki etkileri hakkında yeterli bilgiye sahip olmadıkları görülmektedir. Sonuç olarak, çalışmada iç mekân bitkilerinin organik kimyasallar üzerindeki etkileri hakkında kullanıcıların bilgilendirilmesi ve bu konuda farkındalık oluşturulması gerektiği ortaya koyulmuş, bu konuda bilgi düzeyinin artırılmasının insan sağlığına önemli katkılar sağlayabileceği bildirilmiştir.

Anahtar Kelimeler: Bitki, Donatı Elemanı, İç Mekân, Mobilya. Organik Kimyasal.

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INTRODUCTION

Considering the data published by the Turkish Statistical Institute (TUIK) in 2021, it is seen that the population living in provinces and districts in Turkey has increased to 93.2%, while the population in towns and villages has decreased to 6.8% (TUIK, 2022). These statistical data show that the population living in the city is increasing day by day. Cengiz et al. (2019) reported that people living in big cities spend at least 80% of their lives indoors. In this period when cities are rapidly becoming concrete and environmental paroblems are increasing, indoor plants that enable people to connect with nature; They are living creatures that make many positive contributions to daily life and reduce stress with their colorful flowers and leaves (Güçlü, 1999). Many studies (Ulrich, 1981; Ulrich, 1991; Ulrich and Simons, 1986; Ulrich and Parsons, 1992; Kaplan and Kaplan, 1989; Hartig et al., 1991; Giese et al., 1994; Wolverton and Wolverton, 1996); Chang and Chen, 2005; Dijkstra et al., 2008; Bringslimark et al., 2007, 2009; Ranaas et al., 2011; Korpela et al., 2017; Sezen et al., 2017; Yıldırım et al., 2020ab; Selim et al., 2020) show that indoor plants affect people's mental and physical health positively. In addition to their health benefits, plants can also be used to enhance the aesthetic appeal of interiors. Interior designers often use plants to add colour, texture and depth to a room (Wang, 2016). Residents can use plants to give modern homes a more organic and natural feel, which can be particularly appealing to people looking for a more sustainable and eco-friendly lifestyle.

In this regard, Ulrich et al. (1991), Shibata et al. (2001), Chang and Chen (2005), Yoo et al. (2006) and Bringslimak et al. (2007), it is suggested that indoor plants reduce the stress of individuals living in closed and stressful environments, have a restorative effect and increase productivity. Lee et al. (2015) noted in their study that plants used indoors help to create a calming and relaxing environment, which can be especially beneficial for people suffering from anxiety or depression. In addition, Giese et al. (1994), Wolverton and Wolverton (1996) and Yıldırım (2013) reported that indoor plants emit water vapor into the air by perspiration of their leaves, however, they carry organic chemicals in the air towards their roots and turn them into a source of nutrients and energy with the help of microorganisms there, through a system called metabolic degradation. It has been reported that plants with a larger leaf surface area absorb the chemicals in the air better and clean the polluted air, and the plants reduce the microorganisms (bacteria, fungi, protists, viruses, viroids, prions) spreading to the environment by 50-60%. In this respect, indoor plants are an important design element that directly affects the health and performance of people (Şevik et al., 2015). Therefore, it is essential determining people's knowledge levels living in large cities about the reparative effects of indoor plants on organic chemicals and to raise awareness on this issue.

In recent years, together with the many advantages (material with a rich color and pattern range, product variety, low cost and price, fast delivery, etc.) brought by fabricated production, the health of users may be adversely affected, albeit unintentionally, due to indoor pollutants emitted from furniture and decoration elements (Yıldırım and Ünlü, 2013). Carcinogens, mutagens, teratogens, viruses, bacteria, and allergies are the most common indoor pollutants. Indoor pollutants can cause serious problems for human health, are commonly encountered in three main forms; flammable (carbon dioxide, nitrogen dioxide, carbon monoxide, sulphur dioxide, etc.), volatile (formaldehyde, organochlores, phenolic compounds, etc.) and harmful gases (nitrogen, radon), particles (suspended particles, fungi, bacteria, viruses) and radiation (Pearson, 1989; Vural ve Balanlı, 2005; Yurtsever, 2007). The chemical emission sources of indoor pollutants identified by Wolverton and Wolverton (1993) are given in Table 1.

Sources of chemical emissions	Formaldehyde	Benzene	Xylene/ Toluene	Trichloro-ethylene	Alcohol	Ammoniac	Acetone
Interior Coatings	■	■	■	-	■	-	-
Particleboard and Fiberboard	■	■	■	-	■	-	-
Plywood	■	-	-	-	-	-	-
Adhesives	■	■	■	-	■	-	-
Paints and Varnishes	■	■	■	-	■	-	-
Joining Elements	■	■	■	-	■	-	-
Biological Substances	-	-	■	-	■	■	■
Carpets and Fabrics	■	-	-	-	■	-	-
Cosmetics	-	-	-	-	■	-	■
Printers and Printed Copiers	-	■	■	■	-	■	-
Tobacco Smoke	■	■	-	-	-	-	-

Table 1. Sources of chemical emissions of indoor pollutants

Table 1 demonstrates that organic chemicals such as Formaldehyde, Benzene, Xylene/Toluene, Trichloro-ethylene, Alcohol, Ammoniac, Acetone are present in artificial materials such as particleboard, fiberboard, plywood, synthetic fibers, plastics, paints and varnishes used in furniture and decoration elements. People exposed to air pollution caused by these chemicals; according to studies, it can cause severe structural damage to the human cells, as well as general symptoms (headache, dizziness, fatigue, nausea, difficulty concentrating), mucous membrane irritation (nose, throat, eye and skin irritation), skin reactions such as redness, difficulty in breathing and cancer (Pearson, 1989). Thiermeyer (1994) reported that volatile gases of organic chemicals released into the environment can cause serious harm to human health if they are inhaled for more than 8 hours a day. For this reason, the selection and use of materials used in furniture and decoration elements is of great importance in terms of human health. One of the most important benefits of indoor plants is their ability to purify the air. Studies have shown that some plants can remove harmful pollutants such as formaldehyde, benzene and trichloroethylene from the air (Meng and Ji, 2012; Zhang et al. 2020).

Given the information provided above, it is crucial that consumers have as much knowledge as possible about the substances that pose a hazard to human life. In this regard, it was revealed in the study by Yıldırım and Ünlü (2013) that a significant number of people lack enough knowledge of organic chemicals. According to a related study by Yıldırım et al. (2020b), parents are under-informed about the organic pollutants released by the nursery furnishings they purchase.

H1: Regarding how indoor plants affect organic compounds, men and women have different levels of knowledge.

H2: Regarding how indoor plants affect organic compounds, different age groups have different levels of knowledge.

H3: Regarding how indoor plants affect organic compounds, different educational groups have different levels of knowledge.

MATERIAL AND METHOD

Participants

Table 2 demonstrates general data on the gender, educational status, and age of the research participants.

Table 2. General information of the participants

Participants' Information		f	%	Total	
				N	%
Gender	Female	109	48,4	225	100
	Male	116	51,6		
Age	18-25	57	25,3	225	100
	26-35	53	23,6		
	36-45	63	28		
	46-55	35	15,6		
	56 and above	17	7,6		
Education	Secondary Education	42	18,7	225	100
	Associate	34	15,1		
	Undergraduate	106	47,1		
	Graduate	43	19,1		

f: Number of participants, %: Percentage value

According to Table 2, 48.4% of the participants were female, 51.6% were male, 25.3% were 18-25 years old, 23.6% were 26-35 years old, 28% were 36-45 years old, 15.6% were 46-55 years old, 7.6% were 56 years and over. In addition, 3.1% of the participants have primary education, 15.6% secondary education, 15.1% associate degree, 47.1% undergraduate and 19.1% graduate education.

Data Collection Tools

A total of 225 Ankara residents took part in this study. The research questionnaire, which was prepared to test the research hypotheses previously defined, consists of two parts. The first part includes general information of the participants, and the second part includes questions to measure the level of knowledge of the participants regarding the effects of plants grown in residences on indoor pollutants. In the design of the research questionnaire, questionnaires that were previously found reliable in studies conducted by Yıldırım and Ünlü (2013), Ünlü and Yıldırım (2015), Yıldırım (1999), Başkaya et al. (2005), Yıldırım and Akalın (2009), Erdogan et al. (2010) and Yıldırım et al. (2020b) were used.

The items of the questionnaire that were aimed to measure the knowledge levels of the participants about indoor plants were applied with the online survey form in a two-week period in April 2022. Each questionnaire was filled in about 20 minutes on the Google Forms interface. Before starting the survey, the participants were given introductory information about the research and then asked to evaluate the questions given respectively. The data obtained from the questionnaire were entered into the SPSS package programme and the necessary analyses were made.

Data Analysis

Participants' evaluations of indoor plants were defined as dependent variables, and participants' gender, age and education level were defined as independent variables. Firstly, Cronbach Alpha reliability tests of the research data were performed, then percentage, mean and standard deviation values of the data were calculated, and one-way analysis of variance (ANOVA) was performed to determine whether the differences between independent variables were

statistically significant at P<0.05 level. Independent variables were explained comparatively with graphs.

FINDINGS

The reliability tests of the data obtained from the questions aimed at measuring the level of knowledge of the participants about the effects of indoor plants on organic chemicals were carried out with Cronbach's Alpha. Accordingly, the reliability coefficient of the scale was calculated as 0.885. The reliability coefficients of the dependent variables and the scale are given in Table 3.

Table 3. Reliability analysis results

Dependent Variables		Dependent Variable Reliability	Scale Reliability
A1	I know that indoor plants have an air purifying effect.	0,902	0,885
A2	I know that indoor plants reduce the effect of harmful gases released from furniture and decoration elements.	0,846	
A3	I know that indoor plants reduce the carcinogenic effect of formaldehyde, which is used as glue and preservative in household products and building materials.	0,844	
A4	I know that indoor plants reduce the carcinogenic effect of radon gas released from building materials and elements containing soil, brick, natural stone.	0,848	
A5	I know that indoor plants reduce the harmful effects of pollutants such as carcinogens, mutagens, teratogens, viruses, bacteria and allergens that cause very serious problems for human health.	0,850	

The reliability coefficient of the main scale consisting of five questions is 0.885. When the alpha reliability coefficient is over 0.70, according to earlier studies by Cronbach (1951) and Panayides (2013), each dependent variable and scale can be regarded as reliable. It is seen that the reliability coefficient of all dependent variables of this study is above 0.70. This result shows that the data are reliable.

The differences between the knowledge levels of women and men about the effects of indoor plants on organic chemicals were analysed by statistical methods and the mean and standard deviation values of the data obtained and the results of ANOVA test are given in Table 4.

Table 4. Results on the effect of gender on dependent variables

Dependent Variables	Gender				ANOVA Test		
	Female		Male				
	Ma	SD	M	SD	F	df	Sig.
A1	2,28	0,86	2,37	1,05	0,416	1	0,520 is
A2	3,05	1,15	2,92	1,17	0,753	1	0,386 is
A3	3,47	1,24	3,31	1,22	0,975	1	0,325 is
A4	3,56	1,27	3,37	1,27	1,302	1	0,255 is
A5	3,13	1,15	3,04	1,22	0,344	1	0,558 is

Note: is: insignificant at p< 0.05 level.
M: Mean value, SD: Standard deviation, F: F Value, df: Degree of Freedom.
a: Variable averages are ranked from 1 to 5. 1: I know a lot, 5: I do not know at all.

Table 4 shows that there are differences between the evaluations of women and men regarding the effects of indoor plants on organic chemicals. According to the results of the ANOVA test, no statistically significant difference was found

between the evaluations of the participants according to their gender for all dependent variables at p<0.05 level. These results are given graphically in Figure 1.

Figure 1 shows that the evaluation results of women and men are close to each other, on the other hand, both genders have A2 (I know that indoor plants reduce the effect of harmful gases released from furniture and decoration elements), A3 (I know that indoor plants reduce the carcinogenic effect of formaldehyde used as glue and preservative in household products and building materials), A4 (I know that indoor plants reduce the carcinogenic effect of radon gas released from building materials and elements containing soil, brick, natural stone) and A5 (I know that indoor plants reduce the carcinogenic effect of radon gas released from building materials and elements containing soil, brick, natural stone); (I know that indoor plants reduce the carcinogenic effect of radon gas released from building materials and elements containing soil, brick, natural stone) and A5 (I know that indoor plants reduce the harmful effects of pollutants consisting of carcinogens, mutagens, teratogens, viruses, bacteria and allergens that cause very serious problems for human health).

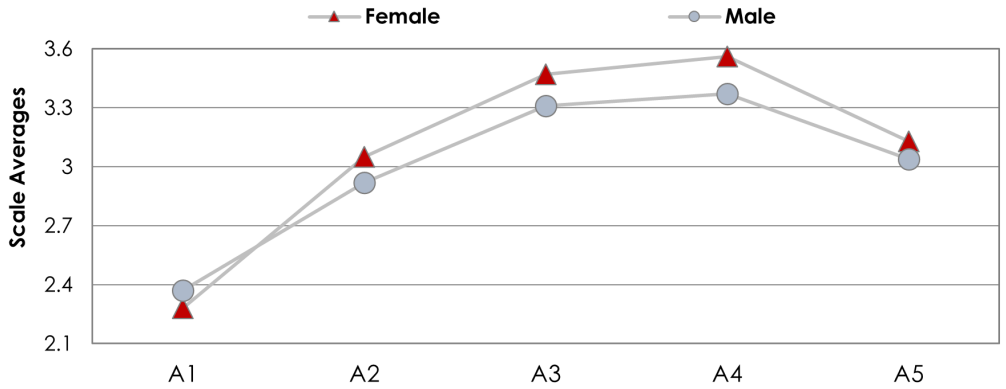


Figure 1. Results on the effect of age on dependent variables

Note: Variable averages are ranked from 1 to 5. 1: I know a lot, 5: I don't know at all

These results show that there is no significant difference between the knowledge levels of women and men about the effects of indoor plants on organic chemicals. According to these results, the hypothesis " Regarding how indoor plants affect organic compounds, men and women have different levels of knowledge." proposed in H1 is not supported in general.

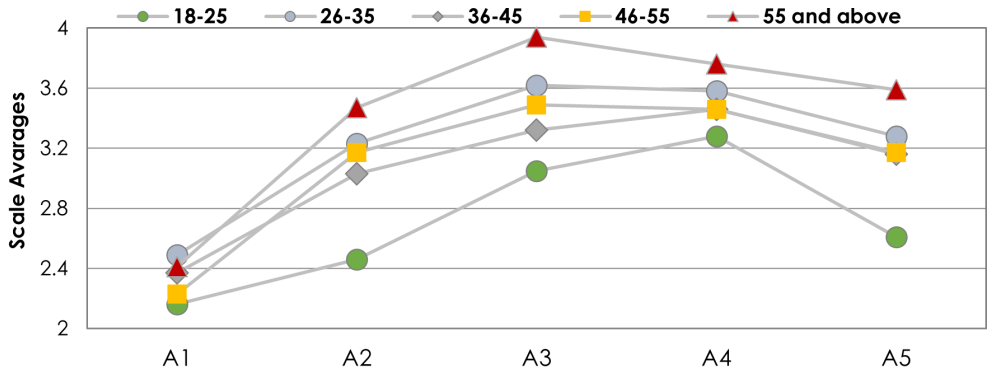
The differences between the knowledge levels of the participants of different age groups (18-25, 26-35, 36-45, 46-55, 55 and over) on the effects of indoor plants on organic chemicals were analysed by statistical methods and the mean and standard deviation values of the data obtained and the results of ANOVA test are given in Table 5.

Table 5. Results on the effect of education level on dependent variables

Dependent Variables	Age										ANOVA Test		
	18-25		26-35		36-45		46-55		56 ve üzeri				
	M[a]	SD	M	SD	M	SD	M	SD	M	SD	F	df	Sig.
A1	2,16	0,92	2,49	1,01	2,37	0,94	2,23	0,88	2,41	1,12	0,981	4	0,419is
A2	2,46	0,96	3,23	1,14	3,03	1,26	3,17	1,04	3,47	1,18	4,851	4	0,001*
A3	3,05	1,23	3,62	1,26	3,32	1,23	3,49	1,12	3,94	1,14	2,569	4	0,039*
A4	3,28	1,29	3,58	1,26	3,46	1,32	3,46	1,17	3,76	1,30	0,650	4	0,627is
A5	2,61	1,00	3,28	1,25	3,16	1,14	3,17	1,18	3,59	1,37	3,675	4	0,006*

Note: *: p < 0.05 is the level of significance. Is: Insignificant at p< 0.05 level.
M: Mean value, SD: Standard deviation, F: F Value, df: Degrees of Freedom.
a: Variable averages are ranked from 1 to 5. 1: I know a lot, 5: I do not know at all.

Table 5 shows that there are differences between the evaluations of the participants of different age groups regarding the effects of indoor plants on organic chemicals. According to the results of the ANOVA test, at the p<0.05 level, there are differences between the evaluations of the participants on A2 (I know that indoor plants reduce the effect of harmful gases released from furniture and decoration elements), A3 (I know that indoor plants reduce the carcinogenic effect of formaldehyde, which is used as glue and preservative in household products and building materials.) and A5 (I know that indoor plants reduce the harmful effects of pollutants consisting of carcinogens, mutagens, teratogens, viruses, bacteria and allergens that cause very serious problems for human health. However, no significant differences were found for the independent variables A1 and A4. These results are given graphically in Figure 2.



Note: Variable averages are ranked from 1 to 5. 1: I know a lot, 5: I don't know at all

Figure 2. The effect of age on dependent variables

Figure 2 demonstrates that the 18-25 age group participants have more knowledge about the effects of indoor plants on organic chemicals than the other age groups, and all age group participants do not have sufficient knowledge about the other variables except the dependent variable A1 (I know that indoor plants have an air purifying effect). These results show that there are significant differences between the knowledge levels of different age groups regarding the effects of indoor plants on organic chemicals. According to these results, the hypothesis proposed in H2, "Regarding how indoor plants affect organic compounds, different age groups have different levels of knowledge." was supported in general.

The differences between the knowledge levels of the participants of different education groups (Secondary Education, Associate Degree, Undergraduate, Graduate) on the effects of indoor plants on organic chemicals were analysed by statistical methods and the mean and standard deviation values of the data obtained and the results of ANOVA test are given in Table 6.

Dependent Variables	Education										ANOVA Test		
	Secondary Education		Associate Degree		Under-graduate		Graduate		Secondary Education				
	M[a]	SD	M	SD	M	SD	M	SD	M	SD	F	df	Sig.
A1	2,26	0,94	2,47	0,83	2,37	1,03	2,16	0,90	2,26	0,94	0,803	3	0,493[is]
A2	3,05	1,08	3,00	1,10	3,06	1,22	2,74	1,14	3,05	1,08	0,794	3	0,498[is]
A3	3,52	1,15	3,50	0,99	3,49	1,33	2,95	1,17	3,52	1,15	2,331	3	0,075**
A4	3,38	1,23	3,50	1,05	3,60	1,34	3,19	1,28	3,38	1,23	1,184	3	0,317[is]
A5	2,95	1,08	3,12	1,04	3,22	1,30	2,86	1,06	2,95	1,08	1,143	3	0,332[is]

Note: **: p < 0.10 is the level of significance. Is: Insignificant at p< 0.05 level.
M: Mean value, SD: Standard deviation, F: F Value, df: Degrees of Freedom.
a: Variable averages are ranked from 1 to 5. 1: I know a lot, 5: I do not know at all.

Table 6. Results on the effect of education level on dependent variables

In Table 6, it is seen that there are differences between the evaluations of the participants of different educational groups regarding the effects of indoor plants on organic chemicals. According to the results of the ANOVA test, a statistically significant difference was found for the dependent variable A3 (I know that indoor plants reduce the carcinogenic effect of formaldehyde, which is used as glue and preservative in household products and building materials) at p<0.10 level. However, no significant difference was found for the independent variables A1, A2, A4 and A5. These results are given graphically in Figure 3.

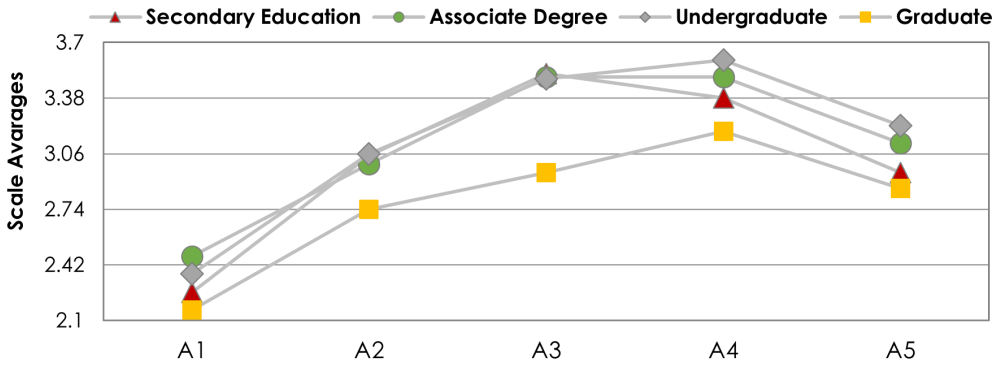


Figure 3. The effect of educational status on dependent variables

Note: Variable averages are ranked from 1 to 5. 1: I know a lot, 5: I don't know at all

The results in Figure 3 indicate the knowledge levels of the participants with postgraduate education are higher than the other education groups regarding the effects of indoor plants on organic chemicals, and all education group participants do not have sufficient knowledge about the other variables except the dependent variable A1 (I know that indoor plants have an air purifying effect). These results show that there are no significant differences between the knowledge levels of the participants regarding the effects of indoor plants on organic chemicals according to the educational groups. According to these results, the hypothesis proposed in H3 "Regarding how indoor plants affect organic compounds, different educational groups have different levels of knowledge." is not supported in general.

CONCLUSIONS AND SUGGESTIONS

In this study, the evaluations of the participants regarding the level of knowledge about the effects of indoor plants on organic chemicals were determined and the results obtained are given below respectively.

In the first result, it was determined that the evaluation results of women and men regarding the effects of indoor plants on organic chemicals were close to each other. However, A2 (I know that indoor plants reduce the effect of harmful gases released from furniture and decoration elements), A3 (I know that indoor plants reduce the carcinogenic effect of formaldehyde used in household products and building materials as glue and preservative), A4 (I know that indoor plants reduce the carcinogenic effect of formaldehyde used in household products and building materials as glue and preservative); (I know that indoor plants reduce the carcinogenic effect of radon gas released from building materials and elements containing soil, brick, natural stone) and A5 (I know that indoor plants reduce the harmful effects of pollutants consisting of carcinogens, mutagens, teratogens, viruses, bacteria and allergens that cause very serious problems for human health). These results show that there is no significant difference between the knowledge levels of women and men about plants. This result does not support the results previously published by Yıldırım and Ünlü (2013).

Another result demonstrated that there were some differences between the participant evaluations of different age groups regarding the effects of indoor plants on organic chemicals. Accordingly, among the evaluations of the participants, A2 (I know that indoor plants reduce the effect of harmful gases released from furniture and decoration elements), A3 (I know that indoor plants reduce the carcinogenic effect of formaldehyde used in household products and building materials as glue and preservative.) and A5 (I know that indoor plants reduce the harmful effects of pollutants consisting of carcinogens, mutagens, teratogens, viruses, bacteria and allergens that cause very serious problems for human health. These results show that there are significant differences between the knowledge levels of the participants of different age groups about plants. This result supports the results previously published by Yıldırım and Ünlü (2013).

Another finding was that the opinions of the participants in the various educational groups regarding the impact of indoor plants on organic compounds varied to some extent. Accordingly, it was found that participants with postgraduate education had higher levels of knowledge about plants compared to other educational groups, and all educational group participants had higher levels of knowledge about plants in all variables except the dependent variable coded A1 (I know that indoor plants have an air purifying effect).

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Conflict of Interest

No conflict of interest was declared by the authors.

Authors' Contributions

The authors contributed equally to the study.

Financial Disclosure

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Ethics Committee Approval

Ethics committee approval was not required for this article.

Legal Public/Private Permissions

In this research, the necessary permissions were obtained from the relevant participants.

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