Indoor plant toxicity concerns some consumers©

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Abstract

The addition of plants to an indoor environment provides many benefits; however, some of the most popular plant species purchased for interior use possess harmful qualities. Using conjoint analysis, this study assayed consumers' preferences for toxic attributes in indoor plants. Consumers demonstrated the highest interest in plants that were non-toxic to humans and pets, whereas consumers demonstrated the lowest interest in plants that were extremely toxic to humans and pets. Cluster analysis revealed two distinct segments of consumers characterized by their divergent responses to toxicity attributes.

INTRODUCTION

The addition of plants to an indoor environment whether to a home, school, or office brings real benefits. Some plant species remove major contaminants of indoor air (Kim et al., 2010). The presence of plants in an office setting has been associated with decreased tension and anxiety (Chang and Chen, 2005). In a classroom setting, students reported the presence of plants improved air quality, increased pleasantness, and improved performance (Khan et al., 2005).

Despite the advantages indoor plants bestow and their popularity in American households and businesses, many of these plants possess toxic features. These plants vary in their degree of toxicity, the species they affect, and their routes of exposure. For example, a number of *Spathiphyllum* and *Philodendron* species contain oxalate crystals which can cause contact dermatitis or, upon ingestion, irritation of mucous membranes in people and animals (Franceschi and Nakata, 2005). The Annual Report of the American Association of Poison Control Centers' National Poison Data System (AAPCC-NPDS) ranks plants in the top 25 substance categories that are most frequently involved in human exposure cases that result in serious outcomes (moderate, severe, or death) (Mowry et al., 2015, 2016). The 2014 and 2015 AAPCC-NPDS provide lists of the top 25 plants most frequently responsible for human exposures. These lists include a number of popular houseplants, including peace lily (*Spathiphyllum*), *Philodendron*, calla lily (*Zantedeschia aethiopica*), pothos (*Epipremnum aureum*), and poinsettia (*Euphorbia pulcherrima*) (Mowry et al., 2015, 2016).

Given the harmful nature of certain plants grown for indoor use, we wanted to investigate whether toxic characteristics affect consumer preference for indoor plants. Two studies investigated the effect of plant toxicity on consumer interest. Solano (2012) included toxicity as a binary attribute (toxic or not toxic) in choice-based conjoint analysis surveys, along with a number of other houseplant features. While toxicity overall had a negative effect on consumer willingness to pay (WTP), WTP increased when toxicity was presented with other attributes such as the ability to remove indoor air pollutants. Rihn et al. (2015) surveyed 91 individuals from central Florida on barriers to purchasing indoor foliage plants. Given the option to "check all that apply", 17% of participants indicated toxicity to pets was a barrier to purchase, while 3% indicated toxicity to kids was a barrier. Though the two studies provide useful baseline information about consumer preference for indoor plants with toxic qualities, their evaluation and scope are limited. New insights into consumer preference can be gained by investigating preference for a range of toxicities (mild to extreme), as well as for toxicity that affects only humans or only pets. Additionally, the small size and localized nature of the study sample in Rihn et al. (2015) constrains the generalization of their results to a wider population. Assaying toxicity preferences in a

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larger, non-localized sample would generate consumer preference data more representative of the broader population and could yield novel results. A detailed evaluation of toxicity attributes would lead to a more thorough understanding of consumers' preferences for them, which could improve how growers and retailers market plants with these features.

The objective of this study was to investigate toxicity attributes in-depth and gain greater insight into their effect on consumer interest. Specifically, we utilized modified conjoint analysis to assess consumers' preferences for indoor plants with a range of toxic attributes.

MATERIALS AND METHODS

To evaluate consumers' interest in houseplants with toxic attributes, modified conjoint analysis was implemented using IdeaMap® (Mind Genomics Advisors, Inc., Saratoga Springs, New York), a software tool which allows for the rapid assay of consumer interest in products composed of various combinations of distinct attributes (Gofman and Moskowitz, 2007). Consumers indicate their interest in each combination of attributes using a 9-point scale. Regression analysis relates the independent variables (the product features) to the dependent variable (consumer interest). The effect of a single independent variable is isolated from a group of independent variables presented together. We chose five categories for toxic houseplants and their purchasing environment and generated seven concise descriptions, or elements, for each category (Figure 1). We also composed a welcome screen, one rating question, 14 demographic questions, and a "thank you" screen. The University of Florida Institutional Review Board (IRB) approved this study as exempt (IRB201600642).

Study participants were recruited from across the US by a contracted company, Panel Direct Online (Focus Forward, LLC, New York, New York). We screened for participants that purchased a houseplant in the past five years. Following the welcome screen, the participant was presented with 50 randomized element combinations, or "concepts". Each concept contained between three and four elements and each element appeared the same number of times (Moskowitz et al., 2006). The participant rated each concept on a 9-point Likert-style scale, with 1 indicating the lowest interest and 9 indicating the highest. After rating all 50 concepts, the participant answered 14 demographic questions. A total of 321 individuals completed this study.

The data were transformed and analyzed in the same manner as characterized extensively in previous work (Gofman and Moskowitz, 2007; Moskowitz et al., 2006; Dewar et al., 2016; Moskowitz, 2012). Regression modeling, executed by the software tool, connected the participant's rating to the presence or absence of every element in the concepts (Gofman and Moskowitz, 2007; Moskowitz et al., 2006). The independent variables (the elements) were related to the dependent variables (the ratings) and each element was given a numerical value. This value was calculated using the following equation, which was generated for each respondent: Rating = k0 + k1 (element A1) + k2 (element A2) +…+ k35 (element E7); k0 denotes the additive or baseline constant, and k1 to k35 denote the coefficients that describe the interest values (InVs) of elements 1 to 35, respectively. The additive constant provides a baseline level of interest that the participant has in houseplants alone without the input of the other elements. The InV of each feature reveals the conditional probability of that element driving consumer interest, and is compared to the additive constant to determine the incremental or detrimental effect of that element on consumer liking (Dewar et al., 2016). An InV of ≥3 suggests that consumer interest is favorably increased by that product feature. InVs between -2 and 2 indicate the element is neutral and does not influence consumer interest. A feature that receives an InV of ≤-3 indicates a negative impact on consumer interest, and should be avoided by retailers. Additionally, k-cluster analysis, executed by the software tool, was used to find segments of consumers within the study population that were similar in their preferences.

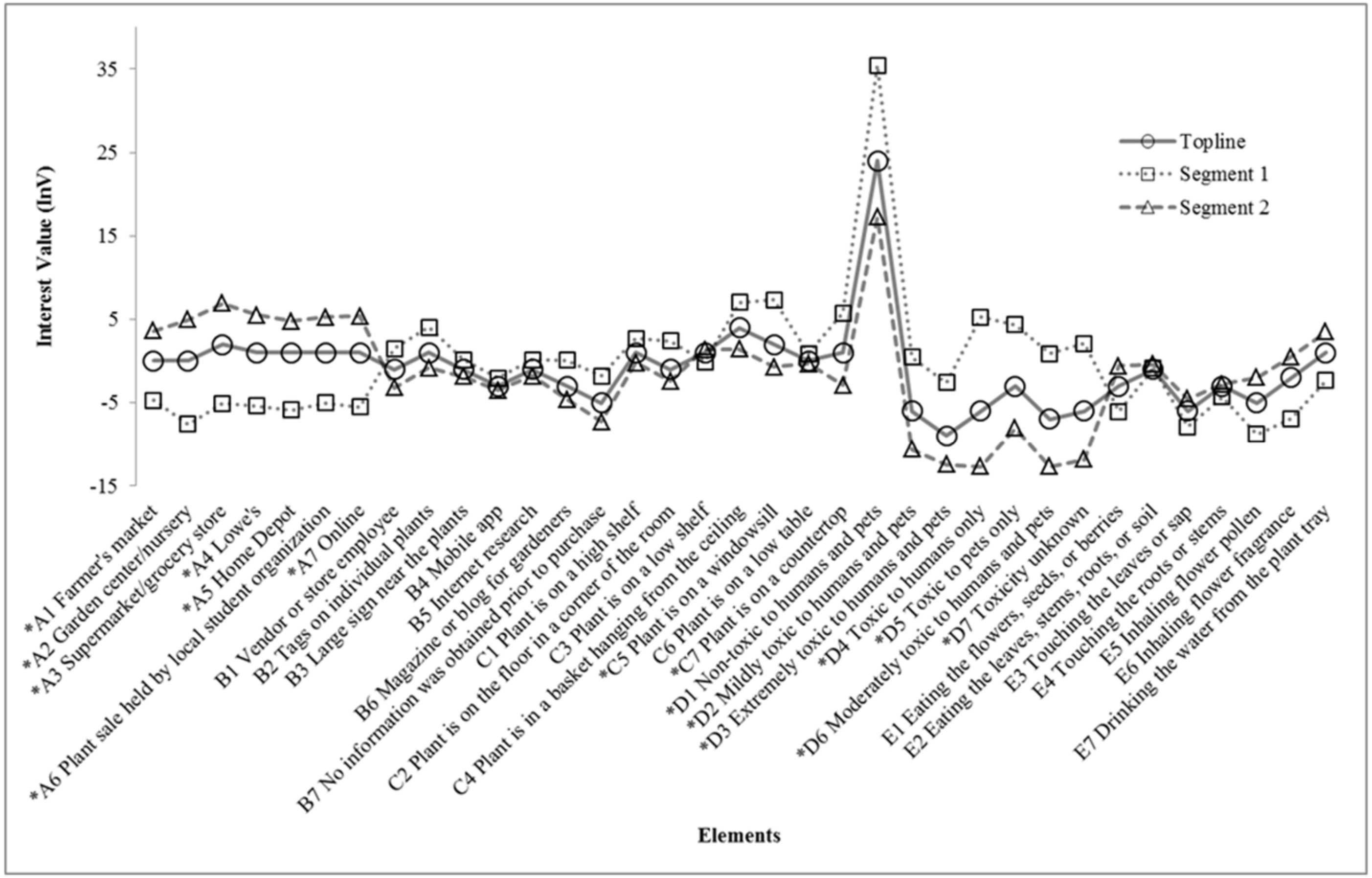

Figure 1. Interest values (InVs) of elements A1 – E7 are provided for the total study and for each segment. The InVs are relative to the baseline constant of each group: 36 for the total study population, 34 for Segment 1, and 37 for Segment 2. An asterisk (*) preceding an element along the x-axis indicates a significant difference ($P<0.05$), identified with a Student's t test, between the InVs of the two segments for that element.

RESULTS

Plants that were "non-toxic to humans and pets" received the highest InV (Figure 1). Many of the elements pertaining to purchase location and the location of the plant in the home were broadly neutral. Fourteen elements received an InV of -3 or lower, indicating a negative effect on consumer interest. The majority of these elements pertained to the degree of toxicity and the route of exposure.

Two segments of consumers were identified as a result of k-cluster analysis (Figure 1). The two segments had similar levels of interest in houseplants with constants of 34 and 37 for the first and second segments, respectively. Segment 1 was characterized by positive interest in several plant locations in the home, plants that were toxic to either only humans or pets, and tags on individual plants. The other elements from the toxicity category were either neutral or only slightly negative. Toxic attributes strongly and negatively affected consumer interest in Segment 2.

DISCUSSION

The purpose of evaluating a range of toxicity attributes was to determine whether consumer preference changed depending on the level of toxicity or specificity. From a topline perspective, consumers most preferred plants that are non-toxic to humans and pets, while every other attribute describing toxicity, including mild, had a negative effect on consumer interest. These results show that, for the study population as a whole, toxicity level or specificity did not alter consumer preference. These results support the findings of Solano that toxicity overall negatively impacted consumer willingness to pay (Solano, 2012). The strong negative response to various toxic attributes contrasts somewhat with the findings of Rihn et al. (2015) that toxicity was considered only a minor barrier to purchasing indoor plants by a small portion of their study population. While our results indicate toxic attributes negatively affect overall consumer interest, ultimately those attributes might not prevent someone from purchasing a plant. Indeed, while not the largest, the market is sizeable for foliage and flowering plants sold for indoor or patio use. The 2014 Census of Horticultural Specialties lists the combined yearly value of all sales of potted foliage and flowering plants for indoor or patio use at $1,806,163,000 (USDA, 2015). The census includes poinsettia, daffodil (*Narcissus*), philodendron, pothos (*Epipremnum*), and peace lily (*Spathiphyllum*) in their list of the top selling plants for indoor or patio use (USDA, 2015). Incidentally, all of the aforementioned plants appear on the AAPCC-NPDS list of plants most frequently responsible for human exposure cases with serious outcomes (Mowry et al., 2015, 2016).

The relatively strong sales of these plants could indicate multiple things. Perhaps some consumers are aware of the toxic attributes possessed by these plants, but do not consider that toxicity a barrier to purchase. The results from the cluster analysis support this idea. Cluster analysis identified two distinct market segments most prominently characterized by their divergent response to toxicity attributes. Simply put, one group of consumers strongly dislikes toxicity while the other group of consumers is not too concerned about it. Another explanation for the strong sales could be that some consumers are unaware of the toxic attributes these plants possess. Retailers are not required to provide such information. If toxicity information is not provided at the point of purchase, then it falls upon the consumer to do their own research, which they may or may not do.

While the results of this study indicate that consumers prefer plants that are non-toxic to humans and pets, advertising a plant as non-toxic could be risky. If an individual buys a plant marketed as "non-toxic" but then has an unexpected, serious allergic reaction to it, the seller of that plant could be liable. On the other hand, labeling a plant as toxic could adversely affect sales. Moreover, if retailers started labeling toxic plants, where would the labeling begin and end? Without an industry-wide standard for what should be labeled toxic, deciding whether to label or how is at the discretion of the retailer. Ultimately, if retailers of indoor plants are aware of the segmented nature of consumer preference for toxicity attributes, they can determine how best to apply that information in how they market plants to their consumers.

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