This is to certify that the

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Environmental Constraints on Marketing, Production, and Postharvest Shelf Life of Edible Flowers

presented by

Kathleen M. Kelley

has been accepted towards fulfillment of the requirements for

Ph.D. degree in Horticulture and Botany and Plant Pathology

[signature]
Major professor

Date 11-29-00

ENVIRONMENTAL CONSTRAINTS ON MARKETING, PRODUCTION AND POSTHARVEST SHELF LIFE OF EDIBLE FLOWERS

By

Kathleen M. Kelley

A DISSERTATION

Submitted to
Michigan State University
in partial fulfillment of the requirements
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Departments of Horticulture and
Botany and Plant Pathology

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ABSTRACT

ENVIRONMENTAL CONSTRAINTS ON MARKETING, PRODUCTION, AND POSTHARVEST SHELF LIFE OF EDIBLE FLOWERS

By

Kathleen M. Kelley

Experiments were conducted to develop marketing, production, and postharvest storage recommendations for edible flowers. Chefs and consumer participants rated edible flowers based on characteristics such as fragrance, taste, and visual characteristics. Chefs were more likely to rate the attributes and uses of the flowers lower than consumers, with the exception of *Tropaeolum majus* L. 'Jewel Mix'. Consumer participants also evaluated edible-flower color and color combinations, container size, and price. A second group rated all characteristics except price. Flower color was allocated the most points in the purchasing decision (63% for the first group and 95% for the second), with the mixtures of all three colors (blue, yellow, and orange) being the most desirable. To determine the level of flower quality consumers would accept, two groups of participants were shown photographic slides of the flowers with visual quality ratings on a scale of (1-5, 5 being flawless). Both groups awarded identical visual quality ratings for all species except *Borago officinalis* which varied with ratings of 5 to 3 or 5 to 4. Eight species were grown for 12 to 18 weeks in a certifiable organic (30% mineral soil) potting medium and fertilized with two organic fertilizers at 300 or 600 ppm N every two weeks. Growth and nutrient content were compared to plants grown with the same mineral soil or a soilless medium fertilized with a synthetic

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water soluble fertilizer at 300 ppm. Shoot dry weight and tissue P concentrations were generally higher with a 6 N-2.6 P -5 K organic fertilizer (Omega 6-6-6) than with the 5 N-0.4 P-0.8 K fish emulsion fertilizer or the 19 N-1.8 P-19 K complete water soluble fertilizer. Shoot tissue N, K, Ca, Mg and micronutrients were in the sufficiency range. Root media pH and EC were in the acceptable range except for the 600 ppm rate of the Omega 6-6-6. The organic fertilizers were not more acidic than the water soluble. Three of five edible flowers received ratings of 5 when stored at 0 to 2.5 °C after two weeks, with *B. officinalis* flowers still marketable, 3 or higher, after two weeks at -2.5 °C. *Phaseolus coccineus* L. flowers were marketable at 0 to 10 °C, after one week, but unmarketable after 10 d at 0 and 2.5 °C, 9 d at 5 °C, and 7 d at 10 °C.

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ACKNOWLEDGMENTS

I would like to thank my committee members for the help and encouragement they have given me for the last three years. Each has made a contribution to my program to make me a better student, researcher, and thinker. I would like to thank my major professors, Drs. John A. Biernbaum and Kenneth L. Poff for the opportunity to be involved in a project that has been exciting every step of the way and one that I feel has a real purpose to add knowledge not only to the scientific community, but to help small farmers practice sustainability with a niche crop.

I would like to thank Drs. Bridget K. Behe and Richard R. Harwood for introducing me to subjects that have interested me and that I have developed a deep passion for: Marketing, CSAs/local food production, and food security. I would like to thank Dr. Arthur C. Cameron for teaching how to write a paper for a scientific audience.

To Jerry, my best friend and husband, thank you for all your help, love, and assurance. My parents Martin and Ellen Boisvert, in-laws Charles and Carol Kelley, and brother and sister-in-law Prescott and Seon Hee Boisvert, have always given me their support and love and have taken an interest in my research. My good friends Bridget Behe and Beth Fausey have made me laugh and helped me enjoy my time as a Ph.D. student. I would also like to thank my friends and fellow grad students at MSU: Jill Hardy, Elizabeth Moore, Emily Clough, Marcus Duck, Mary-Slade Morrison, Hyeon-Hye Kim, Meredith Phares, Susan Baldyga, Lindsey Henige, Erin Nausieda, Jim Heilig, Cathy Whitman, Eric Runkle and others who I have failed to mention.

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DISSERTATION PREFACE

This research project, conducted during the years of 1997-2000 began with a goal to serve the community of the Moapa Band of Paiute Indians who reside in Southeast Nevada. The tribe owns three greenhouses, covering approximately 15,000 square feet, which were used during the 1970's for tomato production. Tomato varieties were grown in bag culture in the glass, Dutch Venlo style greenhouses. During the mid 1970's, a series of hail storms destroyed the glazing and halted production. Over the next 20-30 years, vandals further damaged the structure and removed materials that could be sold off the reservation.

For 10 years, the greenhouses had created a source of income for the reservation. With the damage to the greenhouse and surrounding properties the tribal community lost a valuable source of income. As a result, many of the younger generation left the reservation for opportunities of higher wages and the potential for a better quality of life.

Dr. Ken Poff, a professor in the Department of Botany and Plant Pathology at Michigan State University, is interested in minority student affairs and is actively recruiting minority students with an interest in science for Michigan State. Ken began to talk with tribal elders and the tribal leader about potential opportunities for their members. After touring the greenhouses, surrounding outbuildings, and landscape, Ken talked with Dr. John Biernbaum, a Professor in Horticulture with greenhouse crop production and interest in Native American culture.

Ken and John decided to pursue the possibility of finding funding to repair the damage to the greenhouse, for labor, and for a graduate student to conduct research at Michigan State University in the areas of marketing, production, and postharvest shelf life of a viable crop that coul

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could lead to a sustainable operation. The venture would need to be both economically and environmentally sustainable. Cultural sustainability was also considered since a major importance to the Paiute Indians is their relationship to plants, however, this was not a component of the research. It would need to employ members for the community, provide income for the community and if practical would produce crops that were important to their culture. The most apparent market identified was hotels and resorts in the Las Vegas casino area. Crops that were considered were culinary herbs, edible flowers, medicinal herbs, and leafy greens.

Kathleen Kelley interviewed with both professors and was chosen as the graduate student for this research and to pursue her Ph. D. with Drs. Biernbaum and Poff as co-advisors. Degree certification is joint with Horticulture and Botany and Plant Pathology. Work began during the fall of 1997 with a literature review for the project. No published articles were found in the refereed journals on either the marketing, production, or postharvest shelf life of edible flowers. A few relevant articles were found in farm or greenhouse trade magazines. Faculty from the Departments of Horticulture and Crop and Soil Science were recruited for the Ph.D. committee. Members included: Dr. Bridget Behe, Associate professor in Horticulture with an expertise in marketing; Dr. Richard Harwood, Professor and C.S. Mott Chair of Sustainable Agriculture; and Dr. Art Cameron, Professor of Horticulture who conducts postharvest research. All committee members felt that the research was viable and preliminary greenhouse studies began in late fall of 1997. A list of objectives was developed which included:

1. Identify appropriate crops
    a. Identify and contact experts in the area and solicit information regarding best crops for first stages of the project.

    b. Grow a variety of crops and evaluate feasibility for inclusion in future studies.

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2. Crop scheduling and flowering
    a. Identifying appropriate production stages and times such as propagation, growth, length of harvest time.
    b. Flowering requirement and methods to induce flowering.
    c. Regrowth potential and time for crops suitable for sequential harvesting.
3. Production Methods- Production Facility Arrangements for Maximizing Production Efficiency
    a. Use of ground beds and predominately mineral soils versus containers of predominately soilless media (peat, bark, and coir).
    b. Combination of container production and ground beds to maximize space utilization and scheduling.
    c. Types of containers, pots, bags, baskets, and columns.
4. Nutrient Management Strategies
    a. Comparison of plant growth and product quality using water-soluble fertilizer versus compost, organic matter, and slowly soluble minerals accepted in organic production.
    b. Identification and comparison of various sources of organic matter, compost, and slowly soluble minerals as nutrient sources.
5. Pest and Disease Control

    Facilities most likely will not allow replicated trials. Plant production for research if production methods and nutrient management will provide opportunities were pest and disease control will be essential. Predators and biological control agents used in greenhouses are readily available and will be used on an as needed basis.
6. Packaging
    a. Defining the effect of storage parameters (temperature and humidity) on longevity and quality of edible flowers and culinary herbs.
    b. Investigate the use of specialized films for maintaining quality.
7. Marketing
    a. Consider consumer perceptions and possible constraints.
    b. Develop consumer education information.
    c. Investigate potential marketing or brokering channels.

The objectives were refined as the research progressed. Objectives two through five would fulfil the requirement for environmental sustainability, while objective seven would be required for economically sustainability. The objectives for crop scheduling and flowering were completed, however, they will be presented in nonscientific papers after the dissertation is completed. The use of ground beds and comparison of types of containers, outline in objective three, were not evaluated because it became obvious that many strategies would be feasible once cultura

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cultural methods and growth characteristics for each species were identified. Several varieties of lettuce were planted and grown with organic fertilizers in ground beds in a minimally-heated polyhouse at the Michigan State Horticulture Teaching Research Center. This lettuce research was not conducted for the dissertation. David Cappert, Research Associate for the Department of Entomology, assisted with pest control and has written a final report on methods and beneficials used and the outcomes. The final written report may be used as a basis for future funding opportunities. Packaging evolved to postharvest experiments which concentrated on the visual quality of five flowers exposed to -2.5 to 20°C for two weeks.

The marketing efforts began with focusing on both professional chefs and other consumers. After conducting survey experiments with professional chefs, the researchers found that the rate of surveys returned was quite low. The researchers then decided to focus efforts on consumers who were involved with Master Gardeners, Garden Days (an annual event held by the Department of Horticulture), and Bloomfest (an annual flower show held at the Cobo Center in Detroit, Mich.), since the rate of survey return and completion were near 100%.

Efforts for the focus of the research also shifted from completely serving the Moapa Band of Piaute Indians to serving all small farmers who wanted to grow edible flowers, herbs or other food crops. Communication with the Tribal Council is still occurring. However, they have not fully supported the idea of growing edible flowers in their greenhouse to be sold to hotels and resorts in Las Vegas.

During the fall of 1997, a list of 100 species of edible flowers, compiled from edible-flower cookbooks and web sites, was created for consideration for the researchers to consider for the marketing, production, and postharvest shelf life experiments. From that list, 28 species of culinary herbs and annuals and perennials, with flowers that were edible, were grown in the Plant Science Research Greenhouses on campus during fall 1997 and spring and summer 1998. Species were chosen based on recommendations found in cookbooks and by individuals who grew edible flowers or had tasted them previously.

During the first year (97-98) flowers were evaluated by the researchers for taste, visual appearance, and marketing potential. Many species were started from seeds and were evaluated based on ease of propagation, time to germination, visible bud, first color, beginning of flowering, full flower, and senescence. Media consisting of coconut coir and soilless medium were used as growing material with water-soluble fertilizers and fish emulsion supplying nutrients. The researchers also sampled flowers that were grown in gardens during the summer of 1998 for these same characteristics. A final list was developed for 1998/1999 greenhouse research which included 12 species, including the following annuals and perennials:

Species	Annual (A) or Perennial (P)
Agastache foeniculum Pursh (Anise hyssop)	P
Althea officinalis L. (Marsh Mallow)	P
Begonia × *tuberhybrida* 'Ornament Pink' Voss (Tuber begonia)	A
Borago officinalis L. (Borage)	A
Coriandrum sativum L. (Coriander)	A
Dianthus superbus L. 'Super Fantasy Mixed' (Dianthus)	P
Ocimum basilicum L. 'Siam Queen' (Basil)	A
Origanum vulgare L. (Oregano)	P
Phaseolus coccineus L. 'Dwarf Bees' (Scarlet Runner Bean)	A

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Tropaeolum majus 'Jewel Mix' L. (Nasturtium)	A
Viola tricolor L.'Helen Mount' (Viola)	A
V. × *wittrockiana* L. 'Accord Banner Clear Mixture' (Pansy)	A

Selected plants were used in various experiments presented in this dissertation. Several additional species were evaluated in 1999-2000 including: *Allium schoenoprasum* L. (chives), *A. tuberosum* L. (garlic chives), *Hemerocallis* spp. L. (daylily), *Rosmarinus officinalis* L. (rosemary), *Salvia elegans* Vahl. (pineapple sage), and *S. officinalis* L. (garden sage).

The species were grown using conventional or certifiable organic fertilizers and media. Organic production was chosen since food grown using this method can sometimes command higher prices. We also found evidence that no pesticides have been registered for use on edible flowers. Finally, organic production was considered to be more sustainable and desirable since amendments were renewable. To be compliant with the certification committees in Michigan, pest control methods were employed that were established by the California Certified Organic Farmers Association (Michigan Certifying Committees follow these rules). Beneficial insects and biorational sprays were used to control whitefly, thrip, aphid, spidermite, and mealy bud populations. Data taken included the root medium pH and EC for each species fertilized with the various organic and conventional fertilizers. At the conclusion of the experiment, fresh and dry weights were taken, percent dry weight data were calculated, and ground plant samples were sent to an independent lab for nutrient analysis.

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During the experiment, flowers were harvested for tastings held during Garden Days, and at the Detroit Athletic Club with members of the Michigan Chef de Cuisine. Surveys were also conducted at Bloomfest, and at Garden Days and Master Gardener Conferences to determine consumer preferences of edible-flower color, container size, price, and quality.

Flowers were also harvested for postharvest shelflife studies. Flowers were packaged and placed in -2.5 to 20° control chambers and evaluated daily for visual quality. Rather than emphasizing research comparing packaging films, efforts focused on traditional identification of potential storage temperature and product longevity.

Five manuscripts, prepared for publication in referred journals, were selected for inclusion in this dissertation. The results from these experiments are presented in the following chapters of this Dissertation. Additional research completed is summarized in the conclusion of the dissertation. Chapter one includes three manuscripts containing the marketing experiments conducted with Drs. Bridget Behe, John Biernbaum, and Ken Poff. The first paper included in Chapter One is entitled "Consumer and Chef Perception of Three Edible-Flower Species." This paper was formatted and accepted for the journal HortScience. The second paper entitled "Consumer Preference of Edible-Flower Color, Container Size, and Price" was also accepted for publication in HortScience. A third paper "Consumer ratings of edible-flower quality, color, and mix" will be submitted to the Journal HortTech.

The second chapter contains a paper entitled "Organic Nutrient Management of Greenhouse Production of Edible Flowers in Containers" coauthored with Dr. John Biernbaum. This paper presents the results from one of the production experiments and will be submitted to the Journal of American Society of Horticultural Science.

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The third chapter describes the postharvest experiment and contains that paper coauthored by Drs. Art Cameron, John Biernbaum, and Ken Poff entitled "Postharvest shelflife of five edible flowers". This paper was formatted for the journal HortScience and will be submitted after the internal review is completed.

SECTION I

CONSUMER AND PROFESSIONAL CHEFS PERCEPTIONS OF THREE EDIBLE-FLOWER SPECIES

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Accepted for publication: May 16, 2000

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Consumer and Professional Chef Perceptions of Three Edible-Flower Species

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Marketing and Economics

Additional index words. Survey, economics, visual, taste, fragrance, *Viola tricolor*, *Borago officinalis*, *Tropaeolum majus*

Abstract. Two surveys were conducted to assess consumer and professional chefs' perceptions of three edible-flower species. Our objectives were to determine opinions, preferences, and uses of *Viola tricolor* L. 'Helen Mount' (viola), *Borago officinalis* L. (borage), and *Tropaeolum majus* L. 'Jewel Mix' (nasturtium). Flowers were grown using certifiable organic methods and chosen to reflect a variety of flower tastes, textures, and appearances. We quantified three attributes (taste, fragrance, and visual appeal) with a total of seven semantic, differential scales adapted from a scaling authority. The attributes were rated as: visual -- "appealing", "desirable," and "very interested in tasting"; fragrance -- "appealing" and "pleasant"; and taste -- "tasty" and "desirable". Garden Day participants were self-selected to evaluate and taste flowers from a consumer perspective. When asked to rate the three species on visual appeal and desire, no less than 76% of consumers awarded all flowers an acceptable rating. We found similar results when consumers answered questions regarding the taste of two of the three species. Results from this study support our hypothesis that customers would rate edible flower attributes highly and would be likely to purchase and serve the three species tested. Members of the Michigan Chefs de Cuisine Inc. Association participated in a similar survey. At least 66% of these chefs rated the three visual attributes and two fragrance attributes of viola and nasturtium acceptable. Chefs' ratings of the fragrance of borage as "appealing" and "pleasant" were higher than those of consumers, but the ratings were still low, 21% and 25%, respectively. Unlike consumers, chefs' ratings of the taste of viola as "appealing" and "desirable" were low (29% and 36%, respectively).

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We found some minor differences in ratings when groups were compared, using demographic variables as a basis for segmentation, indicating a homogenous marketing strategy may be employed.

Introduction

The popularity of edible flowers has increased since the late 1980s, as evidenced by upscale restaurants where edible flowers garnish meals. Such flowers are featured in popular articles, and are also the subjects of cookbooks (Barash, 1993; Belsinger, 1991; McVicar, 1997). The list of edible flowers is extensive, with over 55 known genera represented (Badertscher and Newman, 1996; Barash, 1993; Belsinger, 1991; McVicar, 1997). Flowers can be used in salads, to garnish soups and entrees, as ingredients in main dishes, sprinkled on desserts, frozen in ice cubes and floated in drinks (Barash, 1998a, b).

Not only do edible flowers add excitement to food presentations, they also have nutritional benefits. The vitamin content of viola on a weight basis is higher than that of oranges [*Citrus sinensis* (L.) Osbeck], and viola also has a higher concentration of beta-carotene (Kosztolnyik, 1996). Because most flowers are more than 95% water, the nutrient value does not appear to be significant. Flowers, however, are nearly calorie-free (Evans, 1993), a real advantage to health- and weight-conscious consumers. Visual, taste, and nutritional appeal enhance the potential marketability of edible flowers.

Consumers, including professional chefs, may find some edible flowers more appealing than others, and research can facilitate efforts to determine which edible flowers deserve further investigation. With better consumer information, growers, wholesalers, and retailers can selectively target consumer groups with more effective marketing strategies. Consumer information is lacking, althou

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although a few articles include suggestions as to which flowers are edible and indicate that growers are producing flowers for both restaurants and consumers (Evans, 1993; Greenhouse Business, 1998; Whitman, 1991).

As edible flowers become more popular, defining the preferences of consumers and chefs will become more important to producers and marketers. Our objectives were to: a.) determine which characteristics appeal to consumers and chefs, and b) how similar the preferences of these two groups are, which may dictate separate or similar marketing strategies. Edible flowers can be grown using certified organic methods. Since production method is a consideration for the grower and retailer, we also wanted to determine if production method had an effect on edible flower desirability by chefs and/or consumers.

Material and Methods

General. Flowers of viola, borage, and nasturtium were grown in a greenhouse at a constant 20 °C, in Strong-Lite Universal Mix (Strong-Lite, Pinebluff, Ark.), and fertilized every other week with fish emulsion (400 $mg{\cdot}L^{-1}$, 4N-0.4P-0.8K; Northeast Organics, Manchester-by-the Sea, Mass.), MSU special (500 $mg{\cdot}L^{-1}$, 19N-1.8P-19K; Greencare, Chicago, Ill.), or dried blood (12N-0P-0K; Dragon Corporation, Roanoke, Va.). Plants were not treated with pesticides. Commercially raised predators and parasites, including *Aphidius colemani* Viereck (aphid parasite), *Hypoaspis miles* (Berlese) (fungus gnat predatory mite) and *Amblyseius cucumeris* (Oudemans) (thrips predatory mite), were released in the greenhouse to help control aphid and mite populations. Flowers were harvested the mornings of the surveys and stored in a 5 °C cooler several hours until needed. They were rinsed with distilled water 2 h before the tasting to remove any visible debris. Rinsed flowers were placed in labeled, 50-mL paper cups. Order oftas

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of tasting was randomized among participants. One nasturtium (910 mg), three borage (290 mg each), or three viola flowers (80 mg each) were used per cup.

Two surveys were administered, one of consumers who were attending a state-wide annual event, the second of chefs at a monthly professional chef's association meeting in a large metropolitan area. A 43-item consumer-directed questionnaire and a 38-item chef-directed questionnaire were developed to assess perceptions of visual, taste, and fragrance attributes of three edible-flower species. The survey instruments consisted of either twelve preference items for each of the three species plus either seven (consumer-directed) or five (professional chef-directed) demographic questions . We selected three questions for visual evaluation and two questions for fragrance evaluation and adapted two questions for taste from an authority on measurement scales for various product attributes (Bruner and Hensel, 1996). We quantified the attributes with a total of seven, seven-point, semantic differential scales in the reference. We asked both groups of participants if, from a visual perspective, the flowers were "appealing," and "desirable" and if the participants were "very interested in tasting" the flowers after seeing them; if, after smelling the flowers, participants found them "appealing" and "pleasant";and if the participants, after tasting the flowers considered them to be "tasty" and "desirable". We also asked how likely consumers were to grow or to purchase a particular species and how likely they would be to use them in entrees. Professional chefs were asked if they were more likely to purchase the flower if it were grown using certified organic methods, whether they would purchase the flower if it had 10% insect damage, and if they would identify and describe the flavor and fragrance of the flower using their own words. Demographic questions for consumers included age, gender, education, family status, household size and income. Professional chefs were asked questions includ

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including gender, meals served each week, price of least expensive entree, years as a chef, and if they were certified. The order in which participants evaluated the three species was randomized. Results were tested for significance using logistic regression and chi-square with Fisher's exact test (SAS Institute Inc., 1998). The experiment was approved by the Institutional Review Board for Protection of Human Subjects at Michigan State University prior to implementation.

Consumer-directed survey. Forty-one participants were self-selected from 287 registrants who attended Garden Days at Michigan State University on 7 August 1998. During this popular annual event, participants who are highly involved in gardening pay a fee to attend a variety of activities, such as garden walks and seminars on flower paper making, and herb use and production. Minors (under age 18), pregnant women, and those with severe food allergies were self-excluded from our study. Volunteers reflected a diverse sample, including, but not limited to, college students, employed persons, retirees, athletes, and gardeners. When participants entered the room, and after they signed a waiver, they were given three cups, each containing a flower species and a survey form. The survey took approximately 20 min to complete.

Participants ranged in age from 19 to 72 years, 66% were female, and 55% had graduated from college; 72% of the participants had a 1997 household income that ranged from $20,000 to $79,999. Fifty-three percent of the participants had no dependents, and 41% had more than two people in their household. Participants were asked to identify themselves by zip code. Of the 37 who responded, 46% lived within 32 km, the remainder from 33 to 258 km from the survey site.

Participant responses using the seven-point Likert scale were divided into three categories: not acceptable (composite of responses rated either 1, 2, or 3); neutral (response of 4); and acceptable (composite response of either 5, 6, or 7). We assumed that if at least 30% of the resp

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responses for any item were acceptable, a substantial market segment was pleased with that flower attribute.

Professional chef-directed survey. Twenty-six member-chefs of the Michigan Chef de Cuisine Inc. Association participated in a survey at the Detroit Athletic Club in Detroit, Mich., on 8 March 1999. Pregnant or potentially allergic members were self-excluded from the study. The chefs signed a waiver, and were given three cups, each containing a flower species and a survey form. These participants took less than 20 min per person to complete the survey. Chefs who participated in the survey answered demographic questions. Six of the chefs were women, 20 were men. About half of them served 500 or fewer meals each week. The highest number of meals that a chef reported serving in 1 week was 35,000. Half the chefs that participated also served entrees that cost $8 or less, were certified chefs, and had been chefs for 11 years or more; five had been chefs for 20 years. Of those who were certified, six were Certified Executive Chefs. Chefs rated the flower attributes on the same 1-7 scale that consumers used. Their responses were also divided into the same three categories: Not acceptable, neutral, and acceptable.

Results and Discussion

Consumer-directed survey. For all three species, at least 74% of participants rated visual characteristics (appeal, desire, and interest in tasting) acceptable (Table 1). Participants rated visual appeal and desirability of viola higher than those of borage or nasturtium.

The majority of consumer-participants rated all three species acceptable for both taste attributes. For viola and borage, ratings for taste appeal and desire were lower than ratings for visual characteristics. Of all three species, nasturtium was rated highest for appealing taste (80%), but le

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but lowest for interest in tasting after visual examination (74%), visual desire (76%), and visual appeal (74%).

Few participants (8%) rated the fragrance of borage as pleasing. A much higher percentage rated viola (68%) and nasturtium (54%) as having acceptable fragrance. Verbal comments indicated that participants either did not detect or did not approve of the odor of the borage flower. More responses for borage were neutral (80% and 81% for an appealing fragrance and pleasing fragrance, respectively), than acceptable. Thus, borage fragrance may not be a germane issue.

Each species was also evaluated for potential use. At least 68% of participants rated viola acceptable for use as a garnish or in a salad, and 85% would purchase it if available. Similar responses were observed for nasturtium, but only 25% of participants would use it in a salad. Borage received ratings of at least 48% for potential uses, with 65% of the participants finding it acceptable for serving to guests.

We investigated differences in mean ratings by gender, education (college graduate or not), income (household income ≤ $40,000), marital status, and household size (Table 2). The mean ratings of the higher income (≥ $40,000) group were consistently higher on 14 items across the three species tested. They had a higher mean perception of the visual desirability of viola, and were more likely to purchase this flower. They rated borage higher than the other two species in visual appeal, interest in tasting, pleasant fragrance, desirable to taste, use as a garnish and in a salad, and purchasing and serving. They were also more interested in tasting the nasturtium flower, found that it had a pleasant fragrance and desirable taste, and were more likely to use it in a salad.

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Married participants rated 15 items consistently higher than did single participants; these included visual desire of viola, visual appeal of borage, interest in tasting borage, use of borage in a salad, and purchase of borage, as well as nearly all attributes of nasturtium.

We divided participants into two age groups at the median age: 43 years. Participants who were 43 or older rated both fragrance and both taste characteristics of viola higher than did the younger age group. They also rated all of the usage attributes for all species, except for the use of viola as a garnish and in a salad, and purchase of the flower, higher than did their younger counterparts. Aside from the appealing and pleasing fragrance of borage and its appealing taste, the older participants rated all of the other visual, fragrance, and taste attributes of borage and nasturtium lower than did younger participants.

Across all three species tested, we saw only three differences were apparent in mean preference by gender. Males rated the visual appeal of nasturtium lower than did females and indicated that they were less likely to use it as a garnish and grow it.

We found only one difference in mean preference rating when comparing college graduates with non-graduates. College graduates rated use of nasturtium as a garnish higher (5.2) than did non-college graduates (4.0).

Mean preferences of small households (one person) vs. larger households (two persons) differed in only two cases. Respondents from one-person households rated both pleasant and appealing fragrance of viola higher.

Income and marital status were the two variables for which we found greatest differences, and these would be useful in a segmentation scenario. Age, gender, education level, and number of pe

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of people in the household showed few differences and these variables would not be a good basis for segmenting the market for edible flowers.

Professional chef-directed survey. At least 72% of the chefs rated the visual characteristics of viola and nasturtium (appeal, desire, and interest in tasting) as acceptable (Table 1). Nasturtium had the highest rating (96%) for visual appeal, but the lowest (72%) for interest in tasting. Borage did not receive a rating higher than 54% for any of the three characteristics.

Nasturtium received the highest ratings for appealing (87%) and pleasing fragrance (79%). In contrast with the results from consumer participants, viola received the second highest ratings in both categories, 66% and 76%. Although chefs rated borage higher in both categories, 21% and 25%, than did consumer participants, in both categories borage received the lowest ratings among the three species.

For the chef's fragrance ratings, nasturtium received a 72% rating for appealing taste and a 74% rating for desirable taste, and the highest ratings in both taste categories. Unlike consumer participants, the chefs rated viola's appealing taste (29%) and desirable taste (36%) lower than borage's (63% and 48%, respectively).

When chefs were asked whether they were likely to use the three species in a salad, 65% reported that they would use nasturtium, 42% that they would use viola, and 40% that they would use borage. In contrast, consumers rated viola highest, followed by borage and nasturtium. While chefs were more likely to purchase nasturtium (64%), consumer participants were more likely to purchase viola (85%). Only 39% of the chefs gave viola an acceptable rating.

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When chefs were asked if they were more likely to purchase the flower because it was grown organically, the acceptable ratings increased from 39 to 54% for viola and from 38 to 46% for borage. The acceptable rating for nasturtium decreased by 2%.

When chefs were asked if they would purchase the three flowers if they had 10% insect damage, only 8% gave viola an acceptable rating. When asked whether they would purchase a borage flower or a nasturtium flower with 10% damage, only 4% of the chefs, in both instances, indicated that they would.

In order to determine differences in mean ratings for viola, borage, and nasturtium, we divided chefs into groups based on gender, average number of meals served weekly, meal cost, professional certification, and years of experience. Ratings varied little with gender, with the exception of appealing fragrance (3.5 for females vs 5.4 for males) (Table 3). Mean ratings for borage characteristics were similar except for desirable taste, which females rated higher (5.5 vs 3.8). Males were more likely to purchase nasturtium (5.3 vs 3.0).

We found no differences in ratings between professional chefs who served more vs. less than 900 meals per week.

Chefs employed by restaurants where the least expensive entree cost $8 or less were more inclined to purchase viola if grown organically than were those working at restaurants where entrees were more expensive (5.4 vs 3.4). Mean ratings were similar for chefs in both categories for all attributes. We found three differences in mean ratings for nasturtium. Chefs at less expensive restaurants gave higher ratings to visual desirability (6.2 vs 4.6) and interest in tasting (6.3 vs 3.3), and were more likely to purchase if plants were grown organically (6.1 vs 4.7) (Table 3).

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Years of employment did not affect ratings for attributes of viola, but several attributes of borage were rated lower by chefs who had worked for 11 or more years (Table 3).

Certification had little effect on ratings for viola and borage, but non-certified chefs rated fragrance of nasturtium both more appealing (5.6 vs 4.9) and pleasing (5.6 vs 5.0) than did certified chefs (Table 3). Across all five of these comparisons, chefs were more similar in their evaluations than were consumers.

Chefs were also asked to describe the fragrance and taste of the flowers, and how they used them. If they did not use them, they were asked if they intended to use them in the future. If the answer was positive, they were also asked how many days they would use them, and how much they would pay for a dozen (data not shown). Most of those who responded described viola as having a floral to perfume scent. Chefs were not able to describe the fragrance of borage, which corresponds with the low acceptance ratings. Chefs described the fragrance of nasturtium as having a floral, perfumed, sweet, spicy, or fruit-like scent. The tastes of viola and borage ranged from undetectable to bland, "vegetable," or, in the case of borage, sweet or clam-like. Most chefs described nasturtium's taste as peppery, and/or cabbage-radish-or citrus-like. Nearly all chefs said they would use all three species in a salad, but less than half would use the flowers as a garnish. Several chefs reported that they would use borage in seafood presentations, while one reported that he/she would use nasturtium in Asian presentations.

Fifteen percent of the chefs used viola in their presentations, eight used borage, and five used nasturtium. Forty-six percent of the chefs would consider using the flowers at least once a week, and the majority (58%) would use them two to three times a week. Prices that chefs were willing to pay for the flowers varied greatly. They were willing to pay $1.00 to $10.00 per dozen for v

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for viola, \$1.00 to \$5.00 for borage, and \$2.00 to \$15.00 for nasturtium. At least one chef reported that the restaurant grew edible flowers in the garden. Although actual use is low, the potential for increasing use of edible flowers among these chefs appears to be great.

Sample comparisons, consumer and professional chefs. We analyzed the mean ratings of both chefs and consumer participants to determine if the two groups had similar opinions about the edible flower species. For the visual and fragrance attributes of viola, consumers and chefs expressed similar perceptions (Table 4). However, consumers liked the taste better and were more likely to purchase and use viola than were chefs. Consumers liked borage better than did chefs, except for fragrance. In contrast, three nasturtium attributes were rated higher by chefs. Few mean ratings for nasturtium were significantly different between the two groups, with the exception of visual appeal, appealing fragrance, and purchase of the flower. Similarities in ratings may indicate that no separate marketing strategy is warranted. Consumers and chefs appear to have similar preferences about attributes for nasturtium, but this is less true for viola and borage.

There was a significant correlation between the decision to purchase and flower taste for both participant groups. The relationship between taste and purchase for viola was stronger for chefs ($r=0.51$) than for consumers ($r=0.13$). For borage, these correlations were higher (chefs $r=0.71$, consumers $r=0.64$), but, for nasturtium they were similar (chefs $r=0.78$ and consumers $r=0.60$). This indicates that consumer ratings for "tasty" flowers are strongly related to their willingness to purchase the flower.

Conclusions

Most of the participants found nasturtium and viola visually acceptable, while more than half found borage visually acceptable. Viola and nasturtium had an acceptable fragrance rating from

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from more than half of all participants. The acceptability of flower taste varied for consumers vs. professional chefs. At least a portion of both groups liked the taste and would appear to be potential target markets for edible flowers. The species tested appear to have moderate to high market potential, suggesting that a new niche market exists for growers and retailers. We saw many similarities between consumers and chefs in their perceptions of edible flowers.

Given these ratings, we believe that there is adequate reason to further investigate market potential of these flowers. In future studies to determine consumer preferences, determining the effect fragrance has on taste, or on consumers' choice to buy an edible flower product, may be possible. However, packaging could eliminate this as a factor in the decision to buy.

When analyzing the use characteristic data, one important factor is whether the participant would consider purchasing the flower if it were available. Whether a person will buy a product has a profound effect on whether the product will be available in the long term. The fact that at least 58% of the participants reported that they would buy the flowers, if available, supports the hypothesis that more consumers would purchase them if they were readily available. Another consumer segment may choose to grow their own edible flowers. In this study, at least 48% indicated that they would be likely to grow them. These results indicate that grocery stores or specialty food stores may be ready for product and price trials. This may be a more effective variable for market segmentation.

Chefs indicated they would be more likely to purchase viola and borage if grown organically, suggesting that chefs are not only concerned about serving attractive, fragrant, and palatable flowers, but also prefer flowers that have been grown organically. Nevertheless, few would accept flowers that had 10% insect damage. These two responses pose a challenge to producers. Chefs would prefer to purchase organically grown flowers, but would not buy them if they were flawed. Research can help marketers close the gap between an expectation of no tolerance for blemishes and efficacy of pest control methods acceptable in organic production. Flowers grown using certified organic methods may incur more insect damage since pesticides cannot be used for rapid control of outbreaks. Researchers may need to provide information indicating how growers can produce edible flowers with minimal insect damage.

Other areas should be investigated as well. These questions include: the effect of the visual and fragrance characteristics on the decision to purchase, how much will customers pay for edible flowers, how many flowers customers will purchase, and what effect color intensity has on the decision to purchase.

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Table 1. Consumer and professional chef ratings of attributes of three species of edible flowers. Percentage of responses with a composite acceptable rating (5, 6, or 7).

	Ratings of species by consumers				Ratings of species by professional chefs		
Attribute	Viola	Borage	Nasturtium	Attribute	Viola	Borage	Nasturtium
Visual				*Visual*			
Appealing	98 b[z]	82 a	78 a	Appealing	92 b[z]	54 a	96 b
Desirable	97 b	81 a	76 a	Desirable	87 b	50 a	92 b
Interested in tasting	90 a	81 a	74 a	Interested in tasting	86 b	46 a	72 b
Fragrance				*Fragrance*			
Appealing	65 b	8 a	55 b	Appealing	66 b	21 a	87 b
Pleasing	71 b	8 a	54 b	Pleasing	76 b	25 a	79 b
Taste				*Taste*			
Appealing	68 a	67 a	80 a	Appealing	29 a	63 ab	72 b
Desirable	68 a	57 a	64 a	Desirable	36 a	48 ab	74 b
Use				*Use*			
Garnish	73 b	50 a	55 ab	Salad	42 a	40 a	65 a
Salad	68 b	48 ab	25 a	Would purchase this flower	39 a	38 a	64 b
Would purchase this flower	85 b	62 a	58 a	Would purchase because organic	54 a	46 a	62 a
Would grow myself	70 b	55 a	48 a	Would purchase with10% insect damage	8 a	4 a	4 a
Would serve to others	80 b	65 a	58 a				

[z]Mean separation within rows and groups surveyed (consumer and professional chef) by logistic regression, $P \leq 0.05$.

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Table 2. Effects of income, marital status and age of respondents, gender, level of education, and number of people in the household on mean rating of consumers' acceptability of viola, borage, and nasturtium based on visual, fragrance, taste, and usage attributes.

		Income		Status		Age (years)		Gender		Education		No. of persons in the household	
Species	Attribute	<$39K	≥$40K	Single	Married	≤42	≥43	Female	Male	Not a college/ tech.grad	College/ tech. grad	≤1	≥2
Viola	Visual appealing	6.1	6.9	6.3	6.8	6.8	6.4	6.8	6.4	6.6	6.7	6.7	6.5
	Visual desire	5.9	6.6*	6.2	6.5*	6.6	6.2	6.4	6.4	6.2	6.5	6.3	6.4
	Interest in tasting	5.8	6.3	5.6	6.5	6.4	5.8	6.0	6.5	6.3	6.0	6.1	6.1
	Appealing fragrance	5.2	5.5	5.5	5.3	5.4	5.4	5.6	5.1	5.4	5.4	5.6	5.1*
	Pleasing fragrance	5.3	5.7	5.7	5.5	5.6	5.6	5.7	5.4	5.5	5.7	5.8	5.3*
	Appealing taste	4.7	4.8	4.9	4.8	4.5	5.2	4.9	4.8	4.9	4.8	4.9	4.8
	Desirable taste	4.5	4.7	4.9	4.6	4.7	4.7	4.7	4.6	4.8	4.6	5.0	4.3
	Use as a garnish	5.2	5.1	5.5	5.0	4.9	5.4	5.3	4.8	5.3	5.0	4.9	5.6
	Use in a salad	4.7	4.9	4.9	4.8	4.7	4.9	5.0	4.5	5.1	4.6	4.5	5.3
	Grow this flower	4.6	5.0	5.5	6.0	5.8	5.8	6.0	5.5	5.9	5.7	5.7	6.0
	Purchase this flower	5.6	6.0*	4.9	5.1	5.2	4.9	4.8	5.5	4.9	5.2	4.7	5.5
	Serve to others	5.1	5.8	5.5	5.5	5.6	5.4	5.4	5.6	5.4	5.6	5.3	5.8
Borage	Visual appealing	5.0	6.1*	5.1	6.2*	6.4	5.0	5.8	5.5	6.1	5.4	5.8	5.7
	Visual desire	4.7	5.6	4.8	5.7	5.8	4.9	5.7	4.8	5.6	5.2	5.4	5.4

Table 2 (cont'd).

	Interest in tasting	4.7	6.0*	4.9	6.1	6.1	4.8	5.6	5.1	5.5	5.4	5.4	5.4
	Appealing fragrance	3.5	4.0	3.7	3.9	3.7	3.9	4.0	3.6	3.9	3.8	4.1	3.5
	Pleasing fragrance	3.8	3.9*	3.9	3.7	3.7	3.9	4.1	3.3	3.8	3.9	4.0	3.7
	Appealing taste	4.9	4.9	4.3	4.8	4.5	4.7	4.6	4.7	4.6	4.6	4.5	4.8
	Desirable taste	3.5	4.9*	3.7	4.8	4.3	4.3	4.5	4.0	4.4	4.2	4.2	4.4
	Uses as a garnish	3.0	4.6*	3.5	4.6	4.3	4.1	4.3	3.9	4.6	3.8	3.9	4.5
	Use in a salad	3.2	4.6*	3.5	4.5*	4.3	4.0	4.2	4.0	4.6	3.7	4.0	4.4
	Grow this flower	4.2	5.2	4.3	5.1	5.2	4.5	4.9	4.6	4.9	4.7	4.9	4.8
	Purchase this flower	4.2	5.3*	4.3	5.3*	4.6	4.1	4.5	4.7	4.5	4.2	41	4.6
	Serve to others	3.5	5.1*	3.9	5.0	4.8	4.3	4.5	4.8	4.7	4.5	4.4	4.8
Nasturtium	Visual appeal	5.1	5.8	4.8	6.1*	6.1	5.2	6.1	4.6*	5.9	5.4	5.4	5.9
	Visual desire	4.8	6.0	4.8	6.2*	6.3	5.1	6.0	5.1	5.9	5.5	5.6	5.7
	Interest in tasting	4.4	6.1 *	4.4	6.3*	6.1	4.3*	5.7	5.4	5.6	5.5	5.5	5.6
	Appealing fragrance	4.4	5.3	4.9	5.1	5.5	4.5	5.1	4.8	5.1	5.0	5.2	4.8
	Pleasing fragrance	4.2	5.2 *	4.6	5.1*	5.4	4.4	4.9	4.9	5.1	4.8	5.0	4.8
	Appealing taste	4.7	5.5	4.2	5.8*	6.2	4.3*	5.4	5.2	5.1	5.5	5.2	5.5

Table 2 (cont'd).

Desirable taste	3.4	5.3 *	3.6	5.4*	6.1	3.0*	4.8	4.5	4.6	4.8	4.7	4.6
Uses as a garnish	3.8	4.8	3.5	5.2*	5.2	3.8*	4.9	3.9*	5.2	4.0*	4.2	5.0
Use in a salad	2.5	4.6 *	2.7	4.8*	4.8	3.1*	4.1	3.7	4.4	3.6	3.6	4.4
Grow this flower	3.8	5.0	3.8	5.3*	5.5	3.9	4.4	4.1*	5.1	4.3	4.6	4.8
Purchase this flower	3.1	4.5	3.8	5.3*	5.4	3.9*	4.1	4.1	4.5	3.9	3.7	4.8
Serve to others	3.5	5.0	3.5	5.4*	5.7	3.5*	4.2	4.2	4.8	4.4	4.5	4.8

*Mean differences of attributes within categories (income, etc.) significant at $P \leq 0.10$ based on Fisher's Exact Test (2-tail probability).

of least expensive entree, years as a chef, and certification of respondents on mean ratings of

Table 3. Effect of gender, number of meals served each week, price of least expensive entree, years as a chef, and certification of respondents on mean ratings of chefs' acceptability of viola, borage, and nasturtium based on visual, fragrance, taste, and usage attributes.

		Gender		No. of meals served each week		Price of least expensive entree		Years as a chef		Certification	
Species	Attribute	Female	Male	≤500	≥900	≤$8	≥$11	≤10	≥11	Yes	No
Viola	Visual appealing	5.2	6.1	6.5	6.2	6.8	5.9	5.5	6.5	5.8	6.1
	Visual desire	4.8	5.4	5.6	6.1	6.7	4.7	5.2	5.8	5.6	5.3
	Interest in tasting	4.7	4.6	4.0	5.8	4.9	5.0	4.8	4.7	5.2	4.8
	Appealing fragrance	3.5	5.4	4.5	5.9	4.6	6.0	4.0	5.8	4.7	5.0
	Pleasing fragrance	3.5	4.9	3.6	6.0	4.1	5.4	4.2	5.0	4.8	4.8
	Appealing taste	2.3	3.8	3.2	3.9	3.0	4.7	3.3	3.6	3.2	3.9
	Desirable taste	2.5	3.9	2.9	4.3	3.3	4.0	3.7	3.8	3.7	3.9
	Purchase this flower	4.0	3.1	2.6	3.9	2.9	3.6	3.7	3.5	2.6	4.3
	Use in a salad	3.8	4.2	4.2	4.6	4.7	3.7	4.2	4.2	3.9	4.6
	More likely to purchase if grown organically	4.2	4.3	4.3	4.9	5.4	3.4*	4.5	4.2	3.9	4.7
	Purchase with 10% insect damage	2.0	1.8	1.7	1.7	1.7	1.6	2.2	1.6	1.9	1.8
Borage	Visual appealing	5.8	4.3	4.2	5.0	4.8	4.1	6.2	3.3*	4.5	4.8
	Visual desire	5.0	4.0	3.8	4.8	4.2	3.9	5.7	4.3*	4.1	4.8
	Interest in tasting	4.5	3.7	4.0	4.0	4.0	4.0	4.8	3.5	3.8	4.1
	Appealing fragrance	3.2	3.6	3.2	3.9	3.3	2.7	4.1	2.7*	3.8	3.9
	Pleasing fragrance	3.2	3.9	3.5	4.1	3.6	3.3	4.2	3.1*	3.4	3.9
	Appealing taste	4.8	3.8	3.7	3.8	3.7	2.6	5.0	3.2*	3.8	4.4
	Desirable taste	5.5	3.8	4.3	4.1	4.7	3.0	5.4	3.6*	4.2	4.8
	Purchase this flower	3.8	3.4	2.8	3.9	2.4	3.4	3.6	3.6	3.1	4.2
	Use in a salad	3.7	3.6	3.2	3.7	3.1	2.9	4.2	3.4	3.4	4.0

Table 3 (Cont'd).

	More likely to purchase if grown organically	3.0	3.9	3.5	4.0	3.1	3.1	4.2	3.6	3.1	4.6
	Purchase with 10% insect damage	1.8	1.9	1.7	1.8	1.7	1.6	2.2	1.6	1.7	2.0
Nasturtium	Visual appealing	6.5	6.2	6.4	5.8	6.6	5.9	6.2	6.2	6.2	6.4
	Visual desire	5.8	5.4	6.2	5.3	6.2	4.6*	6.0	5.6	6.0	5.6
	Interest in tasting	4.5	4.8	5.4	4.8	6.3	3.3*	5.2	5.1	5.6	4.5
	Appealing fragrance	4.7	5.3	4.6	5.9	4.7	5.4	4.9	5.9	4.9	5.6*
	Pleasing fragrance	4.8	5.0	4.7	5.9	4.9	5.7	4.7	6.1	5.0	5.6*
	Appealing taste	4.3	5.5	6.0	5.0	5.4	5.4	5.2	5.8	5.3	5.4
	Pleasing fragrance	3.7	5.2	5.6	5.0	4.9	5.9	4.9	5.2	4.4	5.4
	Purchase this flower	3.0	5.3	5.3	4.5	5.0	4.9	4.2	5.6	4.6	4.9
	Use in a salad	4.8	5.4	6.0	4.7	5.7	5.0	5.1	5.6*	5.4	4.9
	More likely to purchase if grown organically	4.8	5.2	5.7	5.1	6.1	4.7*	5.1	5.1	4.8	5.1
	Purchase with 10% insect damage	1.5	2.1	2.1	1.7	2.1	1.7	1.9	1.6	2.0	1.9

*Mean differences of attributes within categories (gender, number of meals served each week, etc.) significant at $P \leq 0.10$ based on Fisher's Exact Test (2-tail probability).

Table 4. Mean rating of chef vs. consumer acceptability of three species of edible flowers based on visual, fragrance, taste, and usage attributes.

	Viola		Borage		Nasturtium	
Attribute	Chef	Consumer	Chef	Consumer	Chef	Consumer
Visual appealing	6.1	6.7	4.7	5.8*	6.2	5.7*
Visual desire	6.0	6.4	4.5	5.6*	5.9	5.6
Interest in tasting	5.5	6.1	4.2	5.5*	5.6	5.5
Appealing fragrance	5.3	5.4	3.8	3.9*	5.8	5.0*
Pleasing fragrance	5.6	5.5	4.0	3.9*	5.8	4.9
Appealing taste	3.8	4.8*	4.3	4.6	5.4	5.4
Desirable taste	4.2	4.7*	4.7	4.5	5.5	4.7
Use in a salad	4.1	4.8*	3.7	4.0*	5.2	4.0
Purchase this flower	3.7	5.0*	3.8	4.3	5.0	4.2*

*Mean differences of attributes within categories (chef vs. consumer) significant at $P \leq 0.10$ based on Fisher's Exact Test (2-tail probability).

SECTION II

CONSUMER PREFERENCE FOR EDIBLE-FLOWER COLOR, CONTAINER SIZE, AND PRICE

HORTSCIENCE
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Consumer Preference for Edible-Flower Color, Container Size, and Price

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Abstract. Two surveys were conducted to determine characteristics important in containerized edible flowers that could be sold in retail outlets. Self-selected participants at Bloomfest at Cobo Hall, Detroit, Mich., were assigned to one group that rated the importance of attributes such as color of pansy (*Viola* ×*wittrockiana* Gams. 'Accord Banner Clear Mixture'), color combinations, container size, and price. Participants assigned to a second group rated color, color combinations, and container size. Flower color was allocated the most points in the purchasing decision (63% for the first group and 95% for the second), with a mixture of all three colors (blue, yellow, and orange) being the most desirable. Responses were subjected to Cluster Analysis (SPSS Inc., Chicago, Ill.), which resulted in the formation of three distinct groups. The groups were labeled "Likely Buyer" (those who had eaten and purchased edible flowers before and rated characteristics of edible flowers favorably); "Unlikely Consumer" (those who had eaten edible flowers before and had rated characteristics of edible flowers unfavorably); and "Persuadable Garnishers" (those who had not eaten edible flowers before, but were very likely to purchase edible flowers for a meal's garnish).

Introduction

Edible flowers can be used to add color, fragrance, and flavor to food such as salads, soups, entrees, desserts, and drinks (Barash, 1998a, b). Since the late 1980s, there has been a resurgence in the popularity of edible flowers used by chefs and people entertaining at home. Consumers have been exposed to an increasing number of edible-flower cookbooks, culinary magazine articles, and television segments (Rusnak, 1999). Potential consumers who do not have the space, patience, or time to grow edible flowers can purchase them.

Small, rigid, plastic packages of edible flowers are now available in some retail stores in the United States. Discussions with produce managers have revealed that many of these packages are not sold before the expiration date. Reasons for this may include flower color, species assortment, package size, price, package design, or some other attributes. If unfavorable opinions predominate, marketing efforts can improve an item's appearance, taste, or portion size, or replace it with a more desirable one. Although edible flowers are not one of the top sellers in the produce department, a greater number of baby boomers are using them in entertaining (Rusnak, 1999).

To promote sales, retailers must educate customers about the uses of edible flowers and their ability to enhance food at holiday dinners and other special occasions (Rusnak, 1999). Successful marketing and advertising techniques used to promote sales of culinary herbs can also be used for edible flowers. Rusnak (1999) reported that consumers who purchase fresh herbs are likely to purchase edible flowers. Signage, point-of-purchase material, and storage-condition or recipe information included in the package can draw consumers' attention and attempt to inform them (Moore, 1998).

Marketers also need to understand potential consumers' needs and concentrate on characteristics that should be included in the final product (Food Product Development, 1979). Conjoint analysis is a tool that helps researchers determine the importance of various factors that affect the consumers' in the purchase decision (Behe et al., 1999; Gineo, 1990; Hardy et al., 2000; Price et al, 1980; Robertson and Chatfield, 1982; Shafer and Kelly, 1986; Townsley-Brascamp et al., 1995). Marketers are interested in understanding the components of the edible-flower package and determining changes that should be made to encourage other marketing segments to purchase the product. To date, no data are available regarding consumers' preferences for edible flowers' color, package size, and price. The objective of this analysis was to address this deficiency.

Materials and Methods

Two surveys were conducted at Bloomfest at the Cobo Hall Center in Detroit on 9 and 10 April 1999. Detroit was chosen as a survey cite based on articles that defined the Detroit metropolitan area as a suitable test market (Waldrop, 1992). Bloomfest, a highly advertized event, allows garden enthusiasts to view the offerings of garden center exhibits, nonprofit booths, and various vendors. Participants pay a fee to enter the 4-day event. Participants who agreed to complete a survey were self-selected. Thus, this sample may be more reflective of a population that is more interested in gardening and flowers than is the general public.

A nonorthogonal design was developed by using OrthoPlan, a computer software program component of the SPSS software package (SPSS Inc., Version 8.0, Chicago, Ill). The survey was developed by using three single-color and four multicolor combinations of pansy (blue, yellow, orange, blue and yellow, blue and orange, and all three colors); two sizes (nine pansies per package; 8-oz. (227-g) container and 18 pansies per package; 16-oz. (454-g) container) of a clear, rigid, plastic container; and three prices, basing the first price on packages seen in the retail market by the researchers ($2.99). Doubling the $2.99 price would have created an increment that was between what retailers consider a psychological price barrier (Mason and Mayer, 1984), so it was reduced to the nearest perceived increment ($4.98) and doubled ($9.95). The three colors of pansies were chosen to best reflect contrasting, natural colors. The total number of possible container combinations (color x container size x price) was 42. An orthogonal arrangement was developed with Orthoplan (SPSS Inc.) by using 27 of the possible combinations to reduce participant fatigue while providing data for the complete orthogonal design. Equal weight was given to color, size, and price, and each color and color combination was featured.

Photographs of a single edible-flower package that measured 10.2 by 15.2 cm accurately and reliably portrayed the real objects (Daniel and Boster, 1976; Shafer and Richards, 1974). These were glued onto foam core board and placed in a random layout on four adjacent boards covered with black cloth. Each board measured 0.61 by 0.92 m and was placed on a metal easel on one of the 0.61 m sides. The four boards were placed on a 0.61 by 1.83 m table along the 1.83 m side. On the two outer boards, six photographs were arranged at equal intervals. On one of the two inner boards, seven photographs were arranged. Eight photographs were arranged on the other inner board.

A description of the number of flowers in the package and the price was affixed to a piece of foam core board 5.1 cm tall and 15.2 cm wide and placed under each of the photographs. On the upper right corner next to the photograph, black, vinyl, self-sticking letters from A to AA were placed on 3.8-by-3.8-cm pieces of foam core board. Each letter corresponded to an item on the survey. Small pieces of velcro on the back of each picture, description, and letter board secured the foam core board to the black cloth board.

Expt. I. The arrangement of the pictures on the board corresponded with a schematic that was placed on a two-page survey sheet. In each box of the schematic, a letter from A to AA corresponded to the letter next to the pictures on the board. The experiment was a 100-point exhaustion designed to determine which color or color combinations, price, and size the par

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participants would choose to purchase if shopping for a package of edible flowers to serve to family and friends. Participants were told to assign the 100 points to the containers of edible flowers, giving their favorite the most points, and to continue to assign points until all had been used. Participants did not need to assign points to all the containers, but just the ones they liked. Participants were asked 21 questions, including which edible flowers they had eaten, what their food shopping and gardening habits were, and their demographic status. Demographic questions included year of birth, gender, education level, income (using nine discrete $20,000 categories), family status, number of persons in the household, and zip code. Participants answered questions regarding purchasing edible flowers a.) to be used for garnishes and salads, b.) that were insect-damaged, and c. that were grown without pesticides. A semantic differential on a seven-point Likert scale (7 being the highest rating) was used.

Expt. II. Another arrangement of the pictures was used to ask participants who did not participate in Expt. I. about color, color combinations, and container size. A total of 14 pictures were randomly arranged on the black boards. A description of the package size was placed under the picture and a letter from A to N was placed to the upper right of the photograph. Eighty-six participants filled out the survey and a schematic that corresponded to the arrangement of pictures on the board was on the survey form. Participants who rated these photographs also used the 100-point exhaustion process and answered the 21 questions asked in Expt. 1. Participants' answers to both 100-point exhaustion surveys were analyzed with Conjoint Analyzer software (SPSS Inc); other questions were analyzed with a two-tailed t-test and the Kruskal-Wallis test.

Results

Expt. I. Participants who viewed and rated the 27 pictures of containers indicated that color was the most influential factor (63% of the decision) when deciding which package they would purchase (Table 1). Price was the next most important factor (24%), with container size having the least importance (13%). The utility for all factors (Table 1), indicates a preference that is more or less over an average or ideal. A negative utility for price indicates that participants valued the container less than an ideal or average because of its higher price. The container combinations of color, price, and size were ranked by points allocated by the participants. The nine-count container with all three colors and a price of $2.99 received the most points, with a mean of 13.1. The 18-count container with all three colors and a price of $4.98 received the next highest number, with a mean of 11.7, followed by the 18-count container with blue flowers and a price of $4.98, with a mean of 7.0.

Expt. II. Ratings made by participants who rated containers by color and package size alone were similar to those of the group that rated the containers on all three attributes. Again, color was the most important characteristic in the decision (95%) in choice of container (Table 1), whereas container size had little (5%). Again, the nine-count container with all three colors received the most points, with a mean of 18.2. The ranking of the second and third containers, however, differed from those chosen by the group that viewed all 27 photographs. The second highest number of points was assigned to the 18-count container with blue flowers, with a mean of 13.7, followed by the nine-count container with blue flowers.

To increase the sample size for segmentation analysis, the similarity of both groups was tested. Considering six demographic questions we decided to combine samples if there were no

differences on four of the six demographic questions (Behe et al., 1999). Kruskal-Wallis tests revealed that only gender distribution was significantly different, so samples were combined for a cluster analysis on common variables. Of the 224 participants, 146 had eaten them before, and 33 of them had purchased edible flowers before. The participants had eaten a total of 21 different species, including nasturtium (*Tropaeolum majus* L.) (eaten by 45% of participants), pansy (28%), and violets (*Viola tricolor* L.) (21%). A few of the participants reported that they had eaten flowers that are not recognized as being safe, which supports the current belief that consumers should be told what is edible and whit is not (Barash 1998a, b). Participants were asked how much they would pay for a nine-or 18-count container if they purchased it in a well-known grocery store. For a nine-count container, 3% would pay up to $10, with 27%, the highest percentage of participants, willing to pay $2.99. For the 18-count container, 2.9% of the participants would pay $15, with the greatest percentage of participants, 20%, willing to pay $5.00. These results are consistent with those of Expt. I.

Participants were asked about their purchasing habits. We hypothesized that if they were likely to purchase prepared salad mixes, they might purchase other packaged items or salad mixes with edible flowers as an ingredient. Edible flowers can add value to the product and increase the price that can be charged for the mix. Participants purchased an average of two salad mixes a month and were more likely to eat salad in the summer (91%), but were more likely to purchase separate salad ingredients (70%) than salad mixes (30%).

We asked the participants to answer questions about their gardening habits in a broad sense, including lawn care. They reported that they either did not garden (4.3%), or gardened between 1 and 9 (45%), 10 and 19 (30%), 20 and 45 (20.2%), or 54 h each week (0.5%). Of those who gardened, their gardening area averaged 16.3% vegetables, 51.6% lawn, and 40.7% flowers. Participants who are active gardeners and grow vegetables may be a marketing segment that could be targeted. If edible-flower consumers grow vegetables, they may grow edible flowers for consumption.

Pest management strategies may impact consumer preferences for edible flowers. The percentages of participants who were very likely to purchase edible flowers was 62% if they were grown pesticide free, 52% as a garnish for a meal, and 47% to eat in a salad. Only 14% were likely to purchase edible flowers if they had 10% insect damage, and 75% were very unlikely to purchase such flowers.

Cluster analysis (SPSS Inc.) was used to determine whether meaningful customer segmentations, based on participants' answers to several questions, could be created. These groups could then be targeted by producers or retailers. Variables were used for clustering based on attitudes about edible flowers. By using K-Means, clusters of size 2, 3, and 4 were examined by using six cluster algorithms. After examination of each cluster size, the three-cluster solution was selected to develop the customer market segments. Because of nonresponse of several participants to several questions, only answers from 175 of the 224 participants could be used to create the segments.

Of the three segments that were created, the one labeled "Likely Buyer" comprised 61% of the sample (Table 2). The "Likely Buyer" had eaten edible flowers before, but had not purchased them before taking part in the survey. "Likely Buyers" were likely to purchase edible flowers for use as a garnish and were very likely to use edible flowers in a salad; 80% were very likely to purchase edible flowers because they were grown pesticide free. They showed a significantly greater preference for pesticide-free products and were more willing to buy insect-damaged products than the other two segments.

"Likely Buyers" spent a mean number of 12 h in the garden each week, with 40% of their garden planted with flowers, 17% with vegetables, and 53% with lawn. This segment awarded the nine-count container of flowers with all three colors the highest mean number of points (18) which was significantly different from zero. When the demographics of the segments were analyzed, groups were similar with regard to education level, family size and status, income, and number of dependents. The group of "Likely Buyers" contained a greater percentage of males than did "Persuadable Garnishers."

The second segment, "Unlikely Consumer," contained 23% of the sample. They had eaten edible flowers before, yet had never purchased them. However, they were unlikely to purchase edible flowers for a garnish (93%) or a salad ingredient (73%). When compared with the combined responses of the other two segments, their response was significantly different for the question of purchasing edible flowers as a garnish.

"Unlikely Consumers" were people who were the least "very likely" to purchase edible flowers because they were grown pesticide-free (26%). This response was also significantly different from the combined responses of the other two segments. Only 3% of the respondents were very likely to purchase the flowers with 10% insect damage. This segment included individuals who would also pay the least amount of money for an 18-count container of edible flowers at a major grocery store chain. Other differences between the "Unlikely Consumer" segment and the other two were they spent the least time gardening each week (8 h), allocated the least garden space to flowers (37%), and assigned the least amount of points to the nine-count container of edible flowers with all three colors (10).

The third segment, "Persuadable Garnishers," comprised 17% of the sample. The participants in this segment had never tasted edible flowers but would be very likely to use them as a garnish. Forty-six percent of the "Persuadable Garnishers" segment would be very likely to purchase edible flowers because they were grown pesticide-free and, as with the "Unlikely Consumers,"only 3% would be very likely to purchase edible flowers with 10% insect damage. Participants in this segment were likely to pay the highest mean price for a nine-or 18-count container of edible flowers at a grocery store, ($4.20 and $7.42, respectively). This group had the highest percentage of females. "Persuadable Garnishers" purchased a mean number of three packages of salad mixes in a month vs. two for the other two segments.

Marketing implications

Results of this study suggest there are several approaches that edible-flower producers must use to effectively market the product. Eating food involves more than simply oral senses, flavor, and texture; it also involves color, appearance, and stimulation of the visual senses (Little, 1980). We eat first with our eyes and then our mouths. Food must be visually appealing if consumers are expected to eat it. Consumers are likely to reject food based on appearance, even if the food is considered appealing and pleasing (Little, 1980). Food is selected on variables such as color and defects or the lack thereof (Little, 1980). This selection may be done consciously; however, color and similar characteristics are associated with every object that consumers see in their daily lives (Food Product Development, 1979). Choosing which color of edible pansies to sell is not a trivial matter. If the wrong color is used, consumers may be less likely to purchase the product, and the package may remain on the shelf until the product is no longer marketable.

The same attention must be paid to color combinations in the package. The potential consumer's preference for a package that contains one vs. three colors of pansy must be determined. This preference may be based on the situation. Several participants stated that they would purchase a certain color or color combination of edible flowers to use as decoration on a cake, while they would use a completely different color or color combination in a salad. Results here suggest that a mix of flower colors is preferred over single colors, and some specific color contrasts preferred over others. The mix of blue, yellow, and orange pansies was much more highly valued than any other combination or single color. Research should emphasize what situation is more likely to occur or whether equal numbers of packages would be purchased in either situation. The greater the understanding of what potential edible-flower consumers want in their proposed packages, the greater the probability that packages will be purchased.

Defining the consumer segments with cluster analysis makes it possible to target those segments that are more likely to purchase edible flowers, and is an effective use of marketing dollars. When targeting potential consumers, limited resources, such as time and money, may be used on the consumers who fit this profile only. Coupons or special advertisements might be mailed or otherwise distributed to "Likely Buyers" who have not purchased edible flowers before, but are very likely to purchase the edible flower for use as a garnish or in a salad. The coupons and other inducements may persuade these potential consumers to purchase the item.

Similar marketing efforts can be used to increase the number of packages of edible flowers purchased by segments such as "Persuadable Garnishers." Though the participants in this segment have never eaten edible flowers, they are very likely to purchase edible flowers for use as a garnish and could be as valuable as customers as those in the "Likely Buyer" category. By purchasing the flowers for a garnish, those in this segment might experiment with the edible flowers and begin to use them in food items, possibly becoming "Likely Buyers" more willing to purchase the flowers more often. Edible flowers can be packaged and promoted as a garnish, much as baking soda is used as a refrigerator deodorizer rather than in baking, its traditional use.

In order to convince the "Unlikely Consumer" to buy edible flowers, marketers may have to spend a great deal of time and energy, which may not be an effective strategy. Conversations with several gardening groups indicate that personal production of edible flowers may be more desirable than purchase of them. This segment may purchase edible flowers for applications other than use in salads and garnishes. Future marketing studies will be implemented to address such issues.

Growers should be aware of consumers' attitudes toward the use of pesticides on food items and the consumers' greater inclination to purchase edible flowers grown pesticide-free. Although this sample was drawn from what appeared to be a population interested in gardening and flowers, gardening is the hobby in which the largest percentage of Americans engage (Gallup Organization, Inc., 1999). Consumer's opinion and feelings about the use of pesticides coincide with current production trends and edible-flower growers are aware that consumers prefer pesticide-free products (Whitman, 1991). Each year, more food products are grown using organic methods (DiMartino, 1999), and the demand for such items will continue to grow in other areas of production (DiMartino, 1999). Edible flowers must not be sprayed with chemicals (Kosztolnyik, 1996), since no pesticides are labeled for their production.

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Table 1. Conjoint analysis of two groups of participants who viewed and rated either: 1.) flower color, color combination, container size, and price in 27 photographs or 2.) flower color, color combination, and container size in 14 photographs.

Factor	Relative importance[z]	Utility[y]
	Group 1	
Price ($ U.S.)	23.89	
2.99		1.36 *
4.98		0.52 NS
9.95		-1.87 *
Size	12.77	
9-count container		-0.86 *
18-count container		0.86 *
Color	63.34	
Blue		-0.87 *
Yellow		-3.12 *
Orange		-2.75 *
Blue and yellow		0.81 NS
Blue and orange		1.21 *
Yellow and orange		-0.73 NS
All three colors		5.45 *
Pearson's R = 0.919	Significance < 0.00001	
	Group 2	
Size	5.04	
9-count container		0.28 NS
18-count container		-0.28 NS
Color	94.96	
Blue		4.67 *
Yellow		-4.17 *
Orange		-4.70 *
Blue and yellow		-0.33 NS
Blue and orange		1.51 NS
Yellow and orange		-2.95 *
All three colors		5.98 *
Pearson's R = 0.870	Significance < 0.00001	

[z]A higher value indicates a greater importance.

[y]A more positive value is more desirable.

[NS,*] Nonsignificant or significantly different from 0 at $P \leq 0.05$, as based on a two-tailed t-test.

Table 2. Description of three consumer segments derived from cluster analysis based on participant's responses to variables, including attitudes about edible flowers and salad consumption

Variable	Consumer segment			
	Likely Buyers	Unlikely Consumer	Persuadable Garnisher	Significance[z]
n	106	40	29	
%	60	23	17	
Have eaten edible flowers before (1 = yes, 2 = no) %	1	1	2	* 1,3
	89	63	76	
Purchased edible flowers before (1 = yes, 2 = no) %	2	2	2	* 2,3
	75	95	93	
Intent to purchase edible flowers for a garnish for a meal				
Unlikely				
Moderately likely	5	93	0	* 2,3
Very likely	14	7	31	
	81	0	69	
Intent to purchase edible flowers for a salad ingredient				
Unlikely	0	93	73	* 4
Moderately likely	19	7	27	
Very likely	81	0	0	
Very likely to purchase edible flowers because they were grown pesticide-free (%)	80	26	46	* 2,3

Table 2 (cont'd).

Very likely to purchase edible flowers with 10% insect damage (%)	20	3	3	* 2,3
Mean price ($ U.S.) willing to pay for a container of edible flowers at a major grocery store chain				
9-count	3.09	3.50	4.20	NS
18-count	5.07	2.42	7.42	NS
Mean time spent gardening each week (h)	12	9	12	NS
Mean area (%) percent of garden in:				
Flowers	40	37	38	NS
Vegetables	17	17	16	NS
Lawn	53	56	52	NS
Mean number of total points allocated to a nine-count container with:				
All three flower colors (blue, yellow, and orange)	18	10	11	* 3
Yellow flowers	≤1	≤1	≤1	NS
Likely to:				
(1 = yes, 2 = no) Eat more salad during the summer months	1	1	1	NS

Table 2 (cont'd).

Buy prepackaged salad mixes	2	2	2	NS
Mean number of packages of salad mixes purchased in a month	2	2	3	NS
Age (mean)	48	51	42	NS
Gender (% female)	78	78	97	* 1
Education (% college/tech. graduates)	68	54	61	NS
Family size (% with two people)	38	43	55	NS
Income (% with $40,000-60,000)	22	22	25	NS
Status (% married)	63	70	75	NS
Dependents (% with dependents)	43	35	39	NS

[z]Nonsignificant (NS) or significantly (*) different at $P = 0.05$ as based on a two-tailed t-test and Kruskal-Wallis test. 1 = cluster 1 and 2 combined and tested against 3, 2 = 1 and 3 combined and tested against 2, 3 = 2 and 3 combined and tested against 1, 4 = all cluster comparisons significant.

SECTION III

CONSUMER RATINGS OF EDIBLE-FLOWER QUALITY, MIX, AND COLOR

Consumer Ratings of Edible-Flower Quality, Mix, and Color

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Marketing and Economics

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Summary. Two identical surveys were conducted with separate samples to determine consumer perceptions of quality of five edible flower species. Participants were either members of a class which reviewed the history and uses of edible flowers at Garden Days (n = 23) or were Michigan Master Gardeners (n = 51) attending a similar class. Participants were shown a randomized series of projected photographic slides of five edible flower species and asked to indicate whether or not they found the flower quality acceptable. The slides depicted a range of ratings of mechanical damage, insect damage or flower senescence of the taxa on a scale (1-5) developed by the researchers. A flower that was rated 5 was flawless while a flower that was rated 1 had substantial damage. Nearly half of all participants had eaten edible flowers prior to the study and 57 to 59% had grown them personally for their own consumption, indicating many had previous direct experience. Both samples rated flower quality equally. Analysis showed that *Viola ×wittrockiana* Gams. 'Accord Banner Clear Mixture' (pansy), *Begonia ×tuberhybrida* Voss 'Ornament Pink' (begonia), and *Viola tricolor* L. 'Helen Mount' (viola) were acceptable from stage 5 to 3. Both groups rated the *Tropaeolum majus* L. 'Jewel Mix' (Nasturtium) flowers acceptable at only stage 5. Garden Days participants rated *Borago officinalis* L. (borage) and results showed it was acceptable from stages 5 to 3, while the Master Gardeners results showed acceptability from stages 5 to 4. Participants also rated flower color (yellow, orange, and blue), with results showing all colors equally acceptable.

Introduction

Rigid plastic containers of edible flowers can now be found in some grocery store produce-departments. Though the number of containers purchased is small, upscale clientele and caterers will likely purchase edible flowers as an ingredient or garnish for meals, especially at holiday times (Rusnak, 1999a). For the hotel and restaurant market, Quail Mountain Herbs, in Watsonville, CA, seasonally produces 50 varieties of edible flowers including nasturtium, pansies, and chrysanthemums (Hunn, 1999). While larger quantities and varieties are offered to chefs, consumers may purchase smaller quantities of a mix of edible flowers.

Consumer perception of product quality is often the factor that creates customer loyalty and the continued purchase of that product (Foodservice Equipment and Supplies, 1999). Food service venues such as restaurants strive to improve or keep food quality high. When choosing a restaurant, food-quality is the most important factor among consumers that were surveyed (Dulen, 1999). For instance, a restaurant's reputation can be tarnished if the coffee served is of poor quality (Bendall, 1999). With a product, such as edible flowers, which maybe placed on a plate as a garnish and/or eaten, flower quality may be as important as the coffee that is served. If the flower isn't appetizing, it may reduce visual appeal of the meal and may determine whether a person will eat it or not (Little, 1980).

In the floriculture industry, quality is also essential for customer satisfaction. Consumers want more varieties of top quality plants with a longer shelf-life (Shaw, 1998). As with most products, if customers do not feel that they are purchasing a high quality item, they may choose a competitor's product. Customers are often willing to pay more for a higher-quality product (Shaw, 1998). It is reasonable to assume that packages of edible flowers should contain a desirable mix of species that are palatable, have a reasonably long shelf-life, are of high quality, and contain information such as how to store and use the product.

For edible-flowers, the product quality must begin with planing during the production stage. Since no pesticides are registered for use on edible flowers (Kosztolnyik, 1996), other alternatives must be used to control pests. With an increase in the demand for organic products, edible flower producers may consider growing them using certified organic methods. The supply of organic products as well as product-quality has improved over the past few years (Rusnak, 1999b), but product-quality must continue to meet or exceed consumer's expectations to be profitably competitive with conventional products.

Delicate edible flowers should be protected from damage with proper packaging. They can be marketed in rigid plastic containers similar to containers used to store and protect strawberries and other highly perishable items. Not only do packages protect the easily damaged items, but they also reduce condensation when used to package strawberries (Fite, 1998). Even if all precautions are taken to protect the product, store managers should monitor product quality and remove any containers of edible flowers from the shelves once noticeable deterioration is apparent. Prior research has shown that edible-flower color is the most important product attribute, followed by container price and size (Kelley et al., 2000b). Further, a mix of species and cultivars was preferred to a single color or species (Kelley et al., unpublished data), but it is not know the extent of deterioration that consumers will tolerate in a mix of edible flower species? The researchers hypothesized that various species of edible flowers could be sold through grocery stores with some minimal damage, and still be perceived as acceptable.

Our objective was to provide information to help answer questions regarding consumer preferences and quality perceptions of edible flowers.

Material and Methods

Two major Michigan cities, Detroit and Grand Rapids, are considered variable test markets (Waldrop, 1992). This means that their populations closely resemble an "average" United States city. Results collected in test markets are often extrapolated to other typical cities as one indication of how well the product tested might be perceived. We were more interested in how a sample of consumers who may be more experienced with flowers, and perhaps more critical of flower quality, might rate the edible flowers. Less critical consumers should have similar or lower expectations. Master Gardeners (MG) are more interested and/or experienced in gardening with, perhaps, a heightened sensitivity and awareness of flower quality. MG participants learn about various aspects of gardening and receive certification sponsored by Michigan State University Extension Office. Garden Day (GD) participants pay to attend an annual event and learn about gardening related subjects. Participants are self-selected to attend gardening programs because of their interest in gardening, with a similar level of flower awareness. Both groups were Michigan residents, some of whom resided in test market areas. Twenty-nine percent of MG were residents of Metro Detroit with an additional 15% residing in the Grand Rapids metro area. Twenty-two percent of GD participants were residents of Metro Detroit, none were from Grand Rapids. The remainder of MG and GD participants were from the Greater Lansing Area, cities surrounding the two metro areas, and states bordering Michigan. While drawn from cities identified as representative we found these samples to be an indication, perhaps more critical than what we might expect of groups of "average" Americans who are less involved in gardening.

The Michigan MG participants attended a two-day annual program that allowed members to enroll in classes on various gardening-related topics. Fifty-one self-selected members preregistered and attended one of two 1-h 30-min seminars on edible flowers on 29 June 1999. GD participants also had the opportunity to attend other seminar topics during Garden Days, a two-day annual meeting. Twenty-three self-selected GD participants enrolled in an edible-flower seminar on either 5 or 6 August 1999. All participants were given a survey form that included a scale for visual quality assessment and several other questions pertaining to edible flower preferences, uses, and demographic questions.

Participants were shown 25 projected 35 mm photographic slides (with a projected size of 1.22m x 1.73m) of five edible flower species: *Viola ×wittrockiana* 'Accord Banner Clear Mixture' (Pansy), *Begonia ×tuberhybrida* 'Ornament Pink' (Tuberous Begonia), *Viola tricolor* 'Helen Mount' (Viola), *Borago officinalis* (Borage), and *Tropaeolum majus* 'Jewel Mix' (Nasturtium). Each slide showed a flower with a quality rating on a scale from 1 to 5. Each stage of the scale corresponded with a postharvest visual assessment scale that was developed by the researchers because no damage assessment scales for edible flowers were located in the literature. A flower rated a 5 was flawless (Figure 1). As the numerical rating decreased, the amount of damage or flaws increased. Flowers rated a 1 had the greatest amount of damage from either mechanical damage, insect damage, or senescence (Figure 2). Flower color was also affected and flowers that had ratings lower than 5 had increasing degrees of petal discoloration.

As each slide was shown, participants were asked to indicate on their survey form whether or not the flower quality was acceptable. Each slide was shown a second time, in the same order, to insure that participants had an adequate opportunity to examine each flower carefully. Our hypothesis was that consumers would consider flower quality acceptable from stages 5 through 3. Damage was rated on a 5 to 1 scale, 5 = no visible blemishes. Based on the amount and types of damage, we hypothesized that flowers that received a rating of either 1 or 2 would have a substantial amount of damage and significant browning to be unappealing to consumers. After viewing slides, participants were asked to examine and rate slides of three different colored pansies (yellow, orange, and blue), using a seven point Likert scale (7 = highest rating). They were asked, based on flower color, how likely they would be to eat the pansy shown. Participants then rated how likely they would be to purchase edible flowers if grown organically, purchase flowers with 10% insect damage, if they had ever eaten edible flowers before, how they obtained the edible flowers, and if they preferred mixtures of edible flower species or one single species. Finally, participants responded to a series of demographic questions. Results were tested for significance using the SPSS software for Windows 95 program (SPSS Inc., Chicago, IL).

We hypothesized that Garden Days participants and the Master Gardeners would tolerate a similar threshold of edible flower damage before indicating an unwillingness to purchase a container of edible flowers because they had similar experiences with edible flowers and similar demographic characteristics. Further, the researchers hypothesized that, if at least 50% of the participants found a flower acceptable at a particular rating, that the flower would likely be saleable. We would recommend that packages of edible flowers

remain in the store until the threshold rating was reached. By leaving the packages of edible flowers in the store longer and not discarding them at the first sign of a minor change in appearance, store managers may be able to sell more packages if they remain in their display area longer. This would reduce product shrinkage and enhance profitability. We would recommend that store managers not leave the packages in the display area past the acceptable stage. Consumers should only see packages of edible flowers that are at or above the threshold level.

Results and Discussion

The demographic characteristics of both groups were similar except that 23% more MG participants were married (Table 1). Nearly half of both groups indicated that they had eaten edible flowers in the past 3 months; namely pansy, dandelion, nasturtium, lavender, chives, violet, borage, mint, tulip, calendula, arugula, and signet marigold. This result indicated that participants had some recent experience with the product, perhaps sensitizing them to the product attributes. Only 12% of the participants in both groups purchased edible flowers in the past year, while slightly more than half GD participants and MG participants, respectively, were growing edible flowers for personal consumption. More than half of both groups preferred mixtures of edible flowers. A good percentage of both of these groups had prior experience with edible flowes and could assess damage with a critical eye.

More than half of both MG and GD participants rated flower quality of pansy, tuberous begonia, and viola acceptable at stages 5 through 3 (Table 2). Less than half of both groups rated nasturtium acceptable at stages lower than 5. Flower quality of borage was acceptable at stage 3, for half of the GD participants but for only 47% of MG participants. We asked participants to answer a variety of questions regarding their preferences for edible flower color (Table 3). For all three single pansy flower-colors (yellow, orange, and blue) participants in both groups were very likely (composite rating of 5, 6, or 7), to eat them all. Behe et al., (1999) found there was a group of consumers who may purchase blue geraniums. It may be possible that consumers would prefer blue flower-colors for edible flowers while others may see this color as less appetizing. At least 86% of participants responded that they would purchase edible flowers if grown organically, however, only 30% stated they would purchase edible flowers with 10% insect damage. Information such as this will aid growers who will be making decisions as to what colors to include in the package and how the flowers should be grown. Future studies will help determine if consumers can detect small amount of damage on edible flowers in packages.

Based on these data from these perhaps more highly-sensitized customer groups, we see that potential consumers may purchase edible flowers at quality levels that are less than perfect. However, there is a likely lower-threshold that below which flowers would not be purchased. We can conclude that flowers do not have to be perfect but may be sold with minor flaws, even to consumers with some experience growing and/or eating flowers.

Information that is generated with regards to edible flower quality will help producers and marketers create mixes, package sizes, and pricing techniques that may increase market share and possibly boost profits. Participants in several marketing surveys have indicated that there is an interest in edible flowers and that potential consumers care about flower quality as well as how the flower is grown and treated (Kelley et al., 2000a; Kelley et al., 2000b; Kelley et al., In Preparation). Few companies are producing edible flowers to be sold through retail outlets. As the interest in edible flowers as a garnish and as an ingredient increases, new mixes, new color, and larger quantities may be sold. Edible flowers may also have the potential as being included in ready to go meals or prepackaged salad mixes.

Other factors should be considered when creating edible flower products. The mix of edible flowers may be a factor in the purchasing decision as well as the flower-quality. Robertson and Chatfield (1982) found that flower bouquet composition affected a consumers' preference. Little is know regarding which species or mix of edible flowers consumers would prefer and how quality affects the purchasing decision (Kelley et al., 2000a and unpublished data). Currently marketed containers of edible flowers contain several species. It is possible that consumers may prefer a more homogenous or heterogeneous mix. The desired mix of edible flowers may also be situational, whether the flowers will be used as a garnish or in a food item. Future studies should concentrate on gaining information in these areas.

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Table 1. Comparison of demographic characteristics and edible flower preferences for Master Gardeners and Garden Days participants.

Attribute	Master Gardener participant	Garden Day participant	Significance
Mean Age (years)	45	46	NS
College or tech. graduate (percent)	53	59	NS
Two person families	36	42	NS
Income $40,000 to $60,000 (percent)	21	37	NS
Married (percent)	82	59	*
Female (percent)	86	91	NS
Eaten edible flowers before (percent)	44	45	NS
Purchased edible flowers before (percent)	12	12	NS
Grew edible flowers before (percent)	57	59	NS
Preferred a mixture of edible flower species (percent)	65	68	NS

NS,* Nonsignificant or significantly different at $P \leq 0.05$ in rows, based on a two-tailed t-test and chi-square.

Table 2. Percent of Garden Days (GD) or Master Gardener (MG) participants who rated edible-flower quality acceptable for five species. Scale of 1-5 (5 = perfect).

	Species									
	Pansy		Tuberous Begonia		Viola		Nasturtium		Borage	
Damage Rating	GD	MG	GD	MG	GD	MG	GD	MG	GD	MG
5	100	96 NS	96	96 NS	100	100 NS	77	78 NS	90	92 NS
4	100	96 NS	96	88 NS	77	51 *	35	24 NS	59	71 NS
3	95	71 *	86	78 NS	96	84 NS	5	10 NS	55	47 NS
2	26	10NS	0	4 NS	26	14 NS	0	0 NS	17	2*
1	4	2 NS	23	16 NS	5	0 NS	0	0 NS	36	8*

NS, * Nonsignificant or significantly different for each edible flower (pansy, tuberous begonia, viola, etc.) at $P \leq 0.05$. Statistics preformed using the Kruskal-Wallis Test.

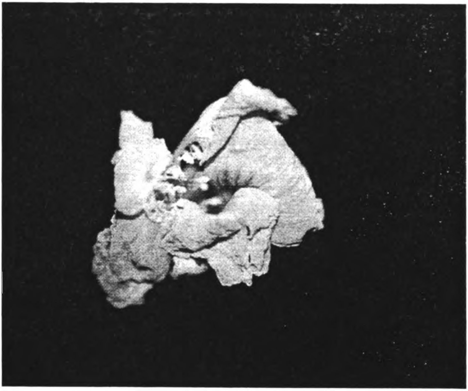
Table 3. Comparison and percentage of GD and MG participants who would be very likely to eat or purchase selected edible flowers.

Variable	GD	MG	Significance
n	23	51	
Eat a yellow pansy	91	90	NS
Eat an orange pansy	74	67	NS
Eat a blue pansy	91	94	NS
Purchase edible flowers if grown organically	90	86	NS
Purchase edible flowers with 10% insect damage	24	35	*

NS, * Nonsignificant or significantly different at $P \leq 0.05$ in rows, based on a two-tailed t-test.

Figure 1. A nasturtium flower that was flawless and was rated a 5.

Figure 2. A nasturtium flower that had the greatest amount of damage and was rated a 1.



SECTION IV

Organic Nutrient Management of Greenhouse Production of Edible Flowers in Containers

Organic Nutrient Management of Greenhouse Production of Edible Flowers in Containers

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Additional index words: Collodial rock phosphate, dried blood, fish emulsion, greensand, nutrient analysis, Omega 6-6-6, pH and EC, water-soluble fertilizer.

Abstract. Eight species with edible flowers: *Begonia* ×*tuberhybrida* 'Ornament Pink' Voss, *Borago officinalis* L., *Coriandrum sativum* L., *Dianthus superbus* L. 'Super Fantasy Mixed', *Phaseolus coccineus* L. 'Dwarf Bees', *Tropaeolum majus* 'Jewel Mix' L., *Viola tricolor* L. 'Helen Mount', and *V.* ×*wittrockiana* L. 'Accord Banner Clear Mixture', were grown in 12.5 cm (1.5 L) square containers in a 30% by volume mineral soil, root medium suitable for organic certification. Plants were fertilized biweekly with 200 ml of either fish emulsion (5-0.4-0.8), or Omega 6-6-6 (a certified organic, commercially available soluble fertilizer (6-2.6-5)), each at 300 or 600 ppm N. Plants in either the 30% soil medium or a standard peat and perlite medium were fertilized with a synthetic water-soluble fertilizer (19-1.8-19) at 300 ppm N (six treatments total). Balanced plant growth and flowering occurred with both organic fertilizers, but shoot dry weight was larger with Omega 6-6-6. There was an increase in shoot dry weight for only three of the 16 comparisons of the 300 vs. 600 fertilizer rate. Shoot dry weight with the synthetic, water-soluble fertilizer in both the soil based and soilless media was either the same or smaller than the organic fertilizer treatments, but the rate of application was increased to weekly, midway through the experiment, to correct and prevent leaf chlorosis. There were no differences in the total number of flowers and flower size for *V. tricolor* and *V.* ×*wittrockiana* species when fertilized with 300 and 600 ppm N Omega 6-6-6. In general, the root media pH increased over the range of 6.0 to 7.0, from the sixth to the 12th sampling week after the first fertilizer application, but only increased or decreased slightly from 12 to 18 weeks and there was little effect of fertilizer type. Root media EC decreased initially with minimal change later, generally in the range of 0.25 to 0.75 $dS{\cdot}m^{-1}$ in

a 1:2 extract, with little effect of fertilizer type. For three species with Omega 6-6-6 at 600 ppm N, root media EC increased above, and pH decreased below acceptable levels. Differences in whole shoot nutrient concentration were greater between species than between fertilizer types. Nitrogen levels ranged from 1.18 to 2.18% for all treatments, but were lowest in the soilless medium control. The fish emulsion and synthetic fertilizer treatments maintained low tissue level of P (0.19 to 0.24%) and adequate K (2.69 to 3.22%). Phosphorus (0.39 to 0.49 %) and K (3.26 to 3.63%) tissue levels were higher with Omega 6-6-6 treatments and increased P most likely was the greatest factor influencing the increased shoot dry weight. Shoot tissue concentrations of micronutrients were in the sufficiency range for all treatments. There was little or no effect of fertilizer rate on shoot tissue nutrient concentration, accept where 600 ppm N of Omega 6-6-6 resulted in increased medium EC and lower medium pH resulting in increased Fe and Mn tissue levels.

Introduction

Greenhouse production of food crops could supply additional income for small farms. Edible flowers are one example of a value-added crop that could be locally produced and marketed. The popularity of edible flowers has increased since the late 1980's. They are featured in popular articles, and are also the subject of several cookbooks (Belsinger, 1991; McVicar, 1997; Barash, 1993).

Edible flowers can be grown using organic methods (Barash, 1993). Certifiable organic media and amendments, such as fish emulsion, dried blood, and other plant and animal by-products are used instead of chemically derived products. Suppliers list several factors as to why consumers prefer organic produce. Some reasons include: "Knowledge of health issues, concern for dietary welfare of loved ones, pathogen fears, and awareness of ecological issues." Predictions have been made that consumer demand for organic products will continue to increase (Di Martino, 1999). Consumers' responses to questions regarding the use of pesticides on edible flowers indicated that they would prefer the product to be grown without such chemicals (Kelley et al., 2000a, b).

Various sources have reported the benefits of using organic amendments. Since organic fertilizers release their nutrients slowly (due to the micro and macro organisms in the soil), the plants are able to capture a greater portion (Mattern, 1996), whereas with synthetic fertilizers, the nutrients are readily available and more vulnerable to leaching. Organic amendments not only supply available nutrients, but they also "influence plant growth indirectly by improvements in the soil's physical condition (e.g., soil tilth and water infiltration)" (Chaney et al., 1992) and the level of biological activity in the soil or medium.

Little has been written about greenhouse crop production using certified organic methods. Biological activity could be important in determining the availability of organic fertilizers and in preventing development of plant pathogens that are common in soilless potting media (Chaney et al., 1992; Hoitink et al., 1991, 1997). Short term greenhouse experiments with media in containers would not focus on physical properties, but instead would concentrate on identifying organic nutrient sources that are readily available and if the ratio between elements is acceptable.

Certified organic potting mixes used in the greenhouse should provide optimum aeration and water holding capacities, retain nutrients, and can include ingredients such as peat, vermiculite, and perlite (ATTRA, 1998). However, for a potting mix to be certified organic it must not contain synthetically derived starter fertilizers or wetting agents. The organic mix may contain components such as soil, compost, kenaf, coconut coir, and organic nutrient amendments approved by the certifying committee (ATTRA, 1998). Prepared organic potting mixes are available for both home gardeners and commercial greenhouse establishments and recipes are available (ATTRA, 1998; Coleman, 1992). Coleman (1992) has developed a compost based potting mix that includes dried blood, greensand, and colloidal rock phosphate to supply nitrogen, potassium, phosphate and micronutrients.

According to Chaney et al. (1992) animal byproducts such as dried blood may have nutrient release rates similar to synthetic fertilizers due to the small amount of organic carbon. Bunt (1988), however, states that biological activity is needed to transform organic sources such as dried blood into a readily available form that plants can use. Colloidal rock phosphate reportedly has acceptable release rates since only little biological activity is needed to convert it to an available form (Matten, 1996). Greensand, however, is released slowly for 10 years or more, but contains high quantities of micronutrients (Mattern, 1996). When added as a preplant nutrient charge, amendments such as greensand are added in larger quantities of 2.3 to 7 $kg \cdot m^{-3}$ (5 to 15 $lbs \cdot yd^{-3}$) as opposed to 0.03 to 0.11 k $g \cdot m^{-3}$ (1 to 3 $oz. \cdot yd^{-3}$) for commercially manufactured fritted trace elements (Nelson, 1998).

Fish emulsion and Omega 6-6-6 are two certified, water-soluble organic fertilizers identified in conversations with organic transplant growers. Growers also apparently prefer biweekly or interval fertilization over constant liquid fertilization, which is more commonly used in commercial greenhouses. Unlike commonly used synthetic, water-soluble fertilizer, organic fertilizer cannot be maintained for long periods as diluted stock solutions suitable for fertilizer injection equipment. Concentrated stock of organic fertilizer is usually at pH <4.0 to decrease biological degradation. Bacterial and/or fungal growth is common once the stock is diluted with water. With interval fertilization, diluted stock solution would be made and used in the same day. Some organic fertilizers, like fish emulsion, have a strong odor which also favors limited rather than regular use. Interval-or-as-needed fertilization also favors more controlled plant growth than a constant fertilization program (Nelson, 1998). Application concentrations or rates used by growers for fish emulsion and Omega 6-6-6 could not be determined along with the effect of these fertilizers on root media pH and electrical conductivity (EC).

Normally inorganic acid must be injected to control media pH of soilless media when using irrigation water with >250 ppm bicarbonate alkalinity (Argo and Biernbaum, 1996; Nelson, 1998). Acid injection is not acceptable for organic certification, so alternative strategies must be considered in areas of the country with high alkalinity water. High alkalinity irrigation water is a common problem in the Midwest. Root media containing mineral soil can provide greater pH and nutrient buffering than soilless media (Nelson, 1998).

This research was conducted to develop recommendations for organic fertilization methods and to compare the growth, development, flowering, and whole shoot nutrient concentration of edible flower species using organic media amendments with organic water-soluble fertilizers or synthetic water-soluble fertilizer. To our knowledge, few published studies have focused on the use of certified organic media or fertilizers in greenhouse container production. Other objectives were to determine whether a common organic fertilizer strategy and rate would be acceptable for a wide range of edible flower species; to compare the organic fertilizer effect (100% ammonium (NH_4-N) nitrogen plus carbon sources) on the root medium pH and EC as opposed to the synthetic fertilizer (25% NH_4-N); and to identify possible differences between a higher-N fertilizer (fish emulsion 5-0.4-0.8) and a more balanced NPK fertilizer (Omega 6-6-6 [6-2.6-5]).

Materials and Methods

Seeds of *Begonia ×tuberhybrida* 'Ornament Pink' Voss, *Borago officinalis* L., *Coriandrum sativum* L., *Dianthus superbus* L. 'Super Fantasy Mixed', *Phaseolus coccineus* L. 'Dwarf Bees', *Tropaeolum majus* 'Jewel Mix' L., *Viola tricolor* L. 'Helen Mount', and *V. ×wittrockiana* L. 'Accord Banner Clear Mixture' were sown between September 25 and October 23, 1998, into 30 cell (80 ml) transplant half-flats with a medium consisting of 40% (by volume) of peat (Sun Gro Horticulture, Bellevue, WA), 40% coconut coir (Chrystal Company Gro-Brick, St. Louis, MO), and 20% coarse vermiculite (Strong-lite, Pine Bluff, AR). Pulverized dolomitic lime (9 $kg \cdot m^{-3}$ (15 $lbs \cdot yd^{-3}$)); National Lime and Stone Co., Corey, OH) was added to the mix to raise the pH to 6.3. The flats were placed into a 25 °C (77 °F) day and night temperature propagation greenhouse with a 16-hour daylength using high-pressure sodium lamps (HPS). After germination the plug trays were placed into a 21 °C (70 °F) day and night temperature greenhouse, also with a 16-hour daylength. The seedlings were watered as needed and were fertilized with 500 ppm N, from fish emulsion (FE) (5-0.4-0.8; Alaska Fish Fertilizer Co., Renton, WA) to supply nutrients for initial growth and development. The water applied to the crops between fertilizer treatments had an EC of 0.6 $dS \cdot m^{-1}$; 105 Ca^{2+}, 35 Mg^{2+}, 12 Na^{+}, and 23 SO_4-S (ppm); and a titratable alkalinity to pH 4.5 (Chau, 1984) of 320 mg $CaCO_3$/liter (well water) (Argo and Biernbaum, 1996).

As a species reached transplant size, over the period from 19 November to 9 December, 112 plants per species were transplanted into a medium composed of 30% (by volume) composted sandy-loam soil and equal parts (15% by volume) of coarse texture peat (Sun Gro Horticulture), finer texture peat (Select Peat Moss Inc., New Brunswick, Canada), coconut coir, perlite, and vermiculite. To supply macronutrients and micronutrients, 4.25 kg•m^{-3} (7 lbs•yd^{-3}) of equal parts (by volume) of greensand (0-0-7; North Country Organics, Bradford, VT), colloidal rock phosphate (0-2-0; North Country Organics), and dried blood (12-0-0; Dragon, Roanoke, VA), were added. This rate is approximately one half the rate used by Coleman (1992). Based on measured fertilizer density, approximately 1.9, 1.4, and 1.0 kg•m^{-3} (3.2, 2.3, and 1.6 lbs•yd^{-3}) of greensand, rock phosphate, and dried blood were added. The pH of the media was 5.6 at the time of planting. No lime was necessary due to the high pH of the composted mineral soil, which offset the low pH of the peat. Growing containers were 14.5-cm-tall x 15.5-cm-wide (1.5-L) plastic, square containers.

An additional 16 plants per species were transplanted into a soilless medium consisting of 70% (by volume) peat and 30% perlite (Strong-lite) mixture with a standard starter nutrient charge (0.6 kg (1 lb•yd^{-3}) KNO_3, 0.3 kg (0.5 lb•yd^{-3}) triple superphosphate (0-19.8-0), and 0.9 kg (1.5 lb•yd^{-3}) gypsum; 0.07 kg (0.1 lb•yd^{-3}) fritted trace elements; 0.3 kg (0.5 lb•yd^{-3}) wetting agent (Aquagro "G", Aquatrols, Pennsaulken, NJ) per m^3 of medium) and 1.5 kg•m^{-3} (2.5 lbs•yd^{-3}) of dolomitic hydrated lime. This medium was used extensively in previous research (Argo and Biernbaum, 1996, 1997). The pH of this medium was 5.7 at the time of planting.

On 21 December, when plants began to look chlorotic, plants in the 30% soil medium were divided into five fertilizer treatments. The number of plants per treatment was between 12 to 16 depending on species. Treatments included: FE at 300 or 600 ppm N; and Omega 6-6-6 (OM) (6-2.6-5; Petrik Laboratories, Inc., Woodland, CA) a commercially available blend (a liquid starter fertilizer from microbial fermentation and digestion of blood meal, bonemeal and potassium sulphate (Harmony Farm Supply and Nursery, 2000)), at 300 or 600 ppm N. The fifth treatment in the 30% soil medium and a sixth treatment in the soilless medium were fertilized with MSU Special (19-1.8-19, 25% NH_4-N) a water-soluble fertilizer at a rate of 300 ppm N, (Greencare, Chicago, Ill.). The plants were fertilized every two weeks with 200 ml of the respective fertilizer treatment to insure that the plants were well fertilized without any leaching. On 29 January it was observed that all species fertilized

with the MSU Special 300 ppm N in the soilless and 30% soil medium looked chlorotic. The These treatments were fertilized weekly at 200 ml of MSU Special until February 26. The *B. officinalis* and *T. majus* plants in these treatments still looked nutrient deficient after this period of time and continued to be fertilized with 200 ml of MSU Special weekly until April 2.

The pH and EC (1:1 and 1:2 soil:water dilutions respectively) of approximately 50 ml root media samples were tested at six week intervals from the first fertilizer application and continued throughout the experiment. Two samples per treatment were collected from the lower half of three pots each. Only two pH and electrical conductivity (EC) readings were taken for *C. sativum* and *P. coccineus*, at six and 12 weeks after December 23, since the rate of flowering declined and whole shoot samples were harvested for nutrient analysis prior to the third pH and EC soil sampling.

The first species began to flower on October 31. On December 22, to encourage larger, high quality flowers the temperature in one of the greenhouses was lowered to 16° C (61° F) day and night temperatures (Niu et al., 1999). The other greenhouse remained at 21 °C (70 °F). Plant species such as *B. officinalis*, *T. majus*, *V. ×wittrockiana*, *V. tricolor*, and *P. coccineus* remained in the 16 °C (61 °F) greenhouse, while species that grew slower at the lower temperature including: *B ×tuberhybrida*, *C. sativum*, and *D. superbus* were moved to the warmer greenhouse to encourage more rapid growth. Beginning on February 5 and continuing weekly until April 19, the flower size (height × width) of 10 *V. tricolor* (viola) and 10 *V.* ×*wittrockiana* (pansy) flowers were measured in each treatment.

All shoot growth and flowers were harvested for a species was harvested on one day during the period of March 22 until May 5. Four samples per species each consisted of three or four plants. The fresh weight of the shoot was recorded after the plant material was cut at the soil line. The plant material was then dried in a 60 °C (140 °F) oven for 48 hours, weighed again to determine the dry weight and the percent dry weight was calculated. Shoot-tissue samples, ground to 40 mesh, were sent to an independent lab for nutrient analysis (MicroMacro International, Athens, Ga.). Data were evaluated using SAS's analysis of variance (ANOVA) procedures and mean separation was preformed using least significant differences (LSD) (SAS Institute, Cary, N.C.).

Results and Discussion

For the three fertilizer solutions applied at 300 ppm N, in the 30% soil medium, three of 8 species (*B. officinalis*, *C. sativum*, *and P. coccineus*), had the highest dry weight when fertilized with OM (Table 1). Plant appearance and leaf color were also better with OM. Based on *V. tricolor* tissue analysis, which was characteristic for most species, the increased growth of these species is likely due to increased phosphorus availability (Table 2). Nutrient analysis means across species were calculated, but were not presented due to significant species by fertilizer treatment interaction for 9 of 12 elements. At the 300 ppm N rate, the concentration of P applied was at least 4.5 times higher (130 vs 28 or 24 ppm) for the OM.

There was an increase in shoot dry weight for only three of the 16 comparisons of the 300 vs. 600 fertilizer rate. There were no differences in the total number of flowers and flower size for *V. tricolor* and *V. ×wittrockiana* species when fertilized with 300 and 600 ppm N OM (Table 3). When the two fish emulsion treatments were compared there were few differences in the dry weight and the percent dry weight.

The soilless medium and MSU Special water-soluble fertilizer provided a tested control comparison to the organic medium and fertilizer treatments. Shoot dry weight with the synthetic, water-soluble fertilizer in both the soil based and soilless media, was either the same or smaller than the organic fertilizer treatments, but the rate of application was increased to weekly, midway through the experiment, to correct and prevent leaf chlorosis. Based on plant growth and tissue analysis the soil and incorporated amendments did not increase growth or nutrient uptake with the synthetic water-soluble fertilizer applied. With the addition of soil the dry weight was larger for *P. coccineus* and *V. ×wittrockiana*, smaller for *C. sativum* and *V. tricolor*, and not different for the other four species.

Media pH increased from the sixth to 12th sampling week, but then generally decreased or stayed the same (Figure 1, Table 4). Differences between the medium pH for the two organic fertilizers compared to 300 ppm N, MSU Special in the 30% soil medium existed only for the *B. ×tuberhybrida* and *P. coccineus* (Figure 1). For both of these species the pH for those fertilized with MSU special were higher than those fertilized with OM at 300 ppm N. Differences in medium pH were not consistent for species over the sampling weeks when comparisons were made between 300 and 600 OM or FE. Where differences did occur, generally medium pH was lower for the 600 ppm N rate.

For four of the eight species, *B. officinalis*, *B. ×tuberhybrida*, *T. majus*, and *V. ×wittrockiana*, the greatest change in media pH over time was with the soilless medium treatment. On the sixth week of sampling, for all but *C. sativum*, the pH for species grown in the 30% soil medium and fertilized with 300 ppm N, MSU Special was at least 0.5 higher than those grown in the soilless medium. Medium pH for *D. superbus* and *P. coccineus* exhibited this trend for the 12th and *B. officinalis* and *V. ×wittrockiana* on the 18th sampling week.

Certain species such as *T. majus* had higher media pH for all treatments tested. This trend may be a species effect and/or the alkaline water source may have affected the media pH since *T. majus* was watered more frequently due to the large plant size.

High alkalinity (320 ppm) in the irrigation water would be expected to increase the root medium pH over time with a 25% NH_4-N fertilizer (Argo and Biernbaum, 1996). Under the conditions of this study the change in medium pH was less than we anticipated. One possible explanation is that little or no excess water was applied at each irrigation. The plants were also grown during the winter when irrigation is reduced.

Bunt (1988) states that organic fertilizers such as hoof and horn (13% nitrogen) and dried blood (10-13% nitrogen), are broken down into a useable form by fungi and bacteria for plants to absorb. Bunt further explains that organic nitrogen is transformed to ammonium faster (mineralization) than ammonium to nitrite and then to nitrate (nitrification). It is possible that mineralization would cause the pH to initially rise over time. When nitrification occurs hydrogen ions (H^+) are released which can make the growing medium acidic. The net effect is little or no change in media pH.

Argo and Biernbaum (1997) demonstrated that pH of root medium was dependent on the water alkalinity, nitrogen form, lime, and peat type. With the combination of a high alkalinity water source, and a 100% NH_4-N fertilizer such as FE or OM, in a 30% mineral soil medium the medium pH there was no sign of declining pH except at the 600 ppm N rate of OM. It is not clear what affect the organic fertilizers would have when applied with a "pure" water source, common in the Northeast U.S., and to a soilless root medium. Adding mineral soil to a potting medium can reduce fluctuations in nutrient content or availability due to cation exchange capacity and buffering related to the higher bulk density.

Media EC values for all species were less uniform and had more variability between fertilizer treatments than for pH. The EC values were generally in the low to acceptable range (0.25 to 1.0 $dS{\cdot}m^{-1}$) for all species. Differences between the EC for these treatments were not considered culturally significant. For *B.* ×*tuberhybrida* and *D. superbus*, the EC was higher for the 600 vs. 300 ppm N rate. Shoot dry weight of *B.* ×*tuberhybrida* was reduced in the OM 600 ppm treatment. It is likely that *B.* ×*tuberhybrida* is a salt sensitive plant and that the soluble salts inhibited growth. *D. superbus* had the highest fresh and dry weight when grown in the 30% soil medium and fertilized with the OM 600 ppm N. The percent dry weight was similar to the plants in the other treatments. Therefore, the higher levels of salts were not detrimental to *D. superbus* growth. Changes in EC were similar for the two media fertilized with 300 ppm N, MSU Special, except for *C. Sativum* were the EC increased in the soilless medium on the 12th week from the sixth week (Figure 2).

Greenhouse container plant fertilization rates for standard water-soluble fertilizers are often adjusted based on media EC. Under the conditions of this study, similar EC readings were obtained with all three fertilizers and both media, which is an indication that EC monitoring would also be a useful tool with organic fertilizers.

Though soil samples were harvested for pH and EC at six, 12, and 18 weeks after the first fertilizer treatment was applied, sampling occurred at different times in relation to date of fertilization, which was on a two week cycle. Species had been divided into groups based on growth characteristics to decrease the number of soil samples that were handled in a weeks time. For each sampling week, soil samples for *B. officinalis*, *C. sativum*, and *T. majus* were harvested and analyzed two weeks after species were fertilized. Soil samples for *B.* ×*tuberhybrida*, *D superbus*, *P. coccineus*, *V. tricolor*, and *V.* ×*wittrockiana* were taken five days after species were fertilized. This may explain the EC variation between fertilizer treatments and higher EC values for *B.* ×*tuberhybrida*, *D. superbus*, and *V.* ×*wittrockiana* at each of the sampling times.

Differences in whole shoot nutrient concentration were greater between species than between fertilizer types. Nitrogen levels ranged from 1.18 to 2.18% for all treatments, but were lowest in the soilless medium control. The FE and MSU special fertilizer treatments maintained low tissue level of P (0.19 to 0.24%) and adequate K (2.69 to 3.22%). Phosphorus (0.39 to 0.49%) and K (3.26 to 3.63%) tissue levels were higher with OM treatments. The increased P was most likely the greatest factor influencing the increased shoot dry weight with OM.

Nitrogen and P levels in the whole-shoot samples for most species fertilized with 300 ppm N, fish emulsion, were lower than the sufficiency range levels recommended for leaf samples (Mills and Jones, 1996). This would be expected, however, since material that was analyzed contained woody stems and not just succulent leaf material. *C. sativum*, *P. coccineus*, and *T. majus* had the lowest N levels of 1.29, 1.23, and 1.35%, respectively. Nitrogen levels for *V. tricolor* ranged from 1.25 to 1.96% for the six treatments and was representative of the mean values across species (Table 2). Potassium levels were adequate for growth and development for all species fertilized with FE even though the N:K ratio applied was 5:0.8. For most water-soluble fertilizer solutions used in most commercial greenhouses the N:K ratio is 1:1.

There were no culturally significant differences in Ca, Mg or S concentrations in all species although for *V. tricolor* there were some statistical differences. As described previously, the water source used for irrigation has high-alkalinity and supplies ample amount of Ca, Mg, and S. Overall Ca to Mg ratios for each species were within the recommended 2:1 to 3:1 range for all species except *B. officinalis* and *B. ×tuberhybrida* which had ratios of 6:1 and 1:1, respectively. Sufficient amount of sulfur were found in the whole shoot analysis for all species with all treatments.

Micronutrients Fe, Mn, B, Cu, and Zn were near the sufficiency range used for leaf tissue analysis for all treatments (Mills and Jones, 1996). Sodium levels for *B. officinalis*, *B. ×tuberhybrida*, and *T. majus* were in the range of 2723 to 5055 ppm, which may indicate Na accumulation, while for all other species the concentration was less than 1000 ppm. There was no indication of higher sodium levels in the tissue due to FE fertilizer. Species grown in the soilless mix tended to have the highest level of micronutrients except when Fe, Mn, and Cu availability were influenced by low pH with the 600 pm OM fertilizer rate.

Balanced plant growth was achieved with OM and FE applied at 300 ppm N at two week intervals, though growth of plants fertilized with OM was better primarily due to increased P availability. Plant growth was similar to that of plants fertilized with twice the rate, hence, the lower rate is recommended for both supplying nutrients and lower costs for growers. Additional tests are necessary to identify rates of organic fertilizers for soilless medium. A higher P analysis in water-soluble fertilizer, like OM, or other media sources of P, like bone meal or compost, or higher rate of rock phosphate, are recommended. Rock phosphate in the 30% soil medium did not supply adequate P, although more controlled studies with varying rates of rock phosphate are needed. The rate used in this study was one half the rate recommended by Coleman (1992). He also recommended incorporating the rock phosphate into a compost-based medium several weeks or months prior to planting, which likely would influence solubility.

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Table 1. Shoot dry weight (dry wt) in grams and percent dry weight (% dw) for eight edible flower species grown with one of six media/fertilizer combinations. Each value is the mean of four samples, each composed of three or four plants.

	300 ppm N MSU Special Soilless		300 ppm N MSU Special 30% Soil		300 ppm N Omega 6-6-6 30% Soil		600 ppm N Omega 6-6-6 30% Soil		300 ppm N Fish Emulsion 30% Soil		600 ppm N Fish Emulsion 30% Soil		Significance	
Species	dry wt	% dw	dry wt	% dw	dry wt	% dw	dry wt	% dw	dry wt	% dw	dry wt	% dw	dry wt	% dw
Begonia x tuberhybrida 'Ornament Pink'	32.8	10.7	18.1	6.7	22.4	9.1	8.8	6.7	12.5	5.7	27.2	8.6	NS	NS
Borage officinalis	31.9 d[y]	15.5 a	39.3 cd	13.6 b	58.5 b	14.2 ab	68.7 a	12.2 c	37.3 cd	14.9 ab	42.8 c	14.1b	**	**
Coriandrum sativum	102.6 ab	24.1	67.2 c	20.4	123.2 a	24.1	91.2 bc	20.8	72.8 c	24.3	100.2 ab	23.9	**	NS
Dianthus superbus 'Super Fantasy Mixed'	34.8 ab	26.7	28.2 bc	24.3	33.3 ab	21.7	42.4 a	20.3	19.4 c	22.7	27.5 bc	24.0	*	NS
Phaseolus coccineus 'Dwarf Bees'	45.3 c	24.3 a	62.9 b	24.7 a	92.0 a	22.4 ab	101.6 a	20.4 b	53.6 bc	23.6 a	63.1 b	22.7ab	**	*
Tropaeolum majus 'Jewel Mix'	28.0 c	17.6 ab	32.9 bc	18.0 a	42.3 b	14.1 c	68.6 a	15.5b c	20.7 c	16.8 ab	26.2 c	15.4bc	**	*
Viola tricolor 'Helen Mount'	37.7 a	21.8 a	29.2 bc	17.0 bc	36.0 ab	18.9 ab	32.5 ab	13.4 c	22.4 c	19.5 ab	24.6 c	18.3ab	**	**

Table 1 (cont'd).

Viola × *wittrockiana* 'Accord Banner Clear Mixture'	15.9 b	18.1 a	27.5 a	16.8 ab	27.3 a	13.7 c	22.0 ab	12.5 c	17.8 b	17.3 a	22.2 ab	14.8 bc	*	**

[y]Significance is in rows for each species and separated by dry weight and percent dry weight. Means followed by the same letter are not significant.
NS, *, **, Non-Significance, Significant to 5%, and highly Significant to 1%.

Table 2. Shoot-tissue analysis for *Viola tricolor* grown with one of six media /fertilizer combinations. Each value is the mean of four samples, each composed of four plants.

	Nutrient Tested											
Treatment	N %	P %	K %	Ca %	Mg %	S %	B ppm	Cu ppm	Fe ppm	Mn ppm	Na ppm	Zn ppm
300 ppm N MSU Special Soilless Medium	1.25 b[y]	0.20 c	2.25 c	0.98 bc	0.61 ab	0.12	24 a	2.9 b	46 bcd	76 b	699	94 a
300 ppm N MSU Special 30% Soil Medium	1.64 ab	0.17 c	3.02 b	0.67 cd	0.47 c	0.14	22 bc	3.0 b	41 cd	20 d	843	82 ab
300 ppm N Omega 6-6-6 30% Soil Medium	1.63 ab	0.34 b	3.15 b	0.98 bc	0.52 c	0.15	20 d	2.5 b	50 bc	33 c	912	46 e
600 ppm N Omega 6-6-6 30% Soil Medium	1.96 a	0.49 a	4.0 a	1.11 a	0.64 a	0.16	21 cd	3.7 a	78 a	94 a	788	60 d
300 ppm N Fish Emulsion 30% Soil Medium	1.70 a	0.18 c	2.89 b	0.96 d	0.50 c	0.15	23 ab	2.6 b	37 d	32 cd	853	75 bc
600 ppm N Fish Emulsion 30% Soil Medium	1.92 a	0.18 c	3.15 b	1.03 ab	0.57 b	0.16	24 a	2.8 b	54 b	35 c	808	64 cd

Table 2 (cont'd).

Overall Mean Value	1.68	0.26	3.08	0.97	0.55	0.15	22	2.9	51	48	817	70
C.V.	16.52	12.82	10.84	8.28	5.91	18.78	5	16.1	15	18	31	12

[y]Significance is in columns for each nutrient tested. Means followed by the same letter are not significantly different at $P = 0.05$.

Table 3. Total flower number, average flower size in cm^2, and plant dry weight in grams, for *Viola tricolor* and *V.* ×*wittrockiana* grown in a 30% soil medium and fertilized with Omega 6-6-6 300 or 600 ppm N.

	Viola tricolor		*Viola* ×*wittrockiana*	
Plant Characteristic	Omega 6-6-6 300 ppm N	Omega 6-6-6 600 ppm N	Omega 6-6-6 300 ppm N	Omega 6-6-6 600 ppm N
Total Number of Flowers[x]	42a[z]	42a	8a	7a
Average Flower Size[y] (cm^2)	6.4a	5.7a	40.6a	33.9a
Plant Dry Weight (g)	18.9a	13.4b	13.7a	12.5a

[x]Average flower number based on 11 observation during the weeks of 2/5/99 to 4/19/99.
[y]Average flower size based on 10 observations during the weeks of 2/5/99 to 4/19/99.
[z]Significance is in rows for each species. Values with the same letter are not significantly different at $P = 0.05$.

Table 4. Summary of analysis of variance for media pH and EC at the sixth, 12th, and 18th sampling week after the first fertilizer application, for eight edible-flower species.

	Media pH			Media EC		
Species	Week 6	Week 12	Week 18	Week 6	Week 12	Week 18
B. ×*tuberhybrida*	**	**	***	**	*	*
B. officinalis	***	NS	***	**	NS	*
C. sativum	NS	NS	NA	NS	NS	NA
D. superbus	**	***	NS	**	***	NS
P. coccineus	***	*	NA	*	NS	NA
T. majus	**	*	*	*	NS	NS
V. tricolor	**	NS	*	*	***	NS
V. ×*wittrockiana*	**	**	**	***	***	**

NS,*,**,*** Nonsignificant or significantly different at P = 0.05, 0.01, or 0.001, respectively

NA, Data not available, shoot-tissue was harvest prior to this sampling week.

Figure 1. Root media pH of eight species in soilless (●) or 30% soil medium with five water-soluble fertilizer treatments (MSU Special (19-1.8-19) a water-soluble fertilizer at 300 (●,○) ppm N; Omega 6-6-6 (6-2.6-5) a commercially available blend of organic nutrient sources at 300 (▾) and 600 (▿) ppm N; and Fish Emulsion (5-0.4-0.8) at 300 (■) and 600 (□) ppm N). Data points are means of two samples of three pots each.

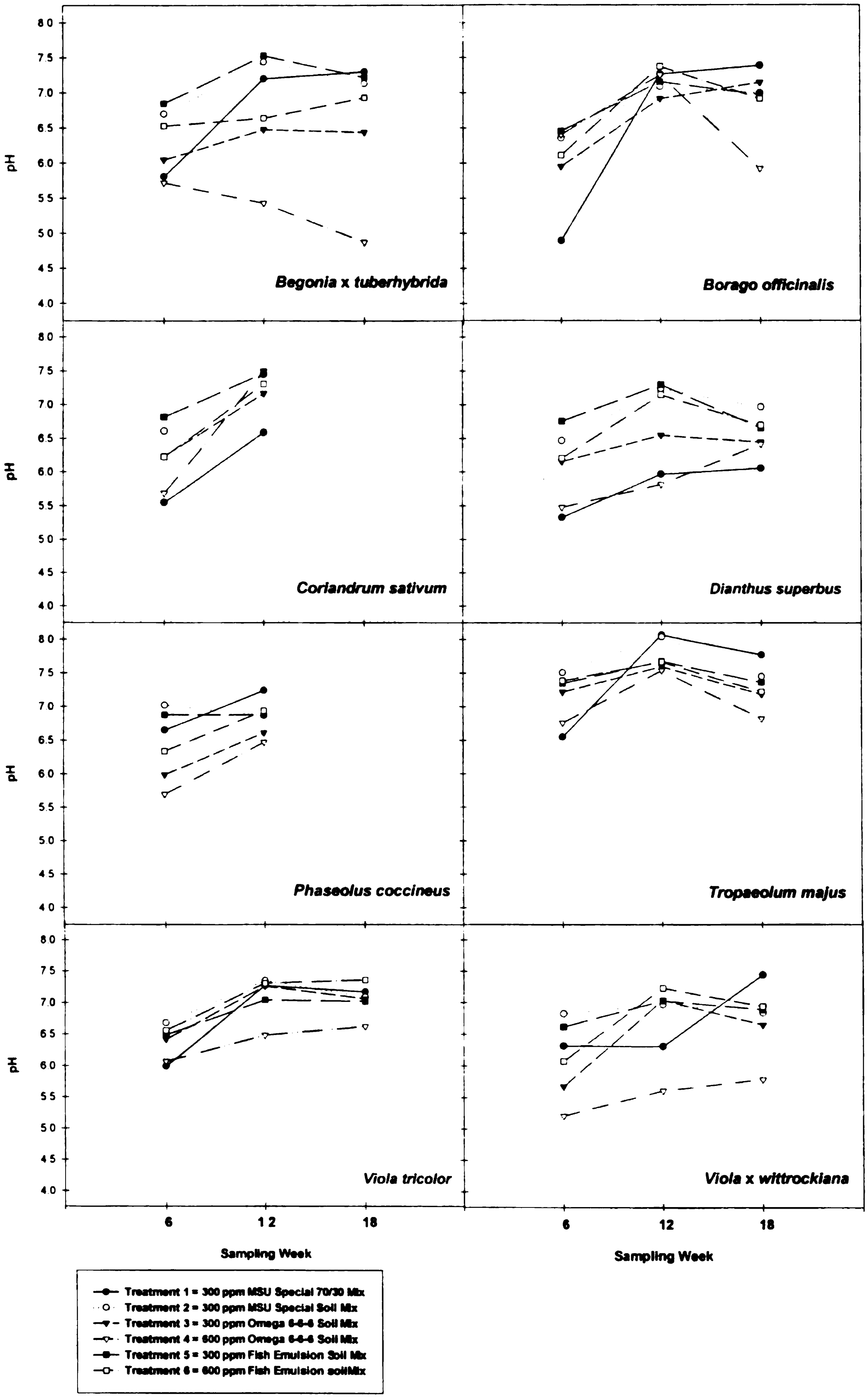
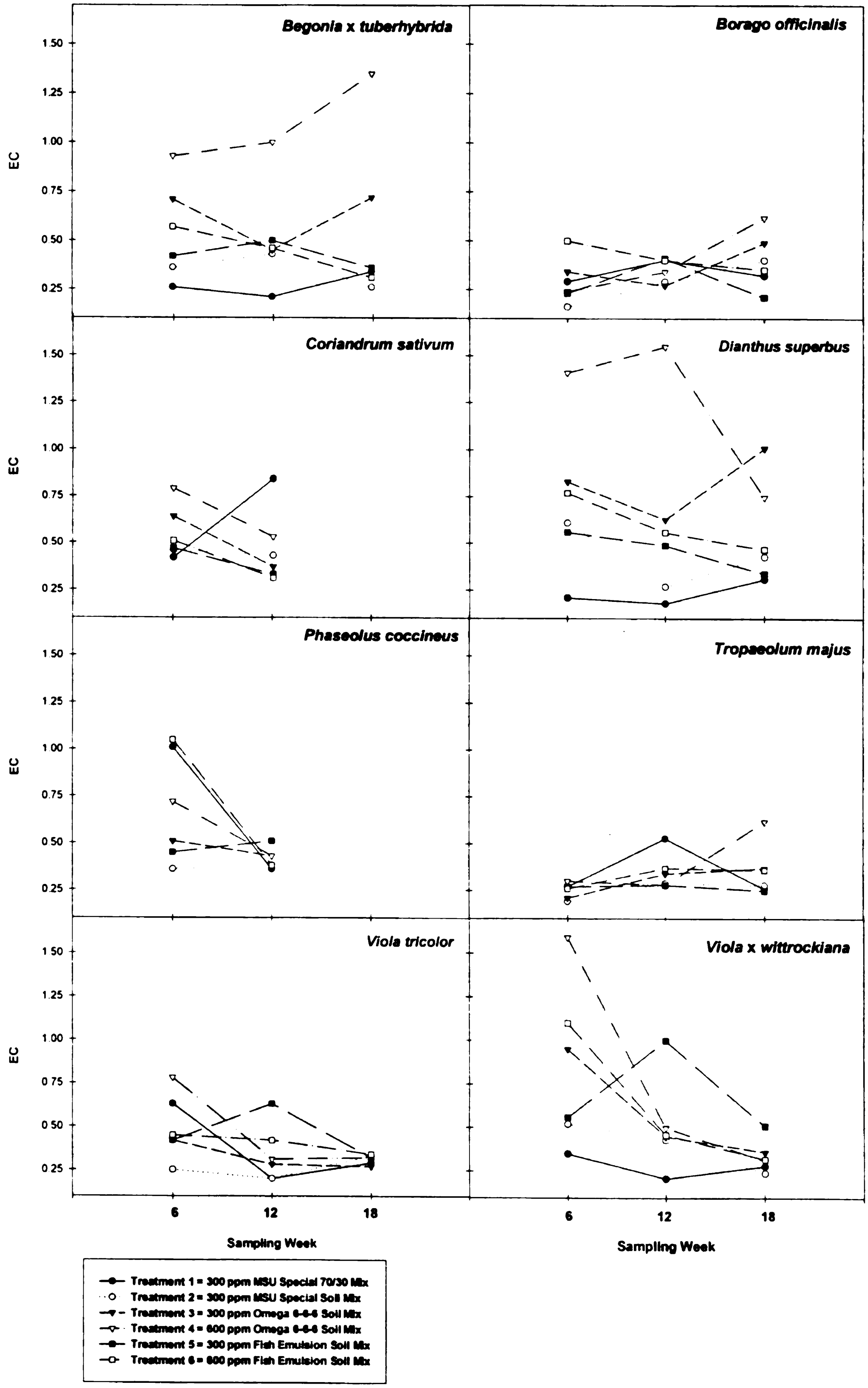

pH
Begonia x tuberhybrida
Borago officinalis
Coriandrum sativum
Dianthus superbus
Phaseolus coccineus
Tropaeolum majus
Viola tricolor
Viola x wittrockiana
Sampling Week
Treatment 1 = 300 ppm MSU Special 70/30 Mix
Treatment 2 = 300 ppm MSU Special Soil Mix
Treatment 3 = 300 ppm Omega 6-6-6 Soil Mix
Treatment 4 = 600 ppm Omega 6-6-6 Soil Mix
Treatment 5 = 300 ppm Fish Emulsion Soil Mix
Treatment 6 = 600 ppm Fish Emulsion soilMix

Figure 2. Root media EC of eight species in soilless (●) or 30% soil medium with five water-soluble fertilizer treatments (MSU Special (19-1.8-19) a water-soluble fertilizer at 300 (●,○) ppm N; Omega 6-6-6 (6-2.6-5) a commercially available blend of organic nutrient sources at 300 (▾) and 600 (▿) ppm N; and Fish Emulsion (5-0.4-0.8) at 300 (■) and 600 (□) ppm N). Data points are means of two samples of three pots each.


Begonia x tuberhybrida
Borago officinalis
Coriandrum sativum
Dianthus superbus
Phaseolus coccineus
Tropaeolum majus
Viola tricolor
Viola x wittrockiana
EC
1.50
1.25
1.00
0.75
0.50
0.25
6
12
18
Sampling Week
Treatment 1 = 300 ppm MSU Special 70/30 Mix
Treatment 2 = 300 ppm MSU Special Soil Mix
Treatment 3 = 300 ppm Omega 6-6-6 Soil Mix
Treatment 4 = 600 ppm Omega 6-6-6 Soil Mix
Treatment 5 = 300 ppm Fish Emulsion Soil Mix
Treatment 6 = 600 ppm Fish Emulsion Soil Mix

SECTION V

POSTHARVEST SHELF LIFE OF FIVE EDIBLE FLOWERS

Postharvest shelf life of five edible flowers

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Abstract. Five species of edible flowers were stored at -2.5 to 20 °C. Flowers were rated for visual quality each day for two weeks on a scale of 1-5 (5 being the greatest). *Viola tricolor* L. 'Helen Mount' (viola), *V. ×wittrockiana* L. 'Accord Banner Clear Mixture' (pansy), and *Tropaeolum majus* L. 'Jewel Mix' (nasturtium) flowers showed similar losses in quality and were all rated a 5 when stored at 0 and 2.5 °C after two weeks. *Borago officinalis* (borage) stored at 0 to 5 °C were rated marketable, 3 or higher, after one week, and those stored at -2.5 °C were still marketable after two weeks. The highest ratings *Phaseolus coccineus* L. (scarlet runner bean) flowers received were 3s and 4s when stored at 0 to 10 °C, after one week. Scarlet runner bean flowers were unmarketable after 10 d at 0 and 2.5 ° C, 9 d at 5 °C, and 7 d at 10 °C.

Introduction

There has been an increased popularity of edible flowers as evidenced by an increase in the number of edible-flower cookbooks, culinary magazine articles, and television segments (Rusnak, 1999). Consumers purchase packaged flowers for use in meals as a garnish or ingredient in salads, soups, entrees, desserts, and drinks (Barash, 1998a; Barash 1998b). Edible flowers are a niche crop (Rusnak, 1999). To successfully market edible flowers, consumer preferred colors and species should be included in the packages (Kelley et al., 2000a; Kelley et al., 2000b; Kelley et al., unpublished data). Growers want to ensure that only their highest quality product, with a maximum shelf life is marketed to encourage repeat purchases.

Edible flowers sold in retail stores are usually placed next to herbs in the refrigerated sections of the produce department (personal observation). To protect the flowers from desiccation and to preserve their frail structure, they are typically packaged in small, rigid, plastic or plastic wrapped packages (Whitman, 1991). To our knowledge, no standards for harvest and handling have been published in referred journals.

Temperature is usually the most important environmental factor limiting shelf life of fruits, vegetables, and herbs (Watada and Qi, 1999; Aharoni et al., 1993; and Paull, 1999). Aharoni et al. (1993) indicated that several herbs were best stored near 0 °C, though some herbs like basil (*Ocimum basilicum* L.) are sensitive to chilling injury when stored below 10 °C (Lange and Cameron, 1994; Cantwell and Reid, 1992). To our knowledge, no information has been published that identify factors limiting quality and no guidelines have been established for how edible flowers should be stored. Though refrigeration will most likely extend shelf life of most edible flowers, some could be sensitive to chilling injury.

Of 100 identified species with edible flowers, 28 were tested for greenhouse production (unpublished data), and 12 were selected for further study. Five of these edible flowers were selected for further marketing and storage studies based on availability, recommendations in cookbooks, and ease of production, harvesting and handling. Seeds of all five species are available from several sources and can be grown to flower in 20 weeks or less. *Viola tricolor* (viola) and *V.* × *Wittrockiana* (pansy) are popular compact-growing bedding plants that are easily grown to flower in containers. Pansy has been hybridized to increase flowers size and is available in a multitude of colors from white to black to multicolor. *Tropaeolum majus* (nasturtium) can be grown in hanging baskets and also has edible foliage.

Borago officinalis (borage) is an annual herb grown frequently for its medicinal properties, but is now recognized for its culinary attributes also. *Phaseolus coccineus* (scarlet runner bean) is grown as an annual with flowers that range in color from white to orange and pink. Each edible flower chosen for this experiment has its own distinct flavor. Viola and pansy have a wintergreen or sweet flavor, while nasturtium can have a taste similar to a radish or a peppery flavor. Borage has a cucumber flavor and scarlet runner bean flowers taste like fresh beans.

The objective for this research was to determine the effect of storage temperatures on the rate of loss of visual quality for these five edible flowers.

Materials and Methods

Seeds of viola, pansy, borage, nasturtium, and scarlet runner bean species were sown between September 25 and October 23, 1998, into 30 (80 ml) cell plug trays with a medium consisting of 40% (by volume) of peat (Sun Gro Horticulture, Bellevue, WA), 40% coconut coir (Chrystal Company Gro-Brick, St. Louis, MO), and 20% coarse vermiculite (Strong-lite, Pine Bluff, AR). Pulverized dolomitic lime (9 $kg\bullet m^{-3}$ (15 $lbs\bullet yd^{-3}$); National Lime and Stone Co., Corey, OH) was added to the mix to raise the pH to 6.3. Plug trays were placed into a 25 °C day and night temperature propagation greenhouse. After germination, plug trays were placed into a 21 °C day and night temperature greenhouse. Four-hundred-watt high-pressure sodium (HPS) lamps provided a photosynthetic photon flux (PPF) of 100 $\mu mol{\cdot}m^{-2}{\cdot}s^{-1}$ when the ambient greenhouse PPF dropped below 200 $\mu mol{\cdot}m^{-2}{\cdot}s^{-1}$ 1 from 0800 to 2400 HR. Supplemental lighting was terminated with PPF exceeded 400 $\mu mol{\cdot}m^{-2}{\cdot}s^{-1}$. Seedlings were watered as needed and fertilized with fish emulsion (500 $mg{\cdot}L^{-1}$ Nitrogen (N), 5N-0.4P-0.8K; Alaska Fish Fertilizer Co., Renton, WA), to supply nutrients for initial growth and development.

From November 19 to December 9, plants were transplanted into a 70% (by volume) peat and 30% perlite (Strong-lite) mixture with a standard starter nutrient charge (0.6 kg (1lb•yd^{-3}) KNO_3, 0.3 kg (0.5 lb•yd^{-3}) triple superphosphate (0-19.8-0), and 0.9 kg (1.5 lb•yd^{-3}) gypsum; 0.07 kg (0.1 lb•yd^{-3}) fritted trace elements; 0.3 kg (0.5 lb•yd^{-3}) wetting agent (Aquagro "G", Aquatrols, Pennsaulken, NJ) per m^3 of medium) and1.5 kg•m^{-3} (2.5 lbs•yd^{-3}) of dolomitic hydrated lime. The pH of this medium was 5.7 at the time of planting. Growing containers were 14.5-cm-tall x 15.5-cm-wide (1.5-L) plastic, square containers.

Starting December 21, plants were fertilized as needed, either weekly or every two weeks, with 200 ml of MSU Special water soluble fertilizer (300 mg·L^{-1} N, 19N-1.8P-19K, 25% NH_4-N, Greencare). The volume of fertilizer chosen insured that plants were well fertilized without any leaching. Species began to flower on October 31. The date of visible bud, first color, when flowering began, full flower and senescence was recorded for 10 to 15 individual flowers on 10 plants of each species. On December 22, to encourage larger, high quality flowers the temperature in the greenhouses was lowered to a constant 16 °C day (Niu et al., 1999).

Flowers were harvested from viola and borage at 1000 HR each week from January 29, 1998 to February 19, 1998. Scarlet runner bean, nasturtium and pansy flowers were harvested at 1000 HR each week from February 26 to March 5 and from March 19 to March 26. On each harvesting date, flowers were removed from the plants and placed in unsealed plastic bags for transporting to the laboratory (≈22°C) for packaging (Lange and Cameron, 1994). Flowers were harvested when completely expanded.

Flowers of each species were placed into 2-mil low-density polyethylene film bags (Dow Chemical Co., Midland, Mich.) constructed using a Magneta 620 heat sealer (Packaging Aids Corp., San Francisco) with four 26.5-gauge needle holes (≈0.4 mm in diameter) in each corner of the bag to improve O_2 and CO_2 exchange (Lange and Cameron, 1994). Viola, borage, and scarlet runner bean flowers were placed in 15 x 11-cm polyethylene bags while pansy and nasturtium flowers were placed in 20 x 11-cm bags. Bags consisted of one of the following: ten viola flowers, ten borage flowers, five scarlet runner bean flowers, three pansy flowers, or three nasturtium flowers. Flowers were inspected to ensure there was no damage prior to being sealed in the bag.

Total time for harvesting and packaging the flowers took less than 90 min on each harvesting date (45 min for harvesting; 45 min for packaging). Six packages of each species were placed in controlled-temperature chambers at 20, 10, 5, 2.5, 0, and -2.5°C, all within ± 1°C. Packages of edible flowers were placed between sheets of black plastic to exclude light during storage. Each day at 1000 HR for 14 days, flower were rated visually using a five-point scale (Table 1.). Data were analyzed using Cochran-Mantel-Haenszel Statistics to determine significance between temperatures for visual quality ratings at one week and two weeks time.

Results and Discussion

Each edible flower showed symptoms of quality decline when stored at temperatures which did not promote maximum shelf life. Symptoms included water soaking, necrosis, surface molds, and total tissue collapse. Visual quality ratings for each flower are given in Table 1. A flower which was rated 1 or 2 was considered unmarketable.

The pattern of quality loss as a function of temperature at two times for flowers of nasturtium, viola, and pansy was largely similar (Figure 1). Flowers of these species stored at 0 and 2.5 °C had no visual defects after two weeks and were of marketable quality, (rated 3 or higher) for one week when stored between -2.5 and 10 °C and for two weeks at -2.5 to 2.5 °C. After two weeks at -2.5, the visual quality of nasturtium flowers declined, though they were still marginally acceptable. At 10 °C viola flowers were rated unmarketable after 7 d (marketable for 7 d), while pansy and nasturtium were both rated unmarketable after 11 d. When stored at 20 °C, viola was rated unmarketable after day two and pansy and nasturtium were rated unmarketable after day five and six, respectively.

As temperature increased, visual quality of borage flowers decreased rapidly (Figure 2). Borage flowers were only marketable for 1 d when stored at 20 °C, 5 d when stored at 10 °C, 8 d at 5 and 2.5 °C, and 12 d at 0 °C. Only borage flowers stored at temperatures of -2.5 to 5 °C were rated marketable after one week. After two weeks, only flowers stored at -2.5 °C were rated marketable.

After one week of storage, scarlet runner bean flowers had the highest visual quality when stored at 0 to 10 °C, but average ratings were never higher than 4 (Figure 2). After two weeks, scarlet runner bean flowers received unmarketable ratings between 1 and 2, independent of temperature. Scarlet runner bean was rated unmarketable after 2 d at -2.5 °C, 10 d at 0 and 2.5 °C, 9 d at 5 °C, 7 d at 10 °C , and 3 d at 20 °C. While on the plant in a greenhouse at 16 °C, it took 4 d from the time scarlet runner bean flowered until senescence, while other flowers tested ranged from 6 d for borage, 8 d for nasturtium and viola and 10 d for pansy. The longevity of bean flowers both on the plant and when harvested and stored in controlled-temperature chambers is much shorter than the other species tested. This flower should only be included in packages expected to be consumed in less than one week.

Conclusion

Based on the results from this research, three of the five flowers, viola, pansy, and nasturtium, can be stored at 0 and 2.5 °C for two weeks and still have a perfect visual quality. Viola and pansy flowers, when stored at even lower temperatures of -2.5 °C, received visual quality ratings above 3. *Viola* species are often one of the first species blooming in early spring in Zone 5 (-20 to -10 °C). Perhaps if the viola and pansy flowers are preconditioned during production to cold temperature similar to those used in this experiment, shelf life might be extended at below-freezing temperatures.

Borage and scarlet runner bean flowers did not store well for two weeks; only borage flowers stored at -2.5 °C were acceptable. The longest period of acceptable visual quality for four of the edible flowers tested existed when they were stored around 0 °C, the benchmark established by Aharoni et al., (1993) for herbs. Only scarlet runner bean flowers were not rated marketable when stored at any temperature after two weeks.

LeBlanc et al. (1996) reported that the mean temperatures of refrigerated cases in grocery stores are 7.6 to 8.4 °C in the winter and summer, respectively. Viola, pansy, and nasturtium flowers rated in this experiment had no defects when stored for two weeks at 0 and 2.5 °C, which is at least 5 °C lower than the display cases in the grocery store. For all flowers tested except pansy, it would be expected that the visual quality would not be marketable after two weeks when stored at temperatures used in the grocery store. Pansy flowers, however, were marketable after two weeks at 5 °C and slightly below a rating of 3 at 10°C. Pansy flowers stored at between 5 and 10 °C may be marketable after two weeks.

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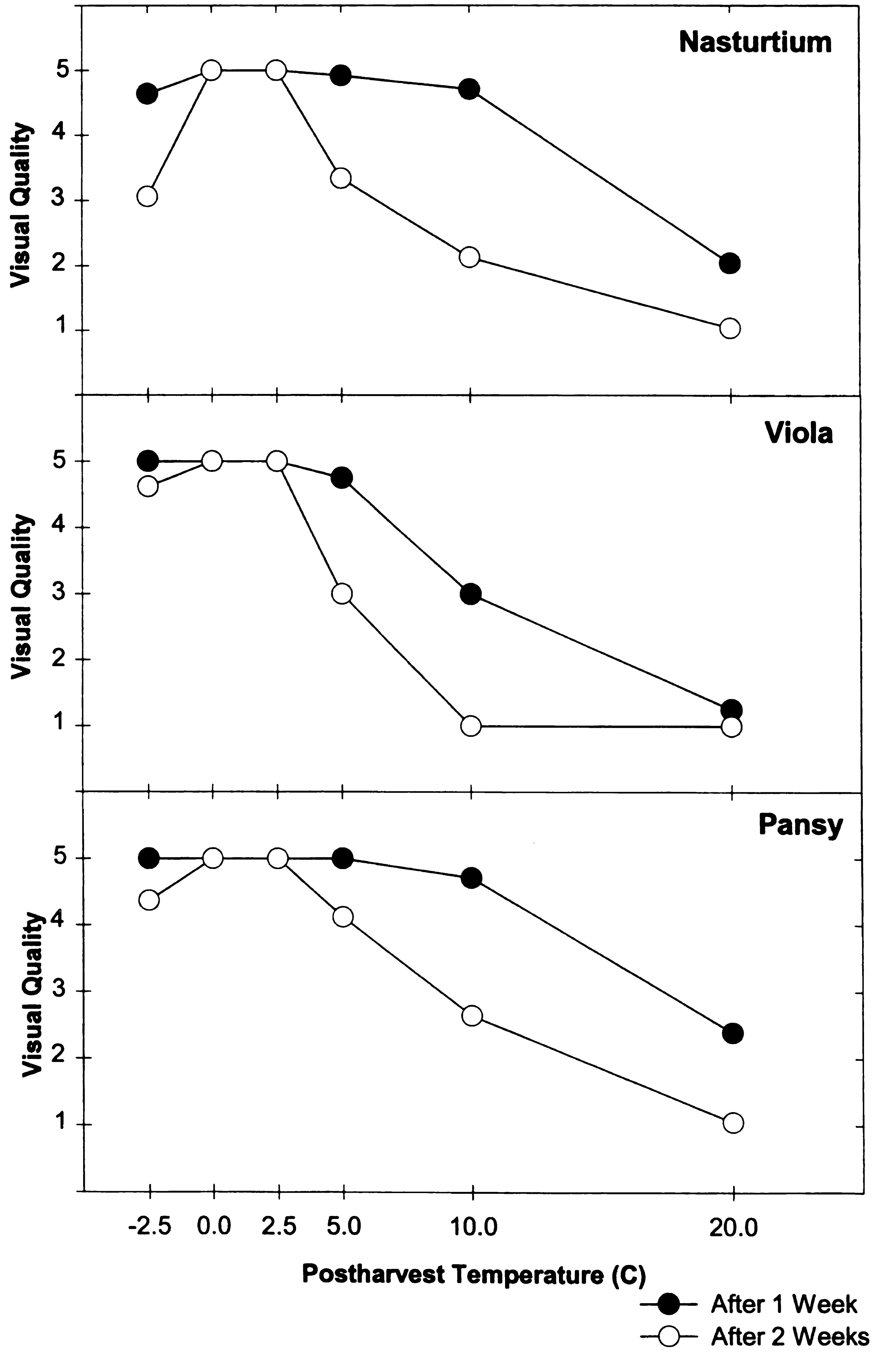
Table 1. Postharvest visual quality characteristics, as influenced by temperature, for five edible flowers rated 1-5 (5 being the greatest).

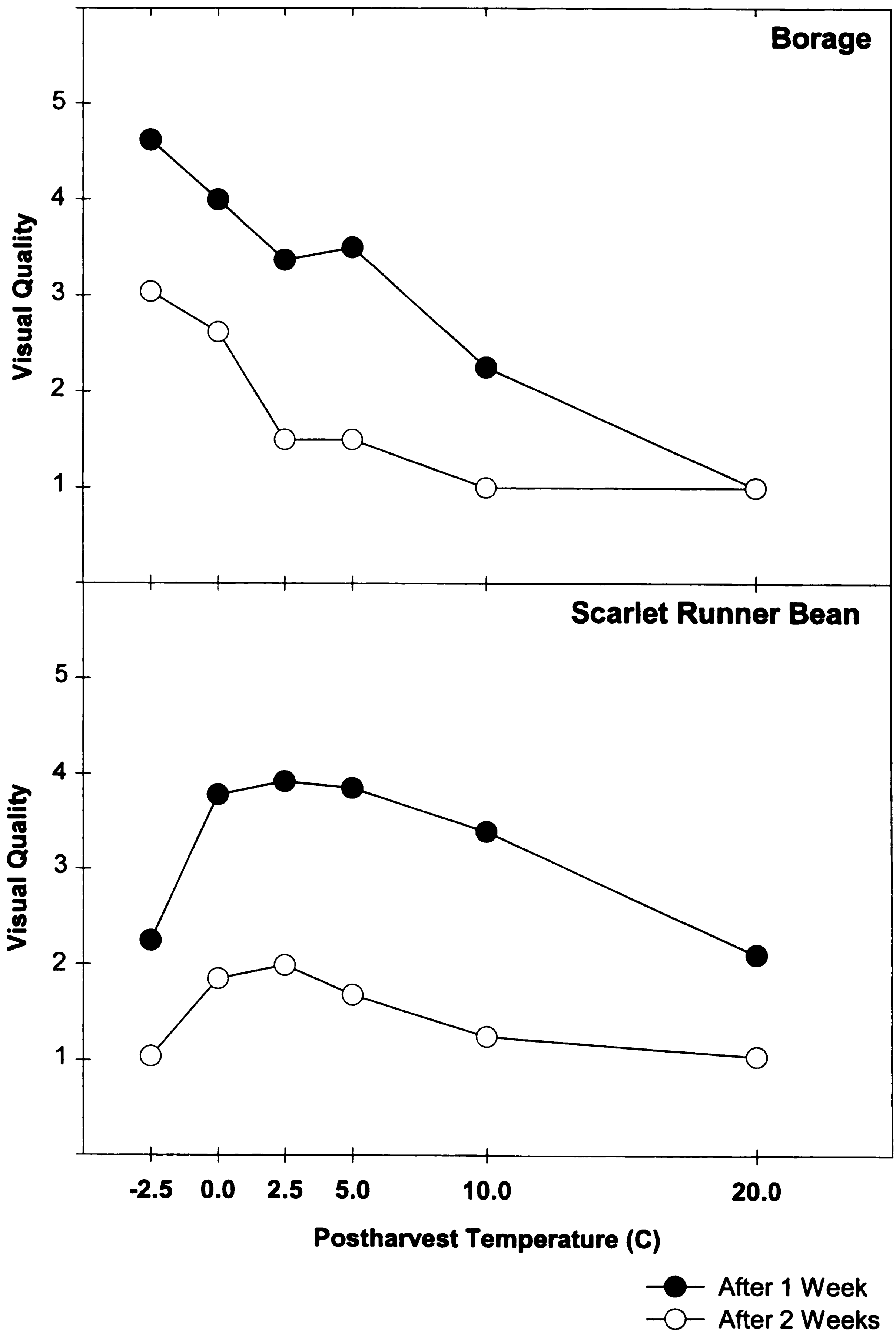
	Rating				
Species	1	2	3	4	5
Borage	Petals are wilted and brown, pistils are split and brown	Petals are wilted and turned from blue to pink, pistils are split and brown	Petals are wilted and pistils are spilt	Petals are wilted	No Defects
Scarlet Runner Bean	Flower are water soaked and dark	Most of petal curled and color darkens	Tips of petals are curled	Tips of petals slightly soft	No Defects
Nasturtium	Flower are water soaked and dark	Most of petal curled and color darkens	Tips of petals are curled	Tips of petals slightly soft	No Defects
Viola	Flowers are wilted	Petals are curled severely	Petals are curled moderately	Petals are curled slightly	No Defects
Pansy	Flowers are wilted	Petals are curled severely	Petals are curled moderately	Petals are curled slightly	No Defects

Fig. 1. The postharvest visual quality assessment for nasturtium, viola, and pansy flowers stored at -2.5 to 20 °C for one and two weeks. Visual quality ratings for one week and two weeks were significantly different at $P = 0.001$.



Nasturtium
Viola
Pansy
Visual Quality
5
4
3
2
1
-2.5
0.0
2.5
5.0
10.0
20.0
Postharvest Temperature (C)
After 1 Week
After 2 Weeks

Fig. 2. The postharvest visual quality assessment for borage and scarlet runner bean flowers stored at -2.5 to 20 °C for one and two weeks. Visual quality ratings for one week and two weeks were significantly different at $P = 0.001$.


Borage
Scarlet Runner Bean
Visual Quality
Visual Quality
5
4
3
2
1
-2.5
0.0
2.5
5.0
10.0
20.0
Postharvest Temperature (C)
After 1 Week
After 2 Weeks

DISSERTATION CONCLUSION AND RESEARCH SUMMARY

Dissertation Conclusion and Research Summary

Based on the information presented in this dissertation, summary comments can be made about marketing, postharvest, and fertilizer experiments. We have learned that there is an acceptance for certain species of edible flowers. Garden Day and Michigan Chef de Cuisine participants were more likely to purchase viola and nasturtium flowers and would be very likely to use them as a salad ingredient, garnish, and as a meal ingredient. Bloomfest participants would also be more likely to purchase the 16 ounce containers, with all three flower colors offered (yellow, orange, and blue), at a price of $2.99. Garden Day and Master Gardener participants rated flower quality and would still purchase viola, pansy, and tuberous begonias with visual quality ratings of 3 (ratings below a 3 were considered unmarketable), on a scale of 1-5, while they would only purchase borage and nasturtium until stage 4.

Viola, pansy, and nasturtium flowers showed similar losses in quality at warmer temperatures, but were rated a 5 after two weeks of storage at 0 and 2.5 °C. Borage flowers received marketable ratings when stored at 0 to 5 °C for a one week period, with those stored at -2.5 °C were still marketable after two weeks. Scarlet runner bean flowers were unmarketable after 2 d at -2.5 °C, 10 d at 0 and 2.5 °C, 9 d at 5 °C, 7 d at 10 °C, and 3 d at 20 °C.

Finally, species of edible flowers were grown using a 30% soil, certifiable organic medium with amendments. Plants fertilized every two weeks with 300 ppm N, fish emulsion (5N-0.4P-0.8K at dilution rates of ml/liter), had fresh weights, dry weights, and percent dry weights that were larger or the same as other treatments used in this experiment. Based on nutrient analysis of dried whole shoots these plants also had low shoot-tissue nutrient levels, but within recognized or published ranges. All species were successfully growth with one soil and fertilizer treatments.

Other research, which will be published after the completion of the dissertation, focused on additional aspects of edible flower marketing and production. Three additional marketing studies were conducted and funded by The Fred C. Gloeckner Foundation, Inc. During Bloomfest 2000, participants answered questions about what species of flowers they would prefer in containers they would purchase. A telephone survey conducted by Team Telecom in East Lansing, MI, contacted 448 households in the Detroit Metro Area about their familiarity with edible flowers. A final marketing experiment was conducted with four Whole Foods Market stores in the Detroit Metro Area. For six weeks, 20 packages of edible flowers were delivered to each store. During the first week, the price for each container was priced at $3.99, $2.99 the following week and $1.99 for the remainder of the experiment.

From February to June 2000, an additional nutrient management experiment was conducted to compare plant growth and development of impatiens grown in a soilless medium vs. a root medium with compost. This research was supported by a grant from the Organic Farming Research Foundation. There were 12 fertilizer treatments and two media treatments for a total of 24 treatments. Organic amendments were either incorporated into the media or applied as a water soluble nutrient source ever two weeks. The response to the organic fertilizer was dependent on the type of root medium used. Nutrient analysis of shoot samples was completed and media samples were analyzed every three weeks for pH and EC.

From June to September 1999, a cost of production model was developed for use with niche crops grown in a minimally-heated greenhouse. Variable and fixed costs were tabulated for an entire greenhouse operation including headhouse options, vehicle purchase or lease options, and three levels of costs for pest control, lighting, and cooling. A final spreadsheet allows the user to total the cost for their operation based on which options they choose.

Cultural information has also been collected on the growth and development of 18 annual and perennial species with edible flowers. Specific production recommendations and expected times to harvest will be published in a how-to article.

Finally, with the help of David Cappert, Research Associate in the Department of Entomology, biological control was used over a three year period to control insect populations in the greenhouse. This research was also partially funded by the Organic Farming Research Foundation, Project GREEEN and a grant from IPM Soils. Information from this component has been compiled into a research report to be presented to growers. While biological control was generally successful, the high level of management and high cost of purchasing small amounts of predators and parasites would not likely make this approach economically feasible. Further research should include the use of spray materials identified as acceptable for organic certification.

Each paper in this dissertation and those that will be published in the near future have added to the sparse knowledge about edible flowers. During the past three years the authors have been contacted by several small growers, consumers who attended the authors presentation on the subject of edible flowers, and other individuals who are interested in production or use of edible flowers. Our future goal is to make this information available to these interested producers and consumers in a form other than scientific papers. Of the original objectives outlined, all have been accomplished at a level that would allow us to provide the information necessary for producers to successfully begin production and marketing organically-grown greenhouse edible flowers. Our goal now must be to communicate this information in a useable format for potential growers.

Though the primary research materials for this dissertation were edible flowers, the experiments conducted for the published papers can be used as models for other niche greenhouse crops where little is known about the market potential, production, and postharvest shelf life. There is great potential for continued study of other crops using the methods described in our papers.

APPENDICES

Appendix A

Survey instrument used for an edible flower tasting with Garden Days participants at Michigan State University 7 August 1998.

Title of Survey: Consumer perceptions of three edible-flower species.

Edible Flower Evaluation, Form A.

Cup A

First, only look at the flowers in the cup and rate them using the 1-7 scale below. Circle the number which most closely reflects your response. If you have no strong feeling either way, please circle a "4" to show you have a "neutral" feeling on this item.

Please look at the flowers in the cup marked "A" and make your responses on those flowers only. Just from a visual perspective, how do you feel these flowers look?

				Neutral				
Unappealing	1	2	3	4	5	6	7	Appealing
Undesirable	1	2	3	4	5	6	7	Desirable
Not at all interested in tasting	1	2	3	4	5	6	7	Very interested in tasting

Now, please smell the flowers in the cup and circle the response that most accurately reflects how you feel about the smell of these flowers. If you don't notice much fragrance, circling a "4" would reflect this.

Unappealing	1	2	3	4	5	6	7	Appealing
Unpleasant	1	2	3	4	5	6	7	Pleasant

Next, please taste the flowers in Cup A and circle the response that most accurately reflects their taste.

Tasteless	1	2	3	4	5	6	7	Tasty
Undesirable	1	2	3	4	5	6	7	Desirable

Finally, how likely would you be to . . .	Very Unlikely			Moderately Likely			Very Likely
Purchase this as a garnish for a meal?	1	2	3	4	5	6	7
Purchase this to eat in a salad?	1	2	3	4	5	6	7
Grow and harvest this from your garden?	1	2	3	4	5	6	7
Purchase this if it were available for use in a salad or as a food garnish? (with a reasonable cost/price)	1	2	3	4	5	6	7
Serve this to friends or family at a meal?	1	2	3	4	5	6	7

Please answer as many of the following questions regarding yourself as you want, giving your best estimate where exact answers are not known. *These questions are very important*; they will help us make sure that we are getting a representative sample of people. Your responses are anonymous; we have no way to connect your response to this form.

1. In what year were you born? ________

2. Are you... ______Female? or ______Male?

3. What is the highest level of education you have completed? Please check one.

    ____some high school ____high school graduate
    ____some college/technical school ____college/tech. graduate

4. Of the following, which category best represents your 1998 household income before taxes? Please check one.

____less than $20,000 ____$60,000 to $79,999 ____$120,000 to $139,999
____$20,000 to $39,999 ____$80,000 to $99,999 ____$140,000 to $159,999
____$40,000 to $59,999 ____$100,000 to $119,999 ____$160,000 or more

5. What is your family status? Please check one.

    ___single, dependents ___married, dependents
    ___single, no dependents ___married, no dependents

6. How many people live in your household, counting yourself as one?

    ____number of people in my household

7. What is the zip code for your mailing address? ____________

Appendix B

Survey instrument used for an edible flowers tasting with members of the Michigan Chef de Cuisine Inc. Association at the Detroit Athletic Club in Detroit, Mich., 8 March 1999.

Title of Survey: Professional chef perceptions of three edible-flower species.

Edible Flower Evaluation, Form A

Cup A

First, only look at the flowers in the cup and rate them using the 1-7 scale below. Circle the number which most closely reflects your response. If you have no strong feeling either way, please circle a "4" to show you have a "neutral" feeling on this item.

Please look at the flowers in the cup marked "A" and make your responses on those flowers only.Just from a visual perspective, how do you feel these flowers look?

				Neutral				
Unappealing	1	2	3	4	5	6	7	Appealing
Undesirable	1	2	3	4	5	6	7	Desirable
Not at all interested in tasting	1	2	3	4	5	6	7	Very interested in tasting

Now, please smell the flowers in the cup and circle the response that most accurately reflects how you feel about the smell of these flowers. If you don't notice much fragrance, circling a "4" would reflect this.

Unappealing	1	2	3	4	5	6	7	Appealing
Unpleasant	1	2	3	4	5	6	7	Pleasant

Describe the fragrance of the flower ________________________

Next, please taste the flowers in Cup A and circle the response that most accurately reflects their taste.

Tasteless	1	2	3	4	5	6	7	Tasty
Undesirable	1	2	3	4	5	6	7	Desirable

Describe the taste of the flower ____________________________

Finally, how likely would you be to . . .	Very Unlikely			Moderately Likely			Very Likely
Purchase this flower for use in a meal?	1	2	3	4	5	6	7
Purchase this to eat in a salad?	1	2	3	4	5	6	7
More likely to purchase if grown organically?	1	2	3	4	5	6	7

Purchase this if 10% of the flower had

insect damage?	1	2	3	4	5	6	7

What food item would you most likely use this flower in? ____________________________

Do you currently use this flower in your presentations, if not would you?_______________

How many days during a week would you use this flower in food presentations?__________

What would you be willing to pay for a dozen of these flowers?_______________________

Please answer as many of the following questions regarding yourself as you want, giving your best estimate where exact answers are not known. These questions are very important; they will help us make sure that we are getting a representative sample of people. Your responses are anonymous; we have no way to connect your response to this form.

1. What is the zip code of your establishment? __________

2. Are you... _____Female? or _____Male?

3. How many meals per week do you serve at your establishment last week? _________

4. Least expensive entrée on your menu? __________

5. Years employed as a chef? __________

6. Are you certified? __________

7. If so, what is your certification level? _______________________________________

Thank you for your time. Any additional comments that you could express in writing would be appreciated.

Appendix C

Survey instrument used at Bloomfest at Cobo Hall, Detroit, Mich., 9 and 10 April 1999.

Title of Survey: Consumer preference of edible-flower color, container size, and price.

Dear Participant:

Several Michigan State University researchers are investigating consumer perceptions of edible flowers. We would like you to take a few minutes (less than 10), to help us evaluate the pictures of the containers of edible flowers. Your response is anonymous. We have no way to connect you, as an individual, to this completed survey form. You are free to not answer any question you choose, but please try to answer every question. We are not able to use incomplete responses. Thank you for your time.

Please look at the corresponding board of containers of edible flowers. Please consider the following situation: You are buying a container of edible flowers to use in a meal you are preparing for family and friends. Using a 100 point system, please assign points to the containers of flowers (A through AA), giving your favorite the most points and continuing to use the points until you do not have any more. The more you like a package the more points you should allocate to it.

EDIBLE FLOWER BOARD

A	**B**	**C**	**D**	**E**	**F**	**G**	**H**
I	**J**	**K**	**L**	**M**	**N**	**O**	**P**
Q	**R**	**S**	**T**	**U**	**V**	**W**	**X**
		Y	**Z**	**AA**			

1. Have you ever eaten edible flowers before? ___yes ___no
   If yes, list the names if you can ______________________

2. Have you ever purchased edible flowers before? If yes, where did you purchase them? _____

3. How much would you pay for a 9 count container at Kroger? __________ Merchant of Vino?_________

4. How much would you pay for a 18 count container at Kroger? _________ Merchant of Vino?_________

5. What is the name of the store where you shop for ingredients for special dinners?

____

6. How many prepackaged salad mixes have you purchased in the last month? ________ number of packages.

7. Are you **more** or **less** likely to eat a salad during the summer months (circle one)?

8. Are you more likely to purchase a **prepackaged salad mix** or **separate salad ingredients** (circle one)?

9. How many meals did you cook at home last week? _______ How many times did you eat out? _____

10. How many hours a week, on the average, do you spend in your garden during the spring and summer months? __________________

11. What percentage of your garden is flowers? _______ vegetables? _______ lawn?

____

12. How likely would you be to ...

	Very Unlikely			Moderately Likely		Very Likely	
Purchase edible flowers because they were grown pesticide free?	1	2	3	4	5	6	7
Purchase edible flowers as a garnish for a meal?	1	2	3	4	5	6	7
Purchase edible flowers to eat in a salad?	1	2	3	4	5	6	7
How likely would you be to purchase edible flowers if they had 10% insect damage?	1	2	3	4	5	6	7

Please answer as many of the following questions regarding yourself as you want, giving your best estimate where exact answers are not known. These questions are very important; they will help us make sure that we are getting a representative sample of people. Your responses are anonymous; we have no way to connect your response to this form.

1. In what year were you born? ______ 2. Are you.. ___ Female? Or ___ Male?

3. What is the highest level of education you have completed? Please check one.
___some high school ___high school graduate ___some college/technical school ___college/tech. grad.

4. Of the following, which category best represents your 1998 household income before taxes? Please check one.
___ less than $20,000 ___ $20,000 to $39,99 ___ $40,000 to $59,999
___ $60,000 to $79,999 ___ $80,000 to $99,999 ___ $100,000 to $119,999
___$120,000 to $139,999 ___ $140,000 to $159,999 ___ $160,000 or more

5. What is your family status? Please check one.
___ single, dependents ___ single, no dependents
___ married, dependents ___ married, no dependents

6. How many people live in your household, counting yourself as one? _____ number of people.

7. What is the zip code for your mailing address? ____________

Appendix D

Survey instrument used at a Master Gardener Conference 29 June 1999 and at Garden Days at Michigan State University, 5 and 6 August 1999

Title of Survey: Consumer ratings of edible-flower quality, mix, and color.

Dear Gardener:

Several Michigan State University researchers are investigating consumer perceptions of edible flowers. We would like you to participate in this survey concerning edible flower quality. Your response is anonymous. We have no way to connect you, as an individual, to this completed survey form. You are free to not answer any question you choose, but please try to answer every question. We are not able to use incomplete responses. Thank you for your time.

Please look at each picture that will be shown on the slide project screen. After looking at the quality of each flower, please mark either acceptable or not acceptable.

Slide Number		
1	_____Acceptable	_____**Not** Acceptable
2	_____Acceptable	_____**Not** Acceptable
3	_____Acceptable	_____**Not** Acceptable
4	_____Acceptable	_____**Not** Acceptable
5	_____Acceptable	_____**Not** Acceptable
6	_____Acceptable	_____**Not** Acceptable
7	_____Acceptable	_____**Not** Acceptable
8	_____Acceptable	_____**Not** Acceptable
9	_____Acceptable	_____**Not** Acceptable
10	_____Acceptable	_____**Not** Acceptable
11	_____Acceptable	_____**Not** Acceptable
12	_____Acceptable	_____**Not** Acceptable
13	_____Acceptable	_____**Not** Acceptable
14	_____Acceptable	_____**Not** Acceptable
15	_____Acceptable	_____**Not** Acceptable
16	_____Acceptable	_____**Not** Acceptable
17	_____Acceptable	_____**Not** Acceptable
18	_____Acceptable	_____**Not** Acceptable
19	_____Acceptable	_____**Not** Acceptable
20	_____Acceptable	_____**Not** Acceptable
21	_____Acceptable	_____**Not** Acceptable
22	_____Acceptable	_____**Not** Acceptable
23	_____Acceptable	_____**Not** Acceptable
24	_____Acceptable	_____**Not** Acceptable

25	_____Acceptable	_____**Not** Acceptable

Next, please look at each of the slides of *Viola* x *wittrockiana* (Pansy). Based on the color of the flower, how likely would you be to eat this pansy?

	Very **Un**likely		Moderately Likely			Very Likely	
Yellow Pansy	1	2	3	4	5	6	7
Orange Pansy	1	2	3	4	5	6	7
Blue Pansy	1	2	3	4	5	6	7

How more likely would you be to...

1. Purchase edible flowers if grown organically?	1	2	3	4	5	6	7
2. Purchase flowers with 10% insect damage?	1	2	3	4	5	6	7

3. Have you ever eaten edible flowers? ____yes ____no

4. Have you eaten edible flowers in the last 3 months? ____yes ____ no

5. Have you purchased edible flowers in the last year? If yes, where did you purchase them?__________

6. Would you ever be likely to buy edible flowers sold in a market? ____yes ____no

7. Do you have edible flowers growing in your garden for consuming this year? ____yes _____no

8. How many hours each week do you typically spend in your garden? ______

9. Of the 21 meals in a week how may did you cook at home? _____ How many did you eat out? ____

10. In what year were you born?_____

11. Are you.... _____Female? Or _____Male?

12. What is the highest level of education you have completed? Please check one.
___some high school ____high school graduate
____some college/technical school ____college/tech. graduate

13. Of the following, which category best represents your 1998 household income before taxes? Please check one.
___less than $20,000 ___$20,000 to 39,999 ___ $40,000 to $59,999 ___$60,000 to $79,999
___$80,000 to $99,999 ___$100,000 to $119,999 ___$120,000 to $139,999 ___$140,000 to $159,999
___$160,000 or more

14. What is your family status? Please check one.
___single, dependents ___single, no dependents ___married, dependents ___married, no dependents

15. How many people live in your household, counting yourself as one? ____number of people.

16. What is the zip code for your mailing address?___________

Appendix E

The University Committee on Research Involving Human Subjects approval form.

Research title: Consumers evaluate edible flowers and culinary herbs.

MICHIGAN STATE
UNIVERSITY

July 22, 1998

TO: Bridget Behe
A216 Plant & Soil Sci. Bldg

RE: IRB#: 98-447
TITLE: CONSUMERS EVALUATE EDIBLE FLOWERS AND CULINARY HERBS
REVISION REQUESTED: N/A
CATEGORY: 1-G
APPROVAL DATE: 07/21/98

The University Committee on Research Involving Human Subjects'(UCRIHS) review of this project is complete. I am pleased to advise that the rights and welfare of the human subjects appear to be adequately protected and methods to obtain informed consent are appropriate. Therefore, the UCRIHS approved this project and any revisions listed above.

RENEWAL: UCRIHS approval is valid for one calendar year, beginning with the approval date shown above. Investigators planning to continue a project beyond one year must use the green renewal form (enclosed with the original approval letter or when a project is renewed) to seek updated certification. There is a maximum of four such expedited renewals possible. Investigators wishing to continue a project beyond that time need to submit it again for complete review.

REVISIONS: UCRIHS must review any changes in procedures involving human subjects, prior to initiation of the change. If this is done at the time of renewal, please use the green renewal form. To revise an approved protocol at any other time during the year, send your written request to the UCRIHS Chair, requesting revised approval and referencing the project's IRB # and title. Include in your request a description of the change and any revised instruments, consent forms or advertisements that are applicable.

PROBLEMS/ CHANGES: Should either of the following arise during the course of the work, investigators must notify UCRIHS promptly: (1) problems (unexpected side effects, complaints, etc.) involving human subjects or (2) changes in the research environment or new information indicating greater risk to the human subjects than existed when the protocol was previously reviewed and approved.

If we can be of any future help, please do not hesitate to contact us at (517)355-2180 or FAX (517)432-1171.

Sincerely,

David E. Wright

David E. Wright, Ph.D.
UCRIHS Chair

DEW:bed

cc: John Biernbaum
Kenneth Poff
Kathleen Kelly

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University Committee on Research Involving Human Subjects (UCRIHS)

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