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POSTHARVEST HANDLING AND STORAGE OF HAWAIIAN FLOWERS

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This topic is indeed very broad and covers many kinds of flowers commercially produced for local and export markets. In the time alloted, it is impossible for me to cover every facet of postharvest handling and storage of each flower. Therefore, I shall confine my discussion to current research findings on vase life extension of anthuriums.

As you know, the flower industry in Hawaii is continuously increasing in production and value, and anthuriums constitute the major portion of this industry. A few statistics would attest to the importance of this flower to the Hawaiian agricultural economy. In 1969, we shipped to the U.S. Mainland $1,140,000 worth of anthuriums, $1,326,000 worth in 1970, and $1,530,000 worth in 1971. The prediction for 1972 out-of-state shipment is still higher. So it appears that we can expect increasing shipments for some time to come and that the sky is the limit as far as the market demand for anthuriums goes.

Fortunately, up to now there have been no serious postharvest handling or storage problems with anthuriums except those of packaging to prevent mechanical injury and desiccation of flowers in transit. Packaging problems have been solved with the development of modern packaging methods which are apparently satisfactory from the practical standpoint. Two factors have contributed to the apparent lack of major problems in postharvest handling of anthuriums thus far. These are (1) the relatively long vase life of the flowers as compared with that of other flowers, and (2) air shipment for the export trade. At present, flowers are packaged for shipping immediately after harvest or after a brief holding period of a day or so with stems in water at room temperature. There is no need for longer holding periods prior to shipping because the demand in general is greater than the supply. Growers and shippers believe that, with increasing production, the flowers eventually will have to be held for extended periods prior to shipping. For top quality, flowers must be harvested at the proper stage of development. Leaving the flowers intact on the plant too long will not only reduce the quality but will also jeopardize the production of succeeding flowers. Furthermore, interruption in shipping will force the storage of harvested flowers on the shippers' premises. Thus, when the holding period is extended, it becomes imperative that the vase life and quality of the flowers are not impaired during this period. With a view to developing methods to maintain or even extend the vase life of cut anthuriums, research was initiated last year in our laboratory in the Department of Plant Physiology at the University of Hawaii. Some of the research findings we have obtained thus far include:

A. Relationship between flower size (length and diameter of flower stem, length and width of spathe, length and diameter of spadix) and vase life.

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In many flowers, such as carnations and roses, the length of the flower stem is an important adjunct to the quality of the flower and, in general, flowers with longer stems command better prices than those with shorter stems. This also applies to cut anthuriums in which a certain degree of balance between spathe size and length of stem is desirable. The minimum grade requirement for the top two grades of Hawaiian anthuriums specifies that the length of the stem be at least 2.5 times the size (average of length and width) of the spathe. Therefore, we investigated the factor of vase life to determine the physical characters of anthuriums that affect vase life and the characteristics of a flower that assures optimal vase life. We have data for the varieties 'Kaumana Red,' 'Nitta Orange,' and 'Ozaki Red,' but as yet data analysis is complete only for 'Kaumana Red.'

We used about 50 anthuriums of the variety 'Kaumana Red.' The stems of randomly selected flowers were cut to varying lengths, ranging from 8 to 28 inches, and each whole flower was weighed. The stem diameter (widest part) at the butt, length (longest part), and width (widest part) of spathe, and length and diameter (at base) of spadix were also measured for each anthurium. The anthuriums were then stored with stems in water under laboratory conditions. A flower was considered unmarketable when the spadix darkened or when the spathe wilted or darkened. Using these criteria, the vase life of each anthurium was calculated. The relationship between physical characteristics and vase life was determined with a series of statistical analyses involving correlations and regressions.

The results showed that only stem length, stem diameter, and flower weight were highly correlated with vase life. These factors were about equally correlated with vase life, and how they affected vase life is seen in Figure 1 which indicates that the greater the factors, the shorter the vase life. Since stem length is more easily measured than stem diameter or flower weight, the former is more suitable for estimating vase life. In general, the shorter the stem, the greater the vase life; however, for aesthetic value, it should not be too short. Therefore, the final stem length should be determined after consideration of aesthetics which are a factor of price, the grade requirement for export flowers, and the desirable vase life.

B. Chemicals, including commercial preparations, for vase life extension.

We conducted many experiments using commercial floral preservatives and other chemicals to extend the vase life of anthuriums. The flower stems were placed in various concentrations of these preparations at room temperature, and the vase life of the anthuriums determined. Most of the study was conducted on the variety 'Ozaki Red' which normally has the poorest vase life among the commercial varieties. Among the commercial preparations, Floralife, Roselife, and Burpee's Everbloom were effective for extending the vase life, with Floralife the most effective. When used at a concentration of about 1.5 times the commercially recommended rate, it extended the vase life of anthuriums four times over that of the flowers in plain water. Among the many chemicals used in attempts to extend the vase life, the following were effective: N_6-benzyladenine, 8-hydroxyquinoline citrate and sulfate, benzoic acid, sodium benzoate, sodium thiocyanate, ascorbic acid, acetic acid, sodium acetate, hydroxylamine sulfate and hydrochloride, potassium sorbate, and sodium dehydroacetate. Benzoic acid at a concentration of approximately .05 percent was the most effective among the chemicals. It doubled the vase life. Even short periods of exposure (2-3 days) to these materials are beneficial; therefore, if flowers must be held before shipping, it is advantageous to use Floralife or benzoic acid or some other effective preservative or chemical.

C. Interference of water uptake by vascular blockage.

That the interference of uptake of water by vascular blockage in the stem shortens the vase life of roses has been demonstrated elsewhere. We demonstrated this in anthuriums by determining the rate of water passage through a segment of the stem. A 1-inch segment of the butt of the flower stem was freshly cut. The lower end of the segment was dipped in water and the upper end was attached to an apparatus which allowed the collection of water forced through the segment by vacuum created by an aspirator. The amount of water forced through the segment per unit time per unit cross sectional area of the segment at constant partial vacuum pressure was used as a measure of the magnitude of vascular blockage. We found varietal differences in the degree of vascular blockage among the commercial varieties.

Since tannin is very commonly found in plants, and since we suspected that the darkening of the exposed end of the stem was caused by the accumulation of some oxidized material such as tannin, we analyzed the stems for this compound. We found varying amounts of tannin in the varieties examined. Table 1 shows the relationship between the relative degree of vascular blockage, relative tannin content, and vase life of the commercial varieties under ordinary conditions. Varieties with lower tannin content have less vascular blockage and greater vase life and vice versa.

Table 1. Vase life, vascular blockage, and tannin content in commercial anthurium varieties

Variety	Vase life (days)	Vascular blockage (relative degree)	Tannin content (relative)
Nitta Orange	36	+	+
Kaumana Red	22	++	++
Kozuhara Red	21	++	++
Ozaki Red	15	+++	+++

One solution to the problem of vascular blockage is the breeding of varieties with low tannin content, but this takes time and effort. Vase life can be prolonged by cutting away a short segment of the stem end every day or so and thus eliminating the blocked passage. Also, by keeping the stem in cold water (above freezing), the vase life is extended.

In summary, vase life of anthuriums can be extended by removing the portion of the stem with blocked vascular system or by preventing vascular blockage. Vascular blockage can be prevented by maintaining unfavorable pH and temperature levels for enzymatic activity. I believe that at least one beneficial effect of the use of chemicals and commercial floral preservatives is the lowering of the pH of the vase water to levels unfavorable for enzymatic activity. Low temperatures also reduce enzymatic activity.

D. Controlled atmosphere (CA) storage.

This is the storage of commodities, usually fresh, such as fruits and vegetables, under atmospheres of known composition at reduced temperatures. Basically the idea is to further reduce the rate of deterioration by a further reduction in the rate of respiration of the commodity. The rate of respiration is reduced by lowering the oxygen concentration or raising the carbon dioxide concentration, or by combining the two in the storage atmosphere. Usually inert nitrogen gas and carbon dioxide are used to modify the atmosphere.

In our experiments, we lowered the oxygen concentration in the air by mixing it with nitrogen from a cylinder. Thus the proportionately mixed atmosphere which maintained the required levels of oxygen (the remainder nitrogen) was continuously purged through large jars in which the anthuriums were placed with stems in water. After a period of 7 days under CA, the anthuriums were removed to ordinary room temperature conditions for vase life determination. We found that CA storage at 55 F is of no benefit, but it extends the vase life at room temperature. The vase life of anthuriums initially stored under CA of about 2 percent oxygen at room temperature was about twice that of comparable flowers stored in open air. Here, again, there seems to be a possibility of extending the vase life with the use of CA storage, if it becomes necessary to hold the anthuriums prior to shipment. Also, shipping anthuriums in modified atmospheres in sealed containers, such as plastic bags, may be feasible. This will be determined in our laboratory. Furthermore, combining the use of preservatives and chemicals with CA storage may result in additional vase life. This needs to be checked out.

E. Stage of flower maturity on vase life.

The state grade requirement for anthuriums stipulates that the true flowers be opened at least one-third the length of the spadix. In general, our anthuriums are harvested at the stage when the true flowers are opened one-half to three-fourths the length of the spadix. This is a satisfactory stage of maturity for anthuriums with long vase life; but for short vase life varieties, such as the 'Ozaki Red,' our experiments indicate that they should be cut when slightly more mature in order to obtain a longer vase life.

F. Premature wilting.

However adequate the current method of packaging for shipping may be, some naturally short-lived varieties, such as the 'Ozaki Red,' wilt prematurely when immediately placed in water after removal from the package. This occurs even when the stem ends are freshly cut. We discovered that the only way to bring the anthuriums back to their full turgid condition is to completely immerse them in tap water for about 1 1/2 hours after making fresh stem cuts. Longer immersion will cause purple discoloration to develop on the spathe. Premature wilting was essentially prevented or reduced by this immersion treatment prior to placing the anthuriums in a vase with water at room temperature.

G. Refrigeration on vase life.

If refrigeration is to be used for storing anthuriums, 55 F is recommended. Lower temperatures are injurious and higher temperatures are ineffective for vase life extension. However, if the anthuriums are to be stored under ordinary conditions after refrigerated storage, refrigeration is of no advantage, because the total vase life of flowers initially stored under refrigeration is the same as that of flowers continously stored in the open. Refrigerated storage extends the vase life only if the anthuriums are continuously stored at 55 F.

H. Vacuum storage on vase life.

Limited amount of research with the use of vacuum indicates that this might be a feasible technology for shipping anthuriums. In a sense, this is CA storage because oxygen concentration in air is reduced, but coupled with reduced atmospheric pressure. Low vacuum storage extended the vase life to some degree; more work needs to be done, however.

I. Water level in vase on shelf life.

The water level requirement in the vase for anthuriums will vary somewhat with the length of the stem and the size of the spathe; but, in general, our conclusion is that it should be at least 5 inches for the different sizes of flowers commercially handled in Hawaii.

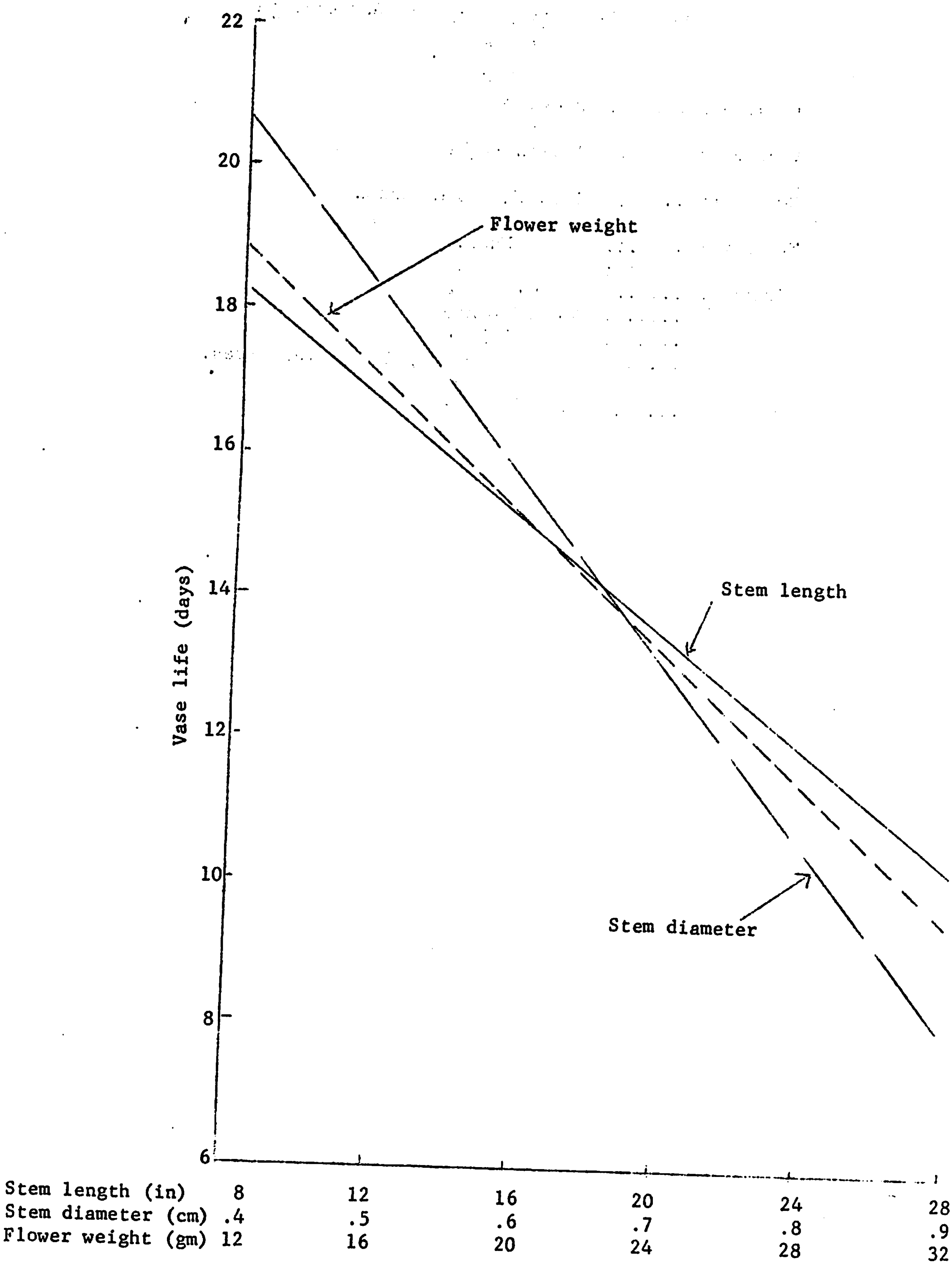

Figure 1. Effect of stem length and diameter and flower weight on vase life of anthuriums.