

A PRELIMINARY INVESTIGATION OF ODOR CHANGES IN CUT AND INTACT ROSES  
IN VARIOUS STAGES OF MATURATION

P.A. van de Pol, F.T. Schiet  
Agricultural University  
Department of Horticulture  
P.O. Box 30  
6700 AA Wageningen  
The Netherlands  
Publication 519

J.E.R. Frijters  
Agricultural University  
Department of Human Nutrition  
De Dreijen 12  
6703 BC Wageningen  
The Netherlands

Abstract

In the present study five fragrant rose varieties were investigated: 'Papa Meiland', 'Sterling Silver', 'Dr. A.J. Verhage', 'Sonia' and a hybrid Tea seedling '73310'. For each variety a different odor profile was used, consisting of five odor descriptors. The intensity of each odor quality was estimated between intact (i.e. still on the bush) and cut roses at various stages of flower maturation, under the same environmental circumstances. Differences were observed between these two conditions, either as a change of the odor profile (quality) or as a change of the odor intensity (quantity). Physiological, (bio)chemical and physical factors are suggested as to what have caused these differences.

1. Introduction

Most of the modern cut roses have any if little fragrance. Preliminary market survey with Freesias however showed that consumers are interested in fragrance and are willing to pay more for flowers having a desirable odor than for those which have not (Van de Pol et al., 1983). The principal reason for the gradual disappearance of fragrance in marketed roses is the low priority in selection programs (Van de Pol, 1980). Previous studies on the scent of roses were concerned either with quantifying the overall odor intensity (Harkness, 1979; Allen, 1980) or with the odor quality (Miller, 1962). In these studies the authors generally omit mentioning the flower stage during which the scent was judged. This is a methodological flaw since the stage of maturity might influence the rose fragrance both in terms of quality and intensity. For instance, the amount and ratio of free monoterpenes (main contributors to the scent) present in rose petals changes as a function of flower maturation (Francis and Allcock, 1969). Another area of interest is the scent of cut roses versus intact ones. We are not aware of any previous study on this topic.

This pilot study therefore attempts to investigate the odor changes in cut and intact roses of five fragrant varieties in various stages of flower maturation.

2. Materials and methods

Freshly cut flowers of the rose varieties 'Papa Meiland', 'Sonia', 'Sterling Silver', 'Dr. A.J. Verhage' and a hybrid Tea seedling '73310' were obtained from a greenhouse of the Agricultural University. These cut roses (stem length 20 cm with the upper 2-3 leaves) were placed in an aqueous solution of citric acid (pH 3) beforehand, in order to optimize water uptake during flowering (Durkin, 1981). About three

hours later, the roses were placed in small test-tubes containing a solution of chrysal (of recommended strength), a commercial product which is a mixture of sugar, bactericide and pH buffering substances to give optimum performance of cut flowers by extending the flowering period. Roses of the variety 'Dr. A.J. Verhage' were also placed in test-tubes containing tap water only.

The cut roses were maintained under the same environmental conditions as the intact roses (i.e. those still on the bush). Testing took place in the greenhouse; one of the authors (F.T. Schiet), previously experienced in olfactory tests, served as subject for the assessment of the odors.

The odor quality of each rose variety was characterized by odor descriptors chosen from two lists (Dravnieks, 1982; Taylor et al., 1981). In the present study five descriptors per rose variety were used to describe the odor profile. The intensity of each odor quality descriptor was assessed on a scale of 0 (= no odor) to 10 (= extremely strong odor). Intact and cut roses were judged separately in each stage of maturity; the minimum number of roses per variety judged was five for each of the four stages examined (Figure 1).

An additional examination was carried out with the rose variety 'Cocktail 80'. Seven cut roses were stored in a dark room at 4° C. for 42 hours. A paired comparison of these (cold treated) flowers against freshly cut ones was performed at room temperature.

### 3. Results

The odor profiles of the five rose varieties are given in Table 1. An analysis of variance was performed for each descriptor. The effects analyzed were cut versus intact specimens, and stages of maturation. The results of these analyses are also given. There was no effect of medium (chrysal versus tap water); the results in Table 1 refer to both media.

Figure 2 shows the arithmetic mean descriptor ratings for the five rose varieties. In general, the odor intensity of cut roses is less ( $p < 0.01$ ) than that of intact flowers.

A measure of the relation among the four odor intensities (for each stage of maturity) of the five descriptors can be determined by the Kendall coefficient of concordance  $W$  (Kendall, 1948; Willerman, 1955), which expresses the degree of association among the five quality descriptors.  $W$  was calculated per rose variety for intact and cut flowers separately. It was found that only intact roses of '73310' showed a significant difference ( $p < 0.01$ ): the odor profile was not constant for the various stages of flower maturation.

No significant difference ( $p < 0.01$ ) was observed between the cold treated roses of 'Cocktail 80' and freshly cut ones at any stage of maturity.

### 4. Discussion

The scent of a rose is produced by evaporation of the essential oil present in rose petals. This fragrant oil consists of a multitude of components (Garnero, 1982), each having its own specific odor. As pointed out by Buccellato (1980), complexes of these components contribute to certain odor characters, and the overall odor can be

described using various odor descriptors (Harper et al., 1968). No suitable models have yet been devised to predict the relation between mixtures of odorants at different concentrations and the perceived odor quality.

The ratio of the essential oil constituents not only varies among different rose varieties (e.g. Ohno and Tanaka, 1977), but also within one variety. Moreover, it is dependent upon the stage of flower maturation (Francis and Allcock, 1969).

Therefore it is difficult to obtain stable multidimensional odor profiles for any fragrant rose variety, as Dravnieks (1982) obtained for ten different odorants, due to variance in stimulus composition. In the present study only one subject participated. The use of more subjects may result in more reliable data.

The odor intensity of each descriptor was assessed by a category rating method (e.g. Cain and Moskowitz, 1974). Another approach would be the use of a fixed standard odorant of known concentration for each odor descriptor separately; this standard stimulus should have an assigned value. The odor intensity of each descriptor of the rose scent should then be estimated as a ratio of the standard odor intensity (Stevens, 1975).

For instance,  $\beta$ -damascenone found in Bulgarian rose oil (Demole et al., 1970) would be suitable for use as a standard stimulus for the fruity note of the rose scent.

For most odor quality descriptors a positive correlation was found for the odor intensity as a function of flower maturation. In another study a positive correlation was also found for the amount of free monoterpenes present in petals versus flower maturation (Francis and Allcock, 1969). Monoterpenes are bound to D-glucose as inodorous monoterpene  $\beta$ -D-glucosides. Hydrolysis with  $\beta$ -D-glucosidase of these derivatives release the free monoterpenes, thus producing the essential oil. In this study no effect of cold treatment was found, so this enzym system was temporary inactivated rather than inhibited.

The maximum concentration of monoterpene  $\beta$ -D-glucosides is reached about a day before the maximum free monoterpenes concentration, which occurs when the petals are unfolded (Figure 1c). The monoterpene  $\beta$ -D-glucosides are accumulated in vacuoles of senescent cells (Stubbs and Francis, 1971). An increase of the odor intensity as a function of flower maturation can be related to an increase in the formation of monoterpene  $\beta$ -D-glucosides as well as an increase in the number of the vacuolated cells. Also, senescent cells are less turgid than younger cells (Borochoy et al., 1982), enabling them to release a larger amount of once formed free monoterpenes.

A number of odor qualities decreased in intensity after the third stage of maturity (Figure 1c). This might be attributed to either a strong decrease of the cell turgor, especially in case of 'Sterling Silver' where all quality intensities show a decrease, or it might have been the result of a difference in the (saturated) vapor pressures of the various constituents. In the latter case one can predict that the rose scent will move gradually toward the odor of the mixture of compounds having the lowest vapor pressure. Because the most volatile components evaporate first, the rose will eventually contain the odor of only compounds having the lowest (saturated) vapor pressures. For instance, two descriptors of 'Sonia' - apple and green - are due

to mixtures of components with relatively high saturated vapor pressures (Buccellato, 1980), such as 1-hexanol, hexyl acetate, citronellyl acetate,  $\beta$ -damascenone and 3-hexenal (Appell, 1964; Weast, 1981).

Intact roses of '73310' did not have a constant odor profile for each stage of maturity. Some constituents of the essential oil are present as alcohols, and oxidation to aldehydes might have strongly altered the odor quality and intensity. In general, aldehydes appear to have stronger odor intensities than their alcohols. This might explain the change of odor profile for intact roses of '73310' in addition to the factors discussed above.

For most odor qualities the intensity of a cut rose is less than that for an intact rose (Figure 2). A lower perceived odor intensity could be explained by a decrease of free monoterpene release in cut flowers. No models are yet developed to describe any possible biosynthetic interrelationships between an intact rose bush, including the root system, and the ultimate formation of free monoterpenes in blooming flowers.

#### References

- Allen, E.F., 1980. Rose scent - a qualitative study. *Rose Annual*, 58-61.
- Appell, L., 1964. Physical foundations in perfumery: vapor pressure. *Am Perfumer*, 79(5): 29-41.
- Borochoy, A., Halevy, A.H., and Shinitzky M., 1982. Senescence and the fluidity of rose petal membranes. *Plant Physiol*, 69: 296-299.
- Buccellato, F., 1980. An anatomy of rose. *Perfumer*, 5(2): 29-32.
- Cain, W.S., Moskowitz, H.R., 1974. Psychophysical scaling of odor. In A. Turk, J.W. Johnston Jr. and D.G. Moulton (eds.), *Human responses to environmental odors*. Academic Press, New York: 1-32.
- Demole, E., Enggist, P., Säuberli, I., Stoll, M., Kováts, E., 1970. Structure et synthèse de la damascénone, constituant odorant de l'essence de rose bulgare (*Rosa damascena* Mill.). *Helv Chim Acta*, 53: 541-551.
- Dravnieks, A., 1982. Odor quality: semantically generated multidimensional profiles are stable. *SCI*, 218: 799-801.
- Durkin, D.J., 1981. Factors effecting hydration of cut flowers. *Acta Horti*, 113: 109-117.
- Francis, M.J.O., and Allcock, 1969. Geraniol  $\beta$ -D-glucoside: occurrence and synthesis in rose flowers. *Phytochem*, 8: 1339-1347.
- Garnero, J., 1982. La rose et son parfum. *Parfums Cosmet Aromes*, 47 (oct/nov): 31-34, 39-42, 45.
- Harkness, J., 1979. *The rose*. McGraw Hill, London: appendix.
- Harper, R., Bate Smith, E.C., and Land, D.G., 1968. *Odour description and classification*. Churchill, London: 36-54.
- Kendall, M.G., 1948. *Rank correlation methods*. Griffin, London: chapter 6.
- Miller, N.F., 1962. A preliminary study of rose fragrance. *American Rose Annual*: 79-89.
- Ohno, Y., and Tanaka, S., 1977. On the constituents of a Chinese rose oil. *Agr Biol Chem*, 41: 399-401.
- Pol, P.A. van de, 1980. Geur, een verwaarloosde eigenschap. *Vakbl Bloemisterij*, 35(14): 57-61.

- Pol, P.A. van de, Schiet, F.T., Duysens, M.J., and Duysens, J., 1983. Geur is een vergeten kwaliteitskenmerk. *Vakbl Bloemisterij*, 37(43): 103.
- Stevens, S.S., 1975. *Psychophysics*. Wiley, New York.
- Stubbs, J.M. and Francis, M.J.O., 1971. Electron microscopical studies on rose petal cells during flower maturation. *Planta Med*, 20: 211-218.
- Taylor W.I., Chant, B., and Loveren, A.G. van, 1981. In *Encyclopedia of Chemical Technology*, Volume 16, 3rd edition. Wiley, New York: 947-971.
- Weast, R.C., 1981. *Handbook of Chemistry and Physics*, 62nd edition. Chemical Rubber Publishing Company, Boca Raton: D174-D189.
- Willerman, B., 1955. The adaptation and use of Kendall's coefficient of concordance (W) to sociometric-type rankings. *Psychol Bull*, 52: 132-133.

Table 1: Odor profiles of five rose varieties. The first + or - indicates whether a significant difference ( $p < 0.01$ ) was observed or not between cut and intact roses, and the second + or - indicates the significant influence ( $p < 0.01$ ) of the stage of maturity.

'Papa Meiland'		'Sonia'		'Sterling Silver'	
fruity	(-,+)	apple	(+,+)	banana	(+,+)
heavy	(+,+)	dry	(+,+)	fruity	(-,+)
rose	(+,+)	fruity	(+,+)	pear	(+,+)
strawberry	(-,+)	green	(+,+)	rose	(+,+)
sweet	(+,+)	light	(+,+)	warm	(+,+)
'Dr. A.J. Verhage'		'73310'			
coconut	(+,+)	apple	(-,-)		
fruity	(-,+)	flowery	(+,+)		
melon	(-,+)	fruity	(+,-)		
rose	(+,+)	melon	(-,-)		
sweet	(-,+)	rose	(+,+)		

Figure 1: Four stages of flower maturation.

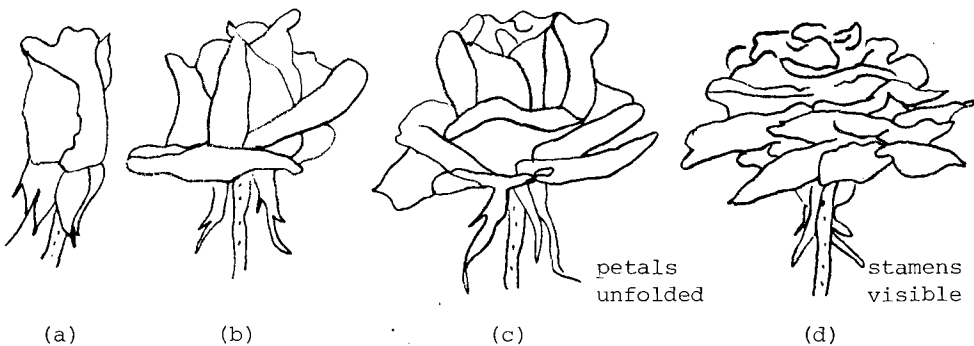


Figure 2: Odor quality intensity OI versus the stage of flower maturation S.

— = intact rose ; - - - = cut rose.

