A Comparison of Color Loss of Red Chile Pepper Pods on or off the Plant and during Storage as Powder

Edith Isidoro¹, Donald J. Cotter², G. Morris Southward³

Department of Agronomy and Horticulture, New Mexico State University, Las Cruces, NM 88003

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Abstract. Color loss of Chile pods (*Capsicum annuum* L.) weathered on and off the plant was compared to that of refrigerated powder of comparable pods. Pods were harvested at 4-week intervals, dried at 65C, and ground and analyzed for color. Powder from these fruit was stored at 2C and analyzed at 4-week intervals. Pods that were weathered on or off the plant lost redness at a rate about one-half of that for refrigerated powder during 84 days of storage or weathering.

About two-thirds of the long, green, pungent peppers produced annually in New Mexico are harvested at the mature red stage. These peppers are dried and ground for use in food for flavor and color enhancement (Purseglove et al., 1981). Hence, high color is a desirable characteristic of dry red powder. Color of powder, measured in American Spice Trade Association units (Amer. Spice Trade Assn., 1985) normally ranges between 100 and 200 units. While a base price is set, local processors often pay bonuses for powder with extractable color above a minimum level, usually 140 units.

High initial color is important, but color retention in the dry powder is also desirable. Color degrades through an autoxidative process (Carnevale et al., 1980; Chen and Gutmanis, 1968). Factors that increase the oxygen supply increase the degradation rate (Lease and Lease, 1956a; Teixeira Neto et al., 1981). Color retention can also be affected by powder moisture content (Arya et al., 1979; Chen and Gutmanis, 1968; Kanner et al., 1977) and exposure to light (Carnevale et al., 1979, 1980; Lease and Lease, 1956a, 1956b; Ramkrishnan and Francis, 1979). We could find no definitive information published describing production and field factors that influence color. In this study, color loss of whole pods weathered on or off the plant was compared with stored powder produced from comparable fruit.

Experimental fruit were obtained from plants grown under a management regime

that approximated commercial practices (Gomez and Nakayama, 1981). Fruit of the cultivars New Mexico No. 6-4 and NuMex R. Naky were used.

In the on-plant weathering experiment, pods of three stages of maturity were tagged on 12 Sept. The stages of maturity were early season pod set (bright red), mid-season pod

set (chocolate), and late-season pod set (green). Pods were harvested at four 28-day intervals beginning 7 Nov. when the early season pods started natural drying and the late-season pods were red and succulent.

In the off-plant weathering test, fruit of only early and late-season pod sets were tagged on 12 Sept. All of the pods were harvested on 9 Nov. after the natural plant defoliation had begun. Pods were placed on racks according to cultivar, stage of maturity, and replicate. The racks, with pods spaced 5 to 7 cm apart, were hung 2 m above the ground in a location free from shade. Five pods were removed from each group at 28-day intervals, starting 9 Nov.

Following harvest, fruit were surface-washed, dried to constant weight at 65C, and ground to pass a 1-mm screen. A subsample was analyzed immediately for color and another subsample was stored in a plastic vial (2.8 × 7 cm) in darkness at 2C until color was measured. Color was measured on stored powder at 1-week intervals.

Pigment content was measured to determine color of powder according to a modified procedure described by the American Spice Trade Association (ASTA, 1985). A representative portion of powder from each vial was redried in a small laboratory-type

Fig. 1. The effect of time after 7 Nov. 1984 on the color loss of whole pods weathered on the plant and of ground powder stored at 2C.

Fig. 2. The effect of time after 9 Nov. 1984 on the color loss of whole pods weathered off the plant and of ground powder stored at 2C.

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¹Former graduate student, Dept. of Horticulture, New Mexico State Univ. Present address: 3900 Sheckler Rd., Fallon, NV 89406.

²Professor, Dept. of Agronomy and Horticulture.

³Professor, Dept. of Experimental Statistics.

oven at 6.5C for 15 hr, and a known weight of powder from each redried sample portion (≈ 70 mg) was mixed with 50 ml of acetone in a 125-ml Erlenmeyer flask and allowed to sit for 4 hr before absorbance of the acetone extract at 460 nm was recorded. Pigment content was computed by a formula using the absorbance of the clear supernatant at 460 nm, the sample weight, and a reading using a standard reference glass filter (National Bureau of Standards 2030) and reported as ASTA units.

An analysis of variance of color data indicated no differences between cultivar or pod maturities but significant differences in color between harvest dates and length of storage. Therefore, a regression analysis of color was computed on data for length of storage and each mode of weathering that combined cultivar and pod maturities.

The color of samples ranged from < 45 to > 165 ASTA units (Figs. 1 and 2). A significant linear loss of extractable color as the whole fruit weathered naturally or as the powder aged under refrigeration was found (Figs. 1 and 2). Field color losses were expected because similar losses have been reported (Lease and Lease, 1956a). Also, such losses conformed closely with experiences described by local processors and growers. A statistical analysis to determine if one regression equation was adequate to describe both data sets within each test (weathered whole pod, powder) showed the lines were not coincident. In both cases, degradation of the color in the ground, refrigerated powder proceeded at a rate more than twice that of weathered whole pods.

Many reports indicate that light enhances autoxidation (Carnevale et al., 1979, 1980; Lease and Lease, 1956a, 1956b; Ramakrishnan, 1979). Hence, it is surprising that the rate of color loss was more than 50% less for the nonshaded pods that weathered on or off the plants than that of ground powder. The color of ground powder degraded the most, even though it was stored in darkness in a dark plastic vial that only allowed limited oxygen contact with the powder. Pos-

sibly, the grinding process destroyed a protective mechanism that retards oxygen movement to the pigment-containing fibril ultrastructures of the chromoplasts (Camara and Brangeon, 1981).

The results show that harvests delayed past the climax date (usually in late October or early November after the plants have frozen) result in less color in the dried product and fewer significant differences in pigment content between pod maturities than had been found in previous studies (Davies et al., 1970; Rahman and Buckle, 1978; Valadon and Mummery, 1977). We assume that the lack of significant differences in pigment content among pod maturities resulted from all pods we used being fully ripe at harvest (either they were already wrinkled and leathery or starting to wrinkle), with synthesis of carotenoids already having been completed. Full synthesis of carotenoids in all red pods and the reduced rate of pigment loss in whole weathered pods over stored powder suggest that the current practice of harvesting red Chile as soon as possible may need to be reevaluated from the standpoint of achieving in maximum color in the largest quantity of peppers. Once harvested, delaying pod grinding of Chile until they are needed in a powder form may also help achieve maximum pigment content.

Our data for stored powder may not typify color losses that occur under commercial circumstances. Processors store powder at controlled moisture content and with an antioxidant (Chen and Gutmanis, 1968; Kanner et al., 1977) under refrigeration in large polyethylene-lined fiber drums, where the oxygen content relative to powder likely would be lower than in the relatively small powder volumes stored in the capped plastic vials we used.

Literature Cited

- Arya, S.S., V. Hatesan, D.B. Parihan, and P. Vijayaraghavan. 1979. Stability of picarotene in isolated systems. *J. Food Technol.* 14:571-578.
- American Spice Trade Association. 1985. Official analytical methods from the American Spice Trade Association. 3rd. ed. Amer. Spice Trade Assn., Englewood Cliffs, N.J. p. 41-42.
- Camara, B. and J. Brangeon. 1981. Carotenoid metabolism during chloroplast to chromoplast transformation in *Capsicum annuum* fruit. *Planta* 151:359-364.
- Carnevale, J., E.R. Cole, and G. Crank. 1979. Fluorescent light catalyzed autoxidation of β -carotene. *J. Air. Food Chem.* 27:462-463.
- Carnevale, J., E.R. Cole, and G. Crank. 1980. Photocatalyzed oxidation of paprika pigments. *J. Agr. Food Chem.* 28:953-956.
- Chen, S.L. and F. Gutmanis. 1968. Autoxidation of extractable color pigments in Chile pepper with special reference to ethoxyquin treatment. *J. Food Sci.* 33:274-280.
- Davies, B.H., S. Matthews, and J.T.O. Kirk. 1970. The nature and biosynthesis of the carotenoids of different color varieties of *Capsicum annuum*. *Phytochemistry* 9:797-805.
- Gomez, R.E. and R.N. Nakayama. 1981. Growing Chile in home and market gardens. New Mexico State Univ. Guide H-206.
- Kanner, J., S. Harel, D. Palevitch, and I. Bengera. 1977. Colour retention in sweet red paprika (*Capsicum annuum* L.) powder as affected by moisture contents and ripening stage. *J. Food Technol.* 12:2356-2362.
- Lease, J.G. and E.J. Lease. 1956a. Factors affecting the retention of red color in peppers. *J. Food Technol.* 10:368-373.
- Lease, J.G. and E.J. Lease. 1956b. Effect of fat-soluble antioxidants on the stability of the red color of peppers. *J. Food Technol.* 10:403-405.
- Purseglove, J.W., E.G. Brown, C.L. Green, and S.R.J. Robbins. 1981. *Spices*. Wiley and Longman, New York.
- Rahman, M.M. and K.A. Buckle. 1978. Pigment changes in *Capsicum* cultivars during maturation and ripening. *J. Food Technol.* 15:241-249.
- Ramakrishnan, T.V. and F.J. Francis. 1979. Stability of carotenoids in model aqueous systems. *J. Food Qual.* 2:189-209.
- Teixiera Neto, R.O., M. Karel, I. Saguy, and S. Mizrahi. 1981. Oxygen uptake and beta-carotene decoloration in a dehydrated food model. *J. Food Sci.* 46:665-676.
- Valadon, L.R.G. and R.S. Mummery. 1977. Carotenoids of lilies and of red pepper: Biogenesis of capsanthin and capsorubin. *Z. Pflanzenphysiol.* 82:407-416.