FORMULA 1 (FOR REDDISH BROWN TONES)

Distilled water	1000.0 cc
Sodium sulphite, anhydrous	12.5 gm
Sodium carbonate, anhydrous	12.5 "
Potassium bromide	0.1 "
l-Ascorbic acid	5.0 "

Prints of a landscape were made on representative "chloro-bromide" papers (Noko, Azo and Velox) and on one bromide paper (Eastman P.M.C.). The relative sensitivities of these emulsions, based on development in ordinary developers, were no guide to the exposures required of prints to be developed in vitamin C. Noko No. 0, the slowest of the papers, required twice its usual exposure. It gave prints with reddish black shadows and pinkish highlights. Azo No. 2, a slightly more sensitive paper, required 10 times its normal exposure. It gave copper-colored prints of good quality. Velox No. 2, a still more sensitive paper, required about 6 times its normal exposure. It gave brown prints of mediocre quality. The highly sensitive bromide emulsion of P.M.C. No. 2 developed so slowly, in spite of relatively long exposures, that chemical fog ruined the prints before density could be built up. The optimal period of development for each emulsion was 7 minutes at 23°. Fog became noticeable in 8 minutes, serious in 15 minutes. There was no stain. The images appeared orange or light brown when wet and darkened to their final color on drying.

In Formula 2, I replaced the sodium carbonate of Formula 1 by a stronger alkali, trisodium phosphate, and increased the amount of bromide. This solution should be used within one or two days.

FORMULA 2 (FOR BROWNISH BLACK TONES)

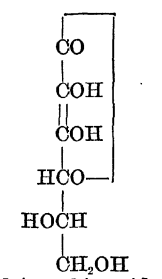
Distilled water	1000.0 cc
Sodium sulphite, anhydrous	12.5 gm
Trisodium phosphate, hydrous	40.0 "
Potassium bromide	0.5 "
l-Ascorbic acid	5.0 "

Prints were made on Azo No. 2 paper. The required exposure was 3 times the normal. The optimal period of development was 3 minutes at 23°; the fog limit, 4 minutes. There was no stain. In fresh solution the images were brownish black, of good quality. Older solutions gave increasingly brown tones.

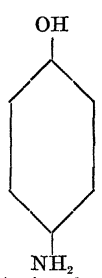
That the (photographic) reduction potential of vitamin C is low in comparison with other developers is indicated by the sensitiveness of ascorbic acid to the restraining action of bromide.[4] This low reducing energy and a comparatively high fogging power are doubtless related to the anomalous properties which Green[5] observed in his study of the potentials of this reversibly oxidizable substance.

The developing action of ascorbic acid is a fact of importance in the theory which relates developing function to molecular configuration. It should be recalled that not all reducing agents are developing agents. While innumerable organic compounds, including vitamin C, reduce silver nitrate, only a few have the power to reduce the latent image in silver halide emulsions. The classical studies of A. and L. Lumière[6,7] on the *fonction développatrice* showed that this special reducing ability is confined, except for a few inorganic substances, to benzene derivatives in which there are two hydroxyl or two amino, or one hydroxyl and one amino groups, in the ortho or para positions. A partial exception is found in some naphthalene compounds, but in general the Lumière rule has held for over 40 years.

Ascorbic acid, a sugar derivative, is an outstanding exception, as is shown by its formula in comparison with that of a typical developer within the rule. In all probability, it is but one of a series of exceptions.



l-Ascorbic acid



p-Aminophenol

Those who are interested in the chemistry of photography will want to investigate the developing action of the analogues, homologues and derivatives of ascorbic acid and the related reductones, especially since a considerable number of such compounds have been described in recent months.[3,8]

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[4] A. H. Nietz, "The Theory of Development," New York, Van Nostrand, 1922.

[5] D. E. Green, *Biochem. Jour.*, 27: 1044, 1933.

[6] A. Lumière and L. Lumière, *Bull. Soc. franc. Phot.*, ser. 2, 7: 310, 1891.

[7] A. Seyewetz, "Le Négatif en Photographie," 2nd ed., Paris, Doin, 1923.

[8] "A. H.," *Nature*, 134: 724, 1934.

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