

The stability of vitamin A acetate in aqueous cetomacrogol solutions: a spectroscopic study

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Oily solutions of water insoluble vitamins are being increasingly replaced by aqueous non-ionic surfactant solutions in which they are solubilized in a micellar pseudophase. There still exists, however, a controversy concerning the relative stability of vitamin A in aqueous micellar solutions and in vegetable oil solutions (Sjoblom, 1967). Kern & Antoshkiw (1950) reported that the stability of vitamin A in a Tween-20 aqueous solution was superior to that in cotton seed oil, whereas Patel, Kumta & Radhakrishna Rao (1955) found that aqueous Tween-80 solutions were much less stable than oil solutions.

It was recently reported (Hamburger, Azaz & Donbrow, 1975; McGinity, Hill & La Via, 1975) that autoxidation accompanied by peroxide formation and a decrease in pH in polyoxyethylene-derived surfactants occurs to a considerable degree even under routine storage conditions.

Since the stability of vitamin A is affected by the presence of peroxides and acids (Kern & Antoshkiw, 1950; Patel & others, 1955; Higuchi & Reinstein, 1959; Schwieter & Isler, 1967; Hayashi & Nishii, 1971), we were of the opinion that the above controversy might result from the use of surfactants at different stages of the autoxidative process. We have therefore attempted to test the extent to which the stability of vitamin A is affected by the degree of autoxidation of the surfactant.

Cetomacrogol-1000 (polyethylene glycol cetostearyl ether) was used as a model surfactant for this study. The quantitative determination of vitamin A acetate by ultraviolet spectroscopy was adapted for the present system. The results, summarized in Table 1, show that

Table 1. Absorbance of Vitamin A* in aqueous cetomacrogol† solution at 331 nm.

Concentration of Vitamin A‡ % × 10 ³	Concn of cetomacrogol ‡ %	Absorbance	E 1%, 1 cm Calculated
1.5	0.8	1.16	770
1.16	0.6	0.90	785
1.13	0.6	0.89	790
0.77	0.4	0.60	776
0.75	0.4	0.60	810
0.39	0.2	0.31	785
0.38	0.2	0.30	800

* Vitamin A acetate (NBC crystalline).

† Cetomacrogol 1000 BPC (A. B. M. Chemicals Ltd., Batch No. H-280).

‡ Stock solutions of about 0.03% vitamin A acetate in 20% aqueous cetomacrogol were diluted with phosphate buffer pH 6.

* Correspondence.

in freshly prepared solutions the absorbance ($\lambda_{\max} = 331$ nm) obeys Beer's law at a fixed ratio of concentrations of vitamin A and cetomacrogol. Moreover, determinations of the whole spectra (at concentrations outlined in Table 1) showed that no changes in shape or λ_{\max} occurred on dilution. We could therefore follow the progressive decomposition of vitamin A acetate by examining the ultraviolet spectra of its

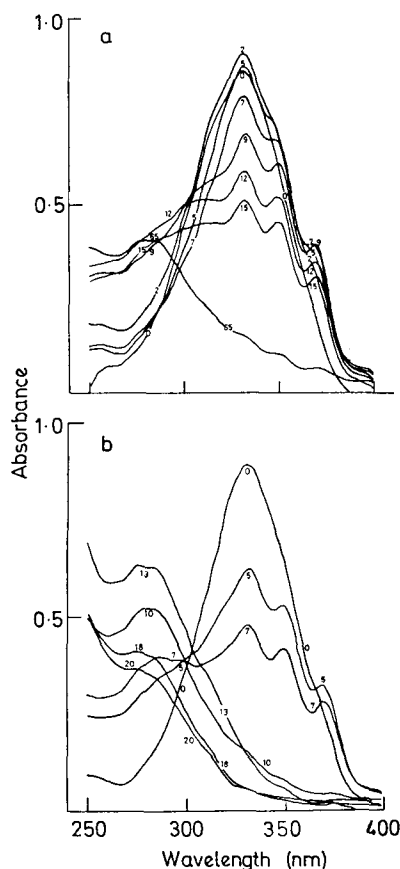


FIG. 1. Spectra of vitamin A acetate after different storage intervals: dissolved in (a) freshly prepared 20% cetomacrogol solution (peroxide number = 0 m equiv kg⁻¹); (b) preheated 20% cetomacrogol solution (peroxide number = 50 m equiv kg⁻¹). The solutions were stored in clear glass vessels provided with air condensers. The numbers on the graphs represent days of storage.

cetomacrogol solutions following various storage intervals at room temperature (Fig. 1a). The following spectral changes are noted: (1) there is a decrease in absorbance at 331 nm, (2) there is a gradual appearance of peaks at 349 and 369 nm (in ethanol absorbances at similar wavelengths were ascribed to anhydrovitamin A) and a broad peak from 270 to 280 nm (ascribed to epoxyvitamin A) (Schwieter & Isler, 1967; Higuchi & Reinstein, 1959) and (3) the ratio of absorbance at the three maxima at 331, 349 and 369 nm reaches a constant value of 1:0.89:0.58 respectively after about nine days. The intensities of these peaks decrease until they finally disappear.

A comparison of the spectra of vitamin A acetate in freshly prepared 20% cetomacrogol solution, 'solution a' (initial peroxide number* = 0 m equiv kg⁻¹ surfactant) with those of the vitamin dissolved in aqueous cetomacrogol in an advanced stage of the autoxidative

process, 'solution b' (peroxide number = 50 m equiv kg⁻¹ surfactant), Fig. 1b, shows that autoxidation of the surfactant markedly accelerates decomposition (Fig. 1a, b). Absorbance at 331 nm is reduced to 50% of its original value already by the seventh day in solution b whereas the same decrease is observed in solution a only by the fifteenth day. Similarly in solution b the typical peaks at 331, 349 and 369 nm had almost disappeared by the thirteenth day whilst in solution a they were still clearly visible after two months. The time intervals for the ratio of absorbance at $\lambda = 331, 349$ and 369 nm to reach a constant value in the two solutions are in line with the above observations.

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*Determined according to Azaz, Donbrow & Hamburger (1973).

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