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Lead Caps on Wine Bottles and Their Potential Problems

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Many types of grape wines are bottled using a cork sealed with a metal cap. The metal cap traditionally used on the better wines is made primarily of lead. Any lead product used in connection with foods or consumable liquids should be examined carefully to evaluate the danger of lead contamination. An earlier report by PERRE and JAULMES (1948) showed that lead caps on wine bottles lead to an increased level of lead in wine. In this study, we report the characterization of the lead compounds associated with the corroded lead caps on wine bottles and their potential contamination problems.

The metal caps on the wine bottles we examined had high specific gravity, were soft and colored with pigment on the outside surfaces. The lead content of 10 metal caps analyzed by atomic absorption spectrophotometry varied from 96% to 98% with an average of 96.8%. A few percent of tin was also present.

A white powdery substance is frequently found on the corroded metal caps, on the cork, and around the mouth of wine bottles. This is particularly true for aged wines showing evidence of seepage through the cork. The X-ray powder diffraction pattern obtained from this corrosion material indicates that it consists of lead carbonate hydroxide $2PbCO_3 \cdot Pb(OH)_2$ and its hydrated form $3PbCO_3 \cdot 2Pb(OH)_2 \cdot H_2O$ (Figure 1). The intense peak at $2\theta = 26.7$ (using Cu K_α X-ray source) is the major diffraction peak of the hydrated form. Other strong diffraction peaks of the hydrated form are hidden under the major peaks of lead carbonate hydroxide (Powder Diffraction File, 1973). The relative amounts of the two forms were found to vary from sample to sample. An amorphous corrosion product was also observed. Infra-red spectrum of this material showed two major absorption bands around 1400 cm^{-1} and 1200 cm^{-1} that can be attributed to a carbonate absorption.

The unhydrated form of lead carbonate hydroxide (hydrocerussite) is a major constituent of white lead, a pigment known since at least Roman times. An ancient process for the manufacture of white lead is the reaction of lead plates with vinegar vapor and carbon dioxide (FRIEND 1921).

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The solubility of lead carbonate is 1.75 mg per liter of pure water at 18°C and increases rapidly with the dissolved carbon dioxide content of the water (FRIEND 1921). This corrosion material deposited around the mouth of the bottle is thus a potential source of contamination during the consumption of wine. If not carefully removed, it may dissolve in the wine during the pouring process. To illustrate this source of contamination, a few examples are shown in the following table:

Type of wine	Process A Pb(ppm)	Process B Pb(ppm)
red	0.31	1.6
white	0.23	1.7
red	0.15	0.4

Process A represents wine samples pipeted out of the bottle whereas process B represents wine poured out of the bottle without removal of the corrosion deposits. In each case, about 50 ml of wine sample was taken. The concentration of lead in wine was determined by the method of additions utilizing a PE-303 atomic absorption spectrophotometer. It should be noted that the last example represents a case where very little corrosion material was present.

The pH of a number of wines which we examined was around 3.5. Wine having such a high acidity is capable of attacking the metal foil. It is common practice to store bottled wines on the side to keep the cork moist in order to prevent shrinking. As a result of the porosity of the cork wine will occasionally be in contact with the metal foil. The quality of the cork used is probably an important factor in determining the rate of seepage and subsequent corrosion of the cap.

The U.S. Public Health Service standard for lead in drinking water is not to exceed 0.05 ppm (U. S. DEPT. HEW 1962). There is no federal regulation regarding the safe level of lead in wine. The maximum acceptable levels of lead in wine as proposed by Canada and by Germany are 0.5 ppm and 0.3 ppm, respectively. Since wine is an increasingly popular drink in the United States, the establishment of a federal permissible level of lead in wine would seem advisable. This study demonstrates that the use of lead caps on wine bottles could result in relatively high levels of lead intake for the consumers of older wines. Should a consumer observe the lead corrosion product described in this paper on a wine bottle, he should carefully remove this material prior to extracting the cork.

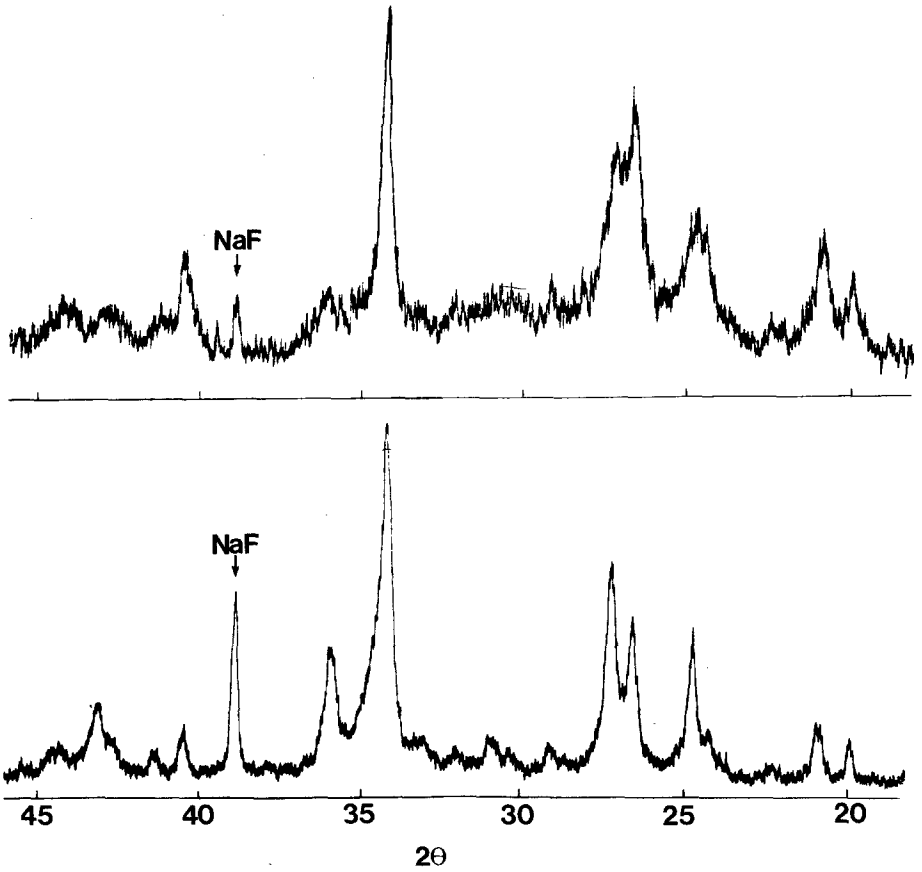

Figure 1. X-ray powder diffration patterns. Top: The white corrosion material collected from a wine bottle with a lead cap. Bottom: Lead carbonate hydroxide previously exposed to the air.

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