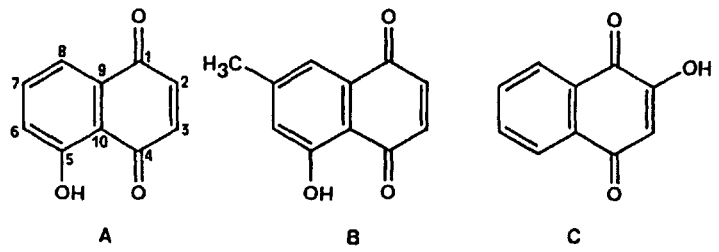

Figure 18 Common naphthaquinones. (A) Juglone; (B) 7-methyljuglone; (C) lawsone.

and vitamin K are included in this group; however, as pigments the most widespread and most important quinones are the 1,4-naphthaquinones (Fig. 18) and the 9,10-anthraquinones (Fig. 19) (Table 10). Methyl, methoxyl, and hydroxyl groups are the most common substituents, and *O*- and *C*-glycosides (see Fig. 20) are frequently present in the anthraquinone group. Several structural modifications exist due to reduction, dimerization (Fig. 21), and addition of side chains.

2. Distribution

The quinones are widely distributed in nature, and altogether 1200 different quinones have been observed in bacteria, in all plant phyla except mosses, and in animal phyla like echinoderms (sea urchins) and arthropods (insects) (53,54). They may occur in all parts of a plant; however, a large proportion are present in roots, heartwood, and bark.

The quinones range in color from yellow through red and purple to almost black. They make relatively little contribution to color in higher plants; their color is perhaps most conspicuous in some fungi, lichen, and insects (Coccidae).

B. TLC of Naphthaquinones

Several solvent systems have been reported for separation of naphthaquinone pigments on silica gel (55). A solvent containing 30% ethyl acetate in petroleum ether (60–80°C) gives acceptable separation of quinones from Plumbaginaceae. Many of the older systems include benzene or chloroform in the mobile phase, which impairs the separation on commercial plates. Polar naphthaquinones are better separated with hexane–acetone–acetic acid (75:25:1.5) (56). Using this latter solvent, a replacement of hexane with petroleum ether (40–60°C) may be beneficial.

Centrifugal TLC on silica gel using toluene–ethyl acetate (15:1) as mobile phase has been applied for the preparative isolation of potent molluscicidal naphthaquinones from the root bark of *Diospyros usambarensis* (57).

Quantitative determinations of naphthaquinones from *Arnebia densiflora* using TLC–densitometry and HPLC were compared and showed no significant differences in the results obtained with the two techniques (57a).

C. Practical Experiments

1. Isolation

A solution of 100 mL of diethyl ether containing 1% concentrated H_2SO_4 was mixed with 50 g of fresh *Drosera rotundifolia*. The mixture was macerated in a Waring blender and allowed to stand for 8 h. After filtration and evaporation, 50 mL of 2 M H_2SO_4 was added. The mixture was steam-distilled, and the yellow distillate was extracted with ether.

Powered leaf of *Lawsonia alba* (20 g) was mixed with 100 mL of 2 N Na_2CO_3 and stirred for 30 min. The mixture was filtered, and 2 M H_2SO_4 was added until neutrality. Precipitated pigments were extracted with ether.

The mesocarp from fresh fruits of *Juglans regia* was cut into small pieces and transferred to methanol. The methanolic extract was used directly. Bark and leaves can be extracted with methanol or ether.