6 SUMMARY AND CONCLUSIONS

Embelin was isolated from berries of *E. ribes*. Embelin was subjected to stress conditions of acid and alkaline hydrolysis, oxidation, photolysis and thermal degradation. Degradation was found to occur under acid hydrolysis, oxidation conditions thermal stress and to a lesser extent under base hydrolysis; the compound was stable to photolytic stress. The acid degradation product isolated was found to be 5-methoxyether of Embelin. Based on the outcome a homologous series of alkyl ethers of embelin viz. Methyl, ethyl, popyl, butyl, hexyl, octyl, decyl and ethoxyethylether of embelin were prepared in 25-42% yields. A histochemical localization study of Embelin, in fruits of *E. ribes* was carried out. Embelin was found to be located in the inundations present in outer coat of seed. The Embelin content of seed, pericarp and whole crushed fruit were determined using HPLC and found to be 0.39, 4.18 and 3.30 percent w/w respectively. Another naturally occurring benzoquinone, Thymoquinone was synthesized from Thymol. Thymoquinoe was extracted using microwave assisted extraction. Under appropriate MAE conditions, such as extraction times of 5 min, ethanol and liquid/solid ratios of 40:1(ml/g), the recovery of thymoquinone from *Nigella sativa* seeds with MAE was equivalent with conventional extraction methods. Those methods include extraction at room temperature (ERT), the traditional Soxhlet extraction, heat reflux extraction and ultrasonic extraction. Due to the considerable savings in time and solvent, MAE was more effective than the conventional methods.

Naphthoquinone, Plumbagin was isolated from roots of *Plumbago zeylanica* L. (60 g) using hydrodistillation to yield 10 mg of Plumbagin. Plumbagin (1.08g) was also extracted from roots of *P. zeylanica* (3 kg) using column chromatography using Petroleum ether: ethyl acetate as eluent. RP-HPLC analysis of Plumbagin was carried out using Fluorescence detection. Component fluorescence detection was achieved using an excitation wavelength of 264 nm with monitoring of the emission wavelength at 605 nm. The Plumbagin content of five herbal formulations containing the same were: Hepatovin 0.009%, *Supachan vati* 0.0085%, *Medhoter guggul* 0.044%, Digestin 0.0002 % and *Chitrakadi bati* contains 0.38% w/w respectively, while that of *P. zeylanica* and *P. auriculata* were 0.22 and 0.48 % w/w respectively. These results revealed the method enables rapid, precise, and highly accurate for quantification of plumbagin. Droserone was
synthesized from Plumbagin. 3-bromoplumbagin was obtained by bromination of Plumbagin by reacting it with bromine in chloroform in presence of glacial acetic acid (Yield 45-47%). The bromine was then substituted by hydroxyl using nucleophilic substitution with sodium hydroxide to obtain Droserone in about 16% yield. Shikalkin (22 mg) which is a racemic mixture of Alkannin (S-isomer) and Shikonin (R-isomer) was isolated from roots of *Arnebia nobilis* (10 g) using base hydrolysis and subsequent solvent extraction. The UV, IR, MS and NMR spectroscopic data of the compounds obtained was found to match with the values reported in literature.
Figure 6.1: Chemical structures of Benzoquinones and Naphthoquinones isolated and semi-synthesized
7 SCOPE FOR FUTURE WORK

The scope of future may include the following:

- Isolation of quinones from different plant sources.
- HPLC quantification methods developed may be extrapolated to biological matrices and also for analysis of other quinones.
- Synthesis of derivatives of these quinones having good bioactivity and enhanced efficacy
- Pharmacological evaluation of isolated phytoconstituents and their corresponding analogs.