CHAPTER V

CONCLUSION

In this research work, the antioxidant, antibacterial, antifungal, anticancer activities and chemical constituents of some plants from Rutaceae family such as *Citrus hystrix* DC., *Feronia limonia* Swing., *Aegle 2marmelos* Corr. and *Citrus aurantifolia* Swing were studied. Some nutrient metal ions of each plant were determined by atomic absorption spectrophotometry (AAS). They were calcium, manganese, zinc, copper, iron, magnesium and sodium present in young and old leaves of each plant. The leaves of each plant were dried, ground and macerated with hexane, chloroform, dichloromethane, ethanol and methanol. The essential oil from the leaves of each plant were isolated by hydrodistillation and analysed by using a combination of gas chromatography-mass spectrometry (GC-MS). The major constituents of essential oil from *C. hystrix* leaves were citronellol (77.74%), β-citronellal (10.48%), citronellyl acetate (2.56%) and linalool (2.25%). The major constituents of essential oil from *F. limonia* leaves were sabinene (64.80%), 4-terpineol (10.32%), γ-terpinene (5.89%) and α-terpinene (3.73%). The major constituents of essential oil from *A. marmelos* leaves were limonene (44.85%), α-phellandrene (25.15%) and *trans*-caryophyllene (8.22%). The major constituents of essential oil from *C. aurantifolia* leaves were limonene (29.49%), geranial (23.98%), neral (18.57%), geraniol (4.69%). Most of them are terpenes.

The antioxidant activity of the crude extracts and the essential oil of each plant were determined by ABTS and DPPH methods. The results were compared with three antioxidant standards, Trolox, vitamine C and quercetin. The crude extract of *C. hystrix* exhibited the highest antioxidant activity followed by *F. limonia*, *C. aurantifolia* and *A. marmelos* respectively. The ethanol extract showed the highest antioxidant capacity followed by the methanol, chloroform and hexane extracts of each plant respectively. The essential oil of *C. aurantifolia* exhibited the highest antioxidant activity followed by *F. limonia*, *A. marmelos* and *C. hystrix* respectively.

The antimicrobial activity of the crude extracts and the essential oil of each plant were determined by agar diffusion method. The crude extract and the essential oil exhibited antibacterial activity against *Escherichia coli*, *Pseudomonas aeruginosa* and *Staphylococcus aureus*, using gentamicin as reference standard. The essential oil also showed antifungal activity against *Candida albicans*, *Aspergillus flavas* and *Trichophyton mentagophyte* but the crude extract exhibited only *Candida albicans* and *Trichophyton mentagophyte*, using ketoconazole as reference standard.

The crude *C.* hystrix, *F. limonia* extracts and essential oil of *C.* hystrix, *F. limonia*, *A. marmelos*, *C. aurantifolia* showed anticancer activity against KB cell (Oral Cavity cancer), MCF 7 breast cancer cell (Human breast adenocarcinoma) and NCI-H 187 lung cancer cell (Human small cell lung carcinoma) using Resazurin Microplate assay (REMA). All crude extracts of the leaves of *C. hystrix* and the hexane and chloroform extracts of *F. limonia* showed anticancer activity against NCI-H187-human, small cell lung cancer. Breast cancer (MCF7) was also inhibited by chloroform and dichloromethane extracts of *C. hystrix*. The essential oil of *F. limonia* and *A. marmelos* also showed anticancer activity against small cell lung cancer (NCI-H187-human) and Breast cancer (MCF7) but the essential oil of *C. hystrix* and *C. aurantifolia* do not exhibit anticancer activity. Ellipticine and doxorubicine are used as reference standards.

After maceration and isolation, it was found that two were mixture of hentriacontane, dotriacontane and mixture of hexadecanoic acid, octadecanoic acid present in the leaves of *C. hystrix*. The mixture of stigmasterol, β-sitosterol and mixture of 2-pentadecanone, 6,10,14-trimethyl, hexanedioic acid, bis(2-ethylhexyl) ester was found in the leaves of *F. limonia*.

Certain nutrient metal ions such as calcium, manganese, zinc, copper, iron, magnesium and sodium presented in young and old leaves of each plant present were found in *C.* hystrix, *F. limonia*, *A. marmelos*, *C. aurantifolia* leaves. In addition, the hexane, chloroform, ethanol and methanol extracts of leaves from each plant showed antioxidant activity by using the ABTS and DPPH methods. The leaves of each plant could inhibit Gram-positive and Gram-negative organism's bacteria and it also showed antifungal activity. Therefore, *C.* hystrix, *F. limonia*, *A. marmelos*, *C. aurantifolia* leaves showed antioxidant, antibacterial, antifungal, anticancer activities,

they may play important roles in drug, food, health supplements and cosmetic industries.