Chapter 15

General discussion on medicinal plants studied

The present study provided a large number of useful data on the biomarkers, antioxidant polyphenols and other minor compounds present in all the 15 plants screened. Almost all the plants and their parts were found to be rich in phytochemicals such as flavonols, flavones and anthocyanidins. Flavonols are the most common flavonoids. The flavonols located are kaempferol, quercetin, myricetin and gossypetin and their various methoxylated derivatives. Flavones were located in only one plant. Almost all these compounds are physiologically active bioflavonoids. Tannins especially proanthocyanins also are widely distributed in these plants. Quinones, another group of antioxidant phenolics also were fairly common. Alkaloids were rather rare, located in only two plants.

The predominance of flavonols such as quercetin and kaempferol in many plants and plant parts is interesting in that these flavonoids are now attributed with a number of pharmacological properties.

Quercetin appeared to have many beneficial effects on human health including cardiovascular protection, anti-cancer activity, antiulcer effects, antiallergic activity, cataract prevention and antiviral and anti-inflammatory effects (Miller, 1996) and also inhibits lipid peroxidation *in vitro* (Chen *et al.*, 1990). Paired with ascorbic acid, quercetin reduced the incidence of oxidative damage to neurovasculature structures in skin and inhibited damage to neurons caused by experimental glutathione depletion (Skaper *et al.*, 1997). Anti-inflammatory activity quercetin appeared to be due to its antioxidant and inhibitory effects on the inflammation producing enzymes like cyclooxygenase and lipoxygenase and their subsequent inhibition of inflammatory mediators including leukotrienes and prostaglandins (Kim *et* al., 1998).

Quercetin exerted antiviral activity against reverse transcriptase of HIV and the other retroviruses and was shown to reduce the infectivity and cellular replication of the viruses like Herpes Simplex virus-type I, polio virus – type I, para influenza virus type III and respiratory syncytial virus (Kaul *et al.*, 1985). Much of the recent research on

including breast, colon, endometrial, gastrio, leukaemia, ovary and squamous cell (Larocca *et al.*, 1995; Pereira *et al.*, 1996; Caltagirone *et al.*, 1997).

Biosynthesis and enzymes responsible for the synthesis of this compound is well documented (Anon., 2004). This compound is marketed as quercetin dihydrate, a yellow crystalline powder, which is insoluble in water but soluble in alkaline solution.

Kaempferol had a stimulatory effect on alkaline phosphatase activity in MG-63 human osteoblasts through ERK and estrogen receptor pathway (Prouillet et al., 2004). It was also shown to inhibit proliferation and increase mediator content in human leukaemic mast cells (Alexander *et al.*, 2003). Inhibition of estrogen receptor alpha expression and function in MCF-7 cells by kaempferol was studied by Hung (2004). Kaempferol induced growth inhibition and apoptosis in A549 lung cancer cells is mediated by activation of MEK-MAPK (Nguyen *et al.*, 2003). It showed antihistaminic and antioxidant properties and is a reliable inhibitor of topoisomerase I. Quercetin and kaempferol have been found to enhance the therapeutic efficacy of radiation as well as chemotherapeutic drugs.

Many of the phenolic acids also are found to have many pharmacological benefits. According to the data given by Duke (1997) ferulic acid, gentisic acid, and salicylic acid as pain relievers while cinnamic acid is anti-inflammatory. As such all the plants screened contained various benzoic and cinnamic acids in all the parts. These compounds may exert the above-said actions or may have a synergistic activity.

Same is the case with quinones. Apart from their antioxidant properties, many of them exhibit anti-inflammatory and analgesic properties. Therefore, whenever they are present, they may add to the medicinal properties of the plants containing them.

The present project resulted in finding out the biomarkers, chemical diversity and antioxidant compounds of all the parts of the plants selected. The biomarkers are extremely useful in identifying the genuineness of the drug and also to find out adulteration. The keys prepared using the chemical markers useful in identifying the various pants of the drugs provides ample proof for this claim. Here two keys are prepared; 1. for the leaf drugs and 2. for the stem drugs.

1. Keys of identification of leaves of some medicinal plants of the Myrtales using phytochemical markers

1. Lawsone present
   2. Lawsone with flavones - *Lawsonia*
   2. Lawsone with flavonols - *Woodfordia*
1. Lawsone absent
   3. Gossypetin and its derivatives present
      4. Only gossypetin and no other flavonols - *Barringtonia*
      4. Gossypetin with other flavonols
         5. Gossypetin + myricetin - *Syzygium*
         5. Gossypetin + o-coumaric acid - *Combretum*
   3. Gossypetin absent
      6. Alkaloids present
         7. Gallic acid present - *Lagerstroemia*
         7. Gallic acid absent
            8. Both quercetin and kaempferol present - *Alangium*
            8. Only quercetin present - *Ammania*
      6. Alkaloids absent
         9. Volatile oils present - *Pimenta*
         9. Volatile oils absent
            10. Quercetin with myricetin
               11. Kaempferol present - *Terminalia arjuna*
               11. Kaempferol absent - *Psidium*
            10. Quercetin with/without other flavonols
               12. Only quercetin - *Terminalia chebula*
               12. Quercetin with quinone - *Ludwigia*
                  13. Phenolic acids only two
                     i.e. vanillic and syringic - *Melastoma*
                  13. Phenolic acids more than two - *Careya*

2. Keys of identification of young stems of some medicinal plants of the Myrtales using phytochemical markers

1. Flavonoids absent
   2. *p*-Hydroxy benzoic acid - *Woodfordia*
   2. Gallic acid present - *Pimenta*
1. Flavonoids present
   3. Gossypetin present
      4. Gossypetin present with other flavonoids
         5. Kaempferol present - *Terminalia arjuna*
         5. Kaempferol absent - *Syzygium*
      4. Gossypetin without other flavonoids
         6. Gallic acid present - *Psidium*
         6. Gallic acid present - *Barringtonia*

   3. Gossypetin absent
         7. Flavones present - *Lawsonia*
         7. Flavones absent
            8. Alkaloids present
               9. Ferulic acid present - *Ammania*
               9. Ferulic acid absent - *Alangium*
            8. Alkaloids absent
               10. Phenolic acids only two, vanillic and syringic acids - *Melastoma*
               10. Phenolic acids more than two
                  11. Gallic acid present - *Lagerstroemia*
                  11. Gallic acid absent
                     12. *p*-Hydroxy benzoic acid and quinones present - *Ludwigia*
                     12. *p*-Hydroxy benzoic and *p*-coumaric acids present –*Combretum*

Similar to the phytochemical markers, the **pharmacognostic characters** also are found to be of great use in identifying or confirming the identity of a plant drug. The transverse sections of leaves and stems will be of immense use in checking the identity of a medicinal plant. The powder study will help in finding out whether a powdered drug id genuine or adulterated. Locating a particular cell component, not reported from the source plant, in a powdered sample proves that the sample is adulterated. A little bit of plant debris settled at the bottom of a container having an extract will yield very valuable information on the source plant. The keys prepared for both leaves and stems of the medicinal plants of the Myrtales prove the utility of pharmacognostic markers beyond doubt.

3. Keys of identification of leaves of some medicinal plants of the Myrtales using pharmacognostic markers

1. Trichomes present
   2. Trichomes multicellular multiseriate, epidermal cells with cluster crystals - *Melastoma*
   2. Trichomes multicellular uniseriate
      3. Palisade 4-5 layered, resin canals - *Psidium*
      3. Palisade single layered - *Woodfordia*
   2. Trichomes unicellular
      4. Two types of trichomes - *Terminalia arjuna*
      4. Only one type of trichome
         5. Large chloroplasts in palisade - *Ludwigia*
         5. Small chloroplasts in palisade - *Terminalia chebula*
1. Trichomes absent
   6. Palisade two layered
      7. Chlorenchyma with a single large chloroplast, prismatic crystals - *Alangium*
      7. Chlorenchyma with many chloroplasts, no prismatic crystals
         8. Gelatinous fibres present, no pitted parenchyma - *Careya*
         8. Gelatinous fibres absent, pitted parenchyma present- *Lagerstroemia*
   6. Palisade single layered
      9. Cystoliths in palisade - *Combretum*
      9. Cystoliths absent in palisade
         10. Epidermis with tannin deposits
            11. Oil ducts present - *Pimenta*
            11. Oil ducts absent
               12. Cuticle with ridges and furrows
                  13. Pericycle of stone cells - *Syzygium*
                  13. Stone cells absent - *Ammania*
               12. Cuticle smooth
                  14. Palisade with 3-4 large chloroplasts – *Barringtonia*
                  14. Palisade with many small chloroplasts – *Lawsonia*

4. Keys of identification of stems of some medicinal plants of the Myrtales using pharmacognostic markers

1. Cork cells of two types – thin walled and thick walled.
    2. Prismatic crystals present, large parenchyma cells with tannins - *Syzygium*
    2. Prismatic crystals absent, large thick walled pitted cell - *Alangium*

1. Cork cells of only one type
    3. Stratified phloem present
        4. Large square cells of abscission layers present; Unicellular trichomes - *Terminalia arjuna*
        4. Large square cells of abscission layer absent, Both libriform and gelatinized fibres present - *Terminalia chebula*

    3. Stratified phloem absent
        5. Sclerieds present
            6. Chlorenchyma thick walled, rays of square and rectangular cells - *Lawsonia*
            6. Chlorenchyma thin walled, rays with brown contents, resin canals - *Melastoma*

        5. Sclerieds absent
            7. Stone cells in cortex
                8. Xylem with both fire tracheids and libriform fibres - *Ammania*
                8. Xylem with predominantly of fibre tracheids - *Woodfordia*

            7. Stone cells absent, crystals V-shaped - *Lagerstroemia*