2. Review of Literature

2.1 Dental Pathogens

Dental caries is a multifactorial human disease that has widely affected many populations all over the world. Dental caries is a very common problem in humans. It is very prevalent in Asian and Latin countries and least prevalent in African countries. Dental caries are one of the public health concerns for several reasons. Teeth affected with dental caries are sources of infection, which can cause an inflammation of dental pulp, periodontium and gums. If left untreated, this disease gradually leads to teeth loss, which causes chewing difficulties and aesthetic problems (Allen et al., 2003). It remains one of the most widespread diseases of the mankind. In developing countries, dental caries is often at epidemic proportions, especially among the poor. Since the 19th century, when sucrose became a daily used sweetener by many people worldwide, the increasing prevalence of dental caries had also been noticed (Hamada et al., 2002). Therefore it is quite clear that dental diseases have detrimental effect on quality of life both in childhood and older age. Medicinal plants since ancient times have been employed for prophylactic and curative purposes (Amadi et al., 2007).

Bacterial plaque plays the primary role in the pathogenesis of the disease. Dental plaque is a general term for the diverse microbial community (predominantly bacteria) found on the tooth surface, embedded in a matrix of polymers of bacterial and salivary origin. Plaque is an example of a biofilm; current researches are showing that the properties of bacteria associated with a surface in a biofilm can be markedly different than those of the same cells growing in liquid broth (planktonic cells). Plaque
is found preferentially at protected and stagnant surfaces, and these are at the greatest threat of disease (Scheie et al., 1994).

Oral health influences the general quality of life and poor oral health is linked to chronic condition and systemic diseases. The association between the oral disease and the oral micro biota is well established of more than 750 species of bacteria that inhabit the oral cavity (Jenkinson et al., 2005).

The mouth is one of the areas of our body with greatest microbial population and variety. Different ecosystem is found in the mouth, where over 200 different aerobic and anaerobic bacterial species live. Oral bacteria (dental or commensal pathogens) and their products (toxins) may move from this primary location to other neighbouring or distant locations. Invasive dental procedures and oral surgery favor bacterial dissemination, especially into the bloodstream, causing transient bacteraemia. Transient bacteraemia is unavoidable, but its severity (bacterial load), duration (time in which bacteria remain in the bloodstream), type of bacteria in the blood (aerobic, anaerobic or mixed). And the patient’s predisposition (underlying diseases, susceptible site of infection, etc.), all play a significant role in the onset of possible complications (Tandon et al., 2010).

**Fig-2.1: Schematic representation ecological development of dental caries**

( Tandon et al., 2010)
Bacteraemia, initially considering mono-microbial bacteraemia, is caused by contamination or infection of the normal oral and dental pathogenic microbiota during the surgical procedure. Since the thirties, we have known that 75% of patients with caries, gingivitis and periodontitis will have positive *Streptococcus* blood cultures following dental procedures, in comparison with 30% in healthy subjects (Fine *et al.*, 1998).

Predominant organisms are *Streptococcus* from the viridians group (Carmona *et al.*, 2002). *Staphylococcus* sp and, in 4-7% of cases, gram-negative HACEK bacilli (*Haemophilus, Actinobacillus, Cardiobacterium, Eikenella, Kingella*), several of which are considered as dental pathogens (Berbari *et al.*, 1997). We should not neglect the existence of mixed (aerobic/anaerobic) bacteraemia, or anaerobic bacteraemia alone (*Eubacterium, Peptostreptococcus, Propionibacterium, and Lactobacillus*), which are detected in a significantly high percentage of cases when an appropriate microbiological method is used (oxygen-free blood cultures for anaerobic recovery) (Rajasuo, 2004).

Many bacteria and fungi produce diseases which are manifested in or about the oral cavity. Some of these diseases or lesions are of a specific nature and are produced by a specific contribution to the problem of caries etiology (Williams and Williams, 1994). The highest caries susceptibility is in the age group of 20-40 years, also the females are more susceptible to dental caries as compared to males (Nigam and Srivastawa 1990). Dental decay is a chemical parasitic process consisting of two stages, the decalcification of enamel or its total destruction and the decalcification of dentine (dissolution of the softened residue (Marsh *et al.*, 1992). The cariogenic Streptococci is critical to the development of pathogenic plaque. A large number of
Streptococcus, Actinomycyes and Lactobacillus species are involved in root caries and periodontal diseases (Sachipach et al., 1995).

Antibiotic resistance has increased substantially in the recent years and is posing an ever increasing therapeutic problem. One of the methods to reduce the resistance to antibiotics is by using antibiotic resistance inhibitors from plants. Plants are known to produce a variety of compounds to protect themselves against a variety of pathogens. It is expected that plant extracts showing target sites other than those used by antibiotics will be active against drug resistant pathogens (Ahmad and Beg 2001).

Medicinal plants have been used as traditional treatments for numerous human diseases for thousands of years and in many parts of the world. In rural areas of the developing countries, they continue to be used as the primary source of medicine (Chitme et al., 2003). About 80% of the people in developing countries use traditional medicines for their health care (Kim et al., 2005).

Several agents are commercially available, these chemicals can alter oral microbiota and have undesirable side effect, such as vomiting, diarrhea, and tooth staining. Hence the search for unconventional product continues and natural phytochemicals isolated from plants used as traditional medicines are considered as good alternatives. However 80% of the world’s population uses plant as their primary source of medication (Abubakar et al., 2011). In view of the fact that antibiotics are sometimes associated with adverse side effects to the host including hypersensitivity, immunosuppressive and allergic reactions, it is of interest to develop alternative antimicrobial drugs such as medicinal plants for treatment of infectious diseases. The plant extract or phytochemicals that hinder the growth of oral pathogens, diminish the progress of dental plaque, manipulate the adhesions of bacteria to surface and reduce
the symptoms of the oral diseases. Clinical studies that have investigated the safety and worth of such dried plant medicines (Palombo et al., 2009).

2.2 Bacterial pathogens

Bacteria are the primary etiologic agents in periodontal disease. More than 500 bacterial strains may be found in dental plaque (Kroes et al., 1999). These bacteria have evolved to survive in the environment of the tooth surface, gingival epithelium, and oral cavity. Recent technical advances have led to the recognition that dental plaque is a biofilm. Bacteria may be free-floating or attached to a surface. Recent advances in research technology have allowed researchers to study bacteria in their natural environment. These studies have revealed that most bacteria live in complex communities called biofilms.

A biofilm is a well-organized community of bacteria that adheres to surfaces and is embedded in an extracellular slime layer. Once a bacterium attaches to a surface, it activates a whole different set of genes that gives the bacterium different characteristics from those that it had as a free-floating organism. It has been estimated that more than 99% of all bacteria on the earth live as attached bacteria (Coghlan et al., 1996). Biofilms can be found on medical and dental implants living in intravenous and urinary catheters, contact lenses, and prosthetic devices, such as heart valves, biliary stents, pacemakers and artificial joints. Bacteria can also be life threatening; Legionnaire's disease, which killed 29 people in 1976, was the result of a bacterial biofilm in the hotel's air conditioning system.
Fig-2.2. Dental plaque biofilm structure (Coghlan et al., 1996)

The main etiological agents of dental caries are *Streptococcus mutants*, *Streptococcus mitis*, *Streptococcus salivarius* and *Streptococcus sobrinus*. Fermentation of carbohydrate by acidogenic oral bacteria is the key factor in the development of dental caries. The acid released through microbial action leads to demineralization and cavitations of tooth (Islam, 2007). *Streptococcus mutants* can colonize the tooth surface and initiate plaque formation by synthesizing extracellular polysaccharide from sucrose. Accumulation of plaque around the gingival margin and subgingival region may lead to shifts in the population of the microflora from Gram positive to Gram negative bacteria. These Gram negative plaque forming bacteria may cause periodontal disease in periodontal tissues and alveolar bone surrounding the teeth (Pathak et al., 2012).

Several potential periodontal pathogens have been studied and Gram negative anaerobic bacteria such as *Porphyromonas gingivalis*, *Prevotella intermedia*, *Actinobacillus actinomycetemcomitans* and *Campylobacter rectus* are considered to
represent a significant portion of pathogenic bacteria (Iwaki et al., 2006). Dental caries are generally treated with effective antibiotics like Chlorohexidine digluconate, Penicillin, Methicillin, Ampicillin, Erythromycin and Cephalothin. However, it was observed that herbal products used against oral infection have more inhibitory effect on dental pathogen. Various plants and extracts are used traditionally for dental care. Twigs of plants like Babul, Neem, clove oil and many others are used for brushing teeth in India (Arora et al., 2007).

2.3 Dental caries

Dental caries can be defined as the localized, progressive decay of a tooth, starting on the surface and if untreated extending to the inner root chamber and resulting in infection. Periodontal disease is a disease of the tissue surrounding the teeth. The two most prevalent periodontal diseases are gingivitis and periodontitis (inflammation of both the gum and the other supporting structures of the teeth). Orthodontics is the area of dentistry concerned with the bite and how teeth mesh together (Liu, 1993).

Dental caries is an infectious microbiological disease of the teeth that results in localized dissolution and destruction of the calcified tissues. It is the second most common cause of tooth loss and is found universally, irrespective of age, sex, caste, creed or geographic location. It is considered to be a disease of civilized society, related to lifestyle factors, but heredity also plays a role. In the late stages, it causes severe pain, is expensive to treat and leads to loss of precious man-hours. However, it is preventable to a certain extent. The prevalence of dental caries in India is 50%–60% (Burt, 1988).
Fig-2.3: Section of Tooth (Gordan, 2004)

Dental caries are an infection that causes destruction to the hard tissues such as enamel, dentin, and cementum. Bacteria is in the foods eaten that contain sugars and starches that turn into acids which eat away at the tooth’s structure that initially cause tooth decay. Dental caries are a chronic disease that can be prevented but shows mostly in 6 to 11 year old children and 12 to 19 year old adolescents. 9 out of 10 adults are affected with some type of tooth decay. Prevention includes good oral hygiene that consists of brushing twice daily, flossing, eating nutritious meals, and visiting the dentist on a regular basis. Fluoride treatments benefit the teeth by strengthening while sealants help chewing surfaces to not decay (Nizel, 1981).

2.3.1. Aetiology

Interplay of three principal factors is responsible for this multifactorial disease.

- Host (teeth and saliva).
A study on efficacy of traditional herbal antimicrobials in the prevention and treatment of dental caries

- Microorganisms in the form of dental plaque
- Substrate (diet).

Thus, caries requires a susceptible host, cariogenic oral flora and a suitable substrate, which must be present for a sufficient length of time.

**Host factors**

(i). Teeth Babaahmady (Daniels, 1975)

- **Composition**: Deficiency in fluorine, zinc, lead and iron content of the enamel is associated with increased caries.
- **Morphological characteristics**: Deep, narrow occlusal fissures, and lingual and buccal pits tend to trap food debris and bacteria, which can cause caries. As teeth get worn (attrition), caries develop.
- **Position**: The interdental areas are more susceptible to dental caries. Malalignment of the teeth such as crowding, abnormal spacing, etc. can increase the susceptibility to caries.

(ii). Saliva (Daniels, 1975)

Saliva has a cleansing effect on the teeth. Normally, 700–800 ml of saliva is secreted per day. Caries activity increases as the viscosity of the saliva increases. Eating fibrous food and chewing vigorously increases salivation, this helps in digestion as well as improves cleansing of the teeth. The quantity as well as composition, pH, viscosity and buffering capacity of the saliva plays a role in dental caries.

- **Quantity**: Reduced salivary secretion as found in xerostomia and salivary gland aplasia gives rise to increased caries activity.
• **Composition:** Inorganic—fluoride, chloride, sodium, magnesium, potassium, iron, calcium and phosphorus are inversely related to caries. Organic—ammonia retards plaque formation and neutralizes the acid.

• **pH:** A neutral or alkaline pH can neutralize acids formed by the action of microorganisms on carbohydrate food substances.

• **Antibacterial factors:** Saliva contains enzymes such as lactoperoxidase, lysozyme, lactoferrin and immunoglobulin (Ig). A, which can inhibit plaque bacteria.

(iii). **Dental plaque (Rosen, 1977)**

Dental plaque is a thin, tenacious microbial film that forms on the tooth surfaces. Microorganisms in the dental plaque ferment carbohydrate foodstuffs, especially the disaccharide sucrose, to produce acids that cause demineralization of inorganic substances and furnish various proteolytic enzymes to cause disintegration of the organic substances of the teeth, the processes involved in the initiation and progression of dental caries. The dental plaque holds the acids produced in close contact with the tooth surfaces and prevents them from contact with the cleansing action of saliva.

(iv). **Substrate (Burt, 1988)**

The role of refined carbohydrates, especially the disaccharide sucrose, in the aetiology of dental caries is well established. The total amount consumed as well as the physical form, its oral clearance rate and frequency of consumption are important factors in the aetiology. Vitamins A, D, K, B complex (B6), calcium, phosphorus, fluorine, amino acids such as lysine and fats have an inhibitory effect on dental caries.
2.4. Dental diseases

Dental diseases may affect the teeth, the gums, or other tissues and parts of the mouth. Dental diseases can cause much more serious problems than a toothache; they can affect our ability to chew, smile, or speak properly. Their severity may range from a simple aphthous ulcer, to a common tooth cavity, or up to a deadly oral cancer (Chaiya et al., 2013).

Periodontal Disease--Periodontal disease includes several diseases of the tissue surrounding and supporting the teeth. The two most prevalent periodontal diseases are gingivitis and periodontitis. Gingivitis, by far the most common, is inflammation of the gingiva (gum) only; and is by itself relatively innocuous. Periodontitis is inflammation of both the gums and other supporting structures of the teeth (e.g., the outer bone of the tooth socket, the outer layer of the root of the tooth, and the soft tissues that attach these structures to one another). Unlike gingivitis, periodontitis is associated with the destruction or loss of the supporting structures of the teeth. Periodontitis does not develop in the absence of gingivitis, but gingivitis does not always lead to periodontitis. Bacterial infection is an essential factor in both gingivitis and periodontitis (Wagner et al., 2009).

Periodontal disease is more common and more severe among adults than among adolescents. Periodontal problems are generally fewer and less severe than dental caries problems among adolescents, rarely leading to tooth loss during this age period. Nevertheless, adolescents are affected by a variety of acute and chronic periodontal problems, ranging from mild gingivitis to frank periodontal disease. One chronic periodontal condition peculiar to adolescence is localized juvenile periodontitis, which causes the loss of alveolar bone supporting permanent teeth and the weakening of the
dentition thought to be caused by the organism *Haemophilus* (*Actinobacillus*). *actinomycetemcomitans* or a combination of organisms, iodized juvenile periodontitis is insidious and is not necessarily present with inflammation as is gingival disease. It occurs in a small percentage of adolescents (Aneja *et al*., 2010).

Gingivitis and periodontitis are the two major forms of inflammatory diseases affecting the periodontium. Their primary etiology is bacterial plaque, which can initiate destruction of the gingival tissues and periodontal attachment apparatus. Gingivitis is inflammation of the gingiva that does not result in clinical attachment loss. Periodontitis is inflammation of the gingiva and the adjacent attachment apparatus and is characterized by loss of connective tissue attachment and alveolar bone (Armitage, 1999).

**2.4.1 Periodontitis**

Periodontal diseases, specifically periodontitis are caused by pathogenic bacterial species located in the subgingival niche. These bacterial species adhere to the tooth surfaces and are organized in a complex structure, the dental plaque, which has been considered recently as an example of a biofilm. One common dental disease that affects the gums is Periodontitis. Gingivitis that is not treated can lead to periodontitis. Plaque will spread and form underneath the gums. In plaque, the toxins made from the bacteria bother the gums. From the support of the tissues and bone for the teeth, they are broken and shattered. The teeth are separated from the gums and have spaces between them which are infected. As periodontitis continues the bone and gum tissue are no longer available. There are hardly any symptoms for this disease. If not treated, the teeth will become useless and the teeth will have to be taken out. There are
different forms of periodontitis such as chronic and aggressive periodontitis. Chronic periodontitis is the most common disease (Marsh, 2005).

The periodontal diseases range from the relatively benign form of gingivitis to aggressive periodontitis. Many of these conditions are not only a threat to the dentition, but may also be a threat to general health. There are reports suggesting increased prevalence of diabetes, atherosclerosis, myocardial infarction, and stroke in patients with periodontal disease. Thus, the likelihood of periodontal disease being associated with systemic diseases is becoming established fact. All forms of inflammatory periodontal disease are associated with chronic inflammation (accumulation of B and T lymphocytes as well as monocytes and neutrophils), resulting in destruction of the periodontal ligament and bone. If left untreated, significant tissue damage occurs, and the affected teeth can become loose and may be lost if the disease continues to be active. What is particularly curious about this disease is the great variability in presentation. Because of its multifactorial nature, which is modified by systemic, environmental, and microbiological factors, not all individuals are affected to the same degree despite the ubiquitous presence of dental plaque (Yalda, 2000).

2.4.2. Gingivitis

Gingivitis is a swelling and inflammation of the gums (gingiva) is the first stage of periodontal disease. Another common periodontal disease is gingivitis. Periodontal refers to the area the infection affects, which include the teeth, gums, and tissues surrounding the teeth. There is no exact cause of gingivitis but there are many contributing factors (Emedicinehealth). The number one thing that can cause gingivitis is due to the buildup of plaque on the teeth. If the plaque is not taken care of and
continues to accumulate, bacteria may begin to grow and this will cause the gingivitis infection. There are many symptoms of gingivitis; these include bleeding, swelling, inflammation, and also a deep red color of the gums (Emedicinehealth). Treatment of gingivitis is dependent on how severe and how far the disease has progressed. If the disease is not too severe it is possible to be treated with fluoride rinse and fluoride toothpaste to remove the plaque, and kill the gingivitis, but once the infection has progressed antibiotics will be needed to kill the bacteria (Emedicinehealth) (Koo et al., 2002).

Figure-2.4: Common form of gum disease (Koo et al., 2002).

Causes

Gingivitis is a form of periodontal disease. Periodontal disease involves inflammation and infection that destroys the tissues that support the teeth, including the gums, the periodontal ligaments, and the tooth sockets (alveolar bone). Gingivitis is due to the long-term effects of plaque deposits. Plaque is a sticky material made of bacteria, mucus, and food debris that develops on the exposed parts of the teeth. It is a major cause of tooth decay. If you do not remove plaque, it turns into a hard deposit
called tartar that becomes trapped at the base of the tooth. Plaque and tartar irritate and inflame the gums. Bacteria and the toxins they produce cause the gums to become infected, swollen, and tender. Injury to the gums from any cause, including overly vigorous brushing or flossing of the teeth, can cause gingivitis (Chung et al., 2006).

The following raise your risk for developing gingivitis:

- General illness
- Poor dental hygiene
- Pregnancy (hormonal changes increase the sensitivity of the gums).
- Uncontrolled diabetes

Misaligned teeth, rough edges of fillings, and ill-fitting or unclean mouth appliances (such as braces, dentures, bridges, and crowns) can irritate the gums and increase the risk of gingivitis. Medications such as phenytoin and birth control pills, and heavy metals such as lead and bismuth are also associated with gingivitis. Many people have gingivitis to a varying degree. It usually develops during puberty or early adulthood due to hormonal changes and may persist or recur frequently, depending on the health of your teeth and gums (Limsong et al., 2004).

**Symptoms**

- Bleeding gums (blood on toothbrush even with gentle brushing of the teeth).
- Bright red or red-purple appearance to gums
- Gums that are tender when touched, but otherwise painless
- Mouth sores
- Swollen gums
Gingivitis is a reversible disease. Therapy is aimed primarily at reduction of etiologic factors to reduce or eliminate inflammation, thereby allowing gingival tissues to heal. Appropriate supportive periodontal maintenance that includes personal and professional care is important in preventing re-initiation of inflammation (Agerbaek, 1979).

Therapy for individuals with chronic gingivitis is initially directed at reduction of oral bacteria and associated calcified and noncalcified deposits. Patients with chronic gingivitis, but without significant calculus, alterations in gingival morphology, or systemic diseases that affect oral health, may respond to a therapeutic regimen consisting of improved personal plaque control alone. The periodontal literature documents the short- and long-term effects following self-treatment of gingivitis by personal plaque control. However, while it may be possible under controlled conditions to remove most plaque with a variety of mechanical oral hygiene aids, many patients lack the motivation or skill to attain and maintain a plaque-free state for significant periods of time (MacGregor, 1986).

Clinical trials also indicate that self-administered plaque control programs alone, without periodic professional reinforcement, are inconsistent in providing long-term inhibition of gingivitis. Many patients with gingivitis have calculus or other associated local factors (e.g., defective dental restorations) that interfere with personal oral hygiene and the ability to remove bacterial plaque. An acceptable therapeutic result for these individuals is usually obtained when personal plaque control measures are performed in conjunction with professional removal of plaque, calculus, and other local contributing factors (Lovdal, 1975).
Removal of dental calculus is accomplished by scaling and root planning procedures using hand, sonic, or ultrasonic instruments. The therapeutic objective of scaling and root planning is to remove plaque and calculus to reduce subgingival bacteria below a threshold level capable of initiating clinical inflammation (Mandel, 1994).

The success of instrumentation is determined by evaluating the periodontal tissues following treatment and during the maintenance phase of therapy. The use of topical antibacterial agents to help reduce bacterial plaque may be beneficial for the prevention and treatment of gingivitis in some patients. A number of these agents in oral rinses and dentifrices have been tested in clinical trials. However, to be accepted by the American Dental Association (ADA). Council on Dental Therapeutics as an effective agent for the treatment of gingivitis, a product must reduce plaque and demonstrate effective reduction of gingival inflammation over a period of at least 6 months. The agent must also be safe and not induce adverse side effects (Hancock, 1996).

Three medicaments have been given the ADA Seal of Acceptance for the control of gingivitis. The active ingredients of one product are thymol, menthol, eucalyptol, and methyl salicylate. Active ingredients in the other two are Chlorohexidine digluconate and triclosan. If properly used, the addition of a topical anti-plaque agent to a gingivitis treatment regimen for patients with deficient plaque control will likely result in reduction of gingivitis (Brecx et al., 1992).
2.5. Prevention of Dental caries

Dental caries, the major dental infectious disease problem for adolescents, can be prevented in the following ways:

- by increasing the resistance of the teeth via the use of fluoride and dental (occlusal) sealants
- by reducing or interfering with the caries-producing microorganisms in contact with the teeth through the use of fluoride and oral hygiene procedures, and
- By altering a person’s oral environment through dietary interventions (Suomi et al., 1990).

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Figure 2.5: Suspected interrelationships between gingival inflammation, systemic disease, and response to periodontal therapy (Brecx et al., 1992).
2.5.1. Increase the resistance of the teeth

(i). Systemic use of fluoride:

- Fluoridation of water, milk and salt;
- Fluoride supplementation in the form of tablets and lozenges;
- Consuming a fluoride-rich diet such as tea, fish, etc.

(ii). Topical:

- Use of fluoridated toothpaste and mouth wash
- Use of fluoride varnishes (in-office application, longer duration of action, high fluoride content).
- Use of casein phosphopeptide–amorphous calcium phosphate (CPP–ACP), which is available as tooth mousse, helps to remineralize the soft initial carious, demineralized areas of the teeth (Hicks et al., 2004).

2.5.2. Combat the microbial plaque by physical and chemical methods

(i). Physical methods

The correct method and frequency of brushing should be followed—in the morning and before going to bed and preferably after every major meal. Tongue cleaning and the use of indigenous agents such as the bark of neem or mango (where toothbrush and paste are unaffordable) should be encouraged. The use of coarse toothpowder and tobacco-containing dentifrices should be avoided. The use of various interdental cleaning aids such as dental floss, interdental brush, water pik, etc. supplements the cleansing effect of a toothbrush. Use of an electronic toothbrush in children and persons with decreased manual dexterity is recommended (Klock et al., 1978).
(ii). Chemical methods

These include the use of fluoride-containing toothpaste, mouth rinses and 0.2% Chlorohexidine and povidine–iodine mouthwash. These should be used on prescription of a dental surgeon (Klock et al., 1978).

2.5.3. Modify the diet

Reduce the intake and frequency of refined carbohydrates. Avoid sticky foods and replace refined with unrefined natural food. Increase the intake of fibrous food to stimulate salivary flow, which is protective against caries. Consume caries-protective foods such as cheese, nuts, raw vegetables, fruits, etc. Stimulate salivary flow with sugar free chewing gum. Xylitol (a sugar substitute).-containing chewing gum, if chewed between meals, produces an anticaries effect by stimulating salivary flow (Marshall et al., 2004).

The prevention of periodontal disease requires good personal oral hygiene habits, including brushing and flossing, to remove plaque from all teeth surfaces. Personal oral hygiene is also important because gingivitis can be reversed through personal plaque control. Periodontitis is a much more severe disease state and usually requires professional treatment to prevent progression, but personal oral hygiene must be practiced as well. In addition to personal hygiene measures, prophylaxis (cleaning) by a dental professional at least once a year is generally recommended to prevent periodontal diseases. The American Dental Association has suggested the inclusion of prophylaxis by a dental professional in a model dental health insurance benefit (Greene et al., 1990).
2.6. Treatment

The goal is to reduce inflammation. The teeth are cleaned thoroughly by the dentist or dental hygienist. This may involve various instruments or devices to loosen and remove deposits from the teeth. Careful oral hygiene is necessary after professional tooth cleaning. The dentist or hygienist will show you how to brush and floss. Professional tooth cleaning in addition to brushing and flossing may be recommended twice per year or more frequently for severe cases. Antibacterial mouth rinses or other aids may be recommended in addition to frequent, careful, tooth brushing and flossing (Carounanidy et al., 2007).

Dental Diseases can be prevented by taking proper care of your teeth. Brushing, flossing, and regular visits to the dentist will help prevent these diseases. These diseases could affect you in a number of ways, including the loss of your teeth, tongue, or even the ability to speak and eat. Most dental diseases are caused from poor oral hygiene and can be easily cured by taking good care of your teeth (Doss et al., 2009).

2.7. Herbs and their historical importance

Medicinal plants are used to cure variety of diseases for long years. Natives in most countries in the world use herbs to treat all their ailments. The jungle is God’s gift to mankind. Long before western medicine exist, people use leaves, roots, barks and stems of plants for food and medicine. There are natural remedies to relieve pain such as headache and toothache. There are herbs to cure tooth decay, prevent tooth cavities, relieve toothache, reduce the formation of plaque and treat receding gums and
mouth sores. Here are some herbs used to cure tooth decay and other dental problems (Hwang et al., 2004).

Medicinal plants, since times immemorial, have been used in virtually all cultures as a source of medicine. The widespread use of herbal remedies and healthcare preparations, as those described in ancient texts such as the Vedas and the Bible, and obtained from commonly used traditional herbs and medicinal plants, has been traced to the occurrence of natural products with medicinal properties. The World Health Organization estimated that 80% of the populations of developing countries rely on traditional medicines, mostly plant drugs, for their primary health care needs (Jagadish et al., 2009).

Medicinal plants represent a consistent part of the natural biodiversity endowment of many countries in Africa. The use of traditional medicine and medicinal plants in most developing countries, as a normative basis for the maintenance of good health, has been widely observed. Furthermore, an increasing reliance on the use of medicinal plants in the industrialized societies has been traced to the extraction and development of several drugs and chemotherapeutics from these plants as well as from traditionally used rural herbal remedies. Moreover, in these societies, herbal remedies have become more popular in the treatment of minor ailments, and also on account of the increasing costs of personal health maintenance (Akiyama et al., 2001).

Traditional and folklore medicine bequeathed from generation to generation is rich in domestic recipes and communal practice. Encompassing concepts and methods for the protection and restoration of health, traditional medicine has served as a fountain of alternative medicine, new pharmaceuticals, and healthcare products. The best
known examples of traditional medicine, differing in concept and protocol, are well-developed systems such as acupuncture and ayurvedic medicine that have been widely used to conserve human health in China and India (Khan et al., 2008).

Developed countries, in recent times, are turning to the use of traditional medicinal systems that involve the use of herbal drugs and remedies. About 1400 herbal preparations are used widely. Herbal preparations are popular and are of significance in primary healthcare in Belgium, France, Germany and the Netherlands. Such popularity of healthcare plant-derived products has been traced to their increasing acceptance and use in the cosmetic industry as well as to increasing public costs in the daily maintenance of personal health and well being. Examples of such beauty-oriented therapeuticals are skin tissue regenerators, anti-wrinkling agents and anti-age creams. Most dermaceuticals are derived from algal extracts that are rich in minerals and the vitamin B group. Skincare products such as skin creams, skin tonics, etc. derived from medicinal plants are grouped together as dermaceuticals. Also cures and drugs, derived from plants, constitute the main source of healthcare products (Cai et al., 2000).

The power of Chinese folk medicinal potions in treating maladies from eczema and malaria to respiratory disorders, In the quest for new medicines to treat old and emergent diseases such as malaria and AIDS, attention is now being given to discovering the active ingredients encountered in the treasury of over 5,000 Chinese herbs, plants and roots that have been used routinely and traditionally (Rahim et al., 2006).
2.7.1. *Ficus benghalensis*

*Ficus bengalensis* is also known as Indian banyan tree. Different parts of the tree have been found to possess medicinal properties; leaves are good for ulcers, aerial roots are useful in gonorrhea, seeds and fruits are cooling and tonic. The roots of *Ficus bengalensis* are given for obstinate vomiting and infusion of its bark is considered as a tonic and astringent and is also used in diarrhea, dysentery and diabetes. The bark of the plant is used in Ayurvedic medicine for the treatment of diabetes (Mandal et al., 2010).

**Taxonomical classification**

- **Kingdom**: Planate – Plants
- **Subkingdom**: Tracheobionta
- **Superdivision**: Spermatophta
- **Division**: Magnolipophyta
- **Class**: Magnoliopsida
- **Subclass**: Hamamelididac
- **Order**: Urticales
- **Family**: Moraceae
- **Genus**: *Ficus*
- **Species**: *bengalensis*
Fig-2.6. Plant of *Ficus bengalensis* (Mandal *et al.*, 2010)

*Ficus bengalensis* is native to India where it grows from low altitudes to 2000 ft (610 m), especially in dry regions. It is native to a wide area of Asia from India through Myanmar (Burma), Thailand, Southeast Asia, Southern China and Malaysia (Riffle, 1998).

*Ficus bengalensis* is widely cultivated in the tropics. It is cultivated in India and has not had its associated wasp introduced and therefore has not yet spread from initial plantings. *F. benghalensis* is the world's largest tree in terms of its spread with some old trees covering over an acre of ground. The tree's name "banyan" refers to the merchants who set up shop under the spreading trees. One of the most popular banyan trees, *Ficus benghalensis*, on Maui, located on Front St. in Lahaina, is a meeting place for tourists, artists, children, and folks selling their goods. In addition to the large spreading growth form, trees also have attractive red fruits and aerial roots which hang from limbs (Chew *et al.*, 1989). The pests associated with *Ficus* species: mealy bugs, scale insects, spider mites, root knot nematodes, and thrips occur under most
environmental conditions, fungal and bacterial leaf spots, crown gall, twig dieback (Starr et al., 2003).

*Ficus benghalensis* a remarkable tree of India sends down its branches and great number of shoots, which take root and become new trunk. This tree is considered to be sacred in many places in India. The plant is a large evergreen tree distributed all over India from sub Himalayan region and in the deciduous forest of Deccan and south India. It is grown in gardens and road sides for shades. It is a member of four sacred trees Nalpamara (Ksirivrksas) meant to be planted around the home and temples. It is found throughout the year, grows in evergreen except in dry localities where it is a leafless for a short time (John, 2001).

### 2.7.2. *Azadirachta indica*

*Azadirachta indica*, knows as a Neem in the Indian sub-continent, is widely grown all over the tropics. It is a fast growing evergreen tree with very dense crown. The tree height is about 15 - 20 meters. The tree is evergreen but in severe drought condition it may shed most or all of its leaves. The trunk is relatively short, straight and may reach a diameter of 1.2 m. The bark is whitish-grey to reddish-brown in color (Acobson, 1990).

*Azadirachta indica* (Meliaceae) commonly known as neem is native of India and naturalized in most of tropical and subtropical countries is of great medicinal value and distributed widespread in the world. The Chemical constituents contain many biologically active compounds that can be extracted from neem, including alkaloids, lavonoids, triterpenoids, phenolic compounds, Carotenoids, steroids and ketones, Azadirachtin is actually a mixture of seven isomeric compounds labeled as azadirachtin A-G and azadirachtin E is more effective. Other compounds that have a
biological activity are salannin, volatile oils, meliantriol and nimbin. Neem leaf is effective in treating eczema, ringworm, acne, has anti-inflammatory, antiheperglycemic properties and it is used to heal chronic wounds, diabetic foot and gangrene developing conditions. It is believed to remove toxins from the body, neutralize free radicals and purify the blood. It is used as anticancer agent and it has hepato-renal protective activity and hypolipidemic effects (Ahana et al., 2005).

**Taxonomical classification**

Order : Rutales  
Suborder : Rutinae  
Family : Meliaceae (mahogany family).  
Subfamily : Melioideae  
Tribe : Melieae  
Genus : *Azadirachta*  
Species : *indica*

The fruits are edible, all parts are medicinally valuable. The neem oil is used in preparation of cosmetics (soaps, shampoo and creams), leaves are used as pesticide and the neem gum as a bulking agent and for the preparation of special purpose food for diabetics. Slender neem branches chewed in order to clean one's teeth. A decoction prepared from roots is ingested to relieved fever in traditional Indian medicine. Neem leaf paste is applied to the skin to treat acne and also used in other diseases such as measles, small pox, chicken pox, prickly heat disorders and sweat rash. It brings other environmental benefits such as flood control and reduced soil erosion. It helps in restoring and maintaining soil fertility which makes it highly suitable in agro-forestry. It is a source of good timber, being durable and termite resistant; neem wood is used in
making fence posts, poles for house construction, furniture etc. It is a good source of fire wood and fuels. As a source of shade, it is excellent for parks, roadsides, etc. (Lekshmi et al., 2012).

The neem tree contains promising pest-control substances found effective against many economically important pests. Neem does not normally kill pests right away; rather it repels them and affects their growth. As neem products are cheap and non-toxic to humans, animals, they are well-suited for pest control in rural areas. For these reasons neem is considered as “eco-friendly” pesticide, the best substitute to hazardous pesticides. A large amount of scientific evidence is available on the potential of A. indica as a source for the development of human and animal health products. For example, neem seed oil and essential oils from leaves and bark have been shown to inhibit the growth of various genera of pathogenic bacteria, such as Mycobacterium and Streptococcus. Antiviral activity of neem leaf extracts has been evidenced against dengue virus and HIV. Moreover, several important parasitic protozoa, including Trypanosoma, Leishmania and Plasmodium have been shown to be susceptible to neem extracts and purified limonoids. Antifilarial activity has been demonstrated with an alcoholic extract of neem flowers against Setaria cervi, a parasitic nematode of the water buffalo (Bubalis bubalis). Further, many arthropod ectoparasites are susceptible to both the insecticidal, growth regulatory and repellent activity of neem extracts: for example, lice and ticks can be successfully controlled by neem extracts, and many species of mosquitoes, including important vectors of parasitic diseases, have been shown to be susceptible to neem products (Lucantoni et al., 2006).
2.7.3. Achyranthes aspera

Achyranthes aspera L. (Latjeera) is an erect or procumbent, annual or perennial herb of about 1-2 meter in height, often with a woody base. Stems angular, ribbed, simple or branched from the base often with tinged purple colour (Anonymous). The Wealth of India – Raw Materials, Council of Scientific & Industrial Research), branches terete or absolutely quadrangular, striate, pubescent, leaves thick, 3.8 - 6.3 × 22.5 - 4.5 cm, ovate – elliptic or obovate – rounded, finely and softly pubescent on both sides, entire, petiolate, petiole 6 – 20 mm long flowers greenish white, numerous in axillary or terminal spikes up to 75 cm long, seeds subcylindric, truncate at the apex, rounded at the base, reddish brown (Zafar et al., 2009).

**Taxonomical classification**

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<td>Species</td>
<td>Aspera</td>
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</table>

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A study on efficacy of traditional herbal antimicrobials in the prevention and treatment of dental caries

Fig-2.7: Plant of *Achyranthes aspera* (Zafar *et al.*, 2009).

The plant is known for many medicinal uses such as purgative, diuretic, used in dropsy, piles, boils, skin eruption and in treating snake bite. The plant is used by tribal groups in treating abdominal disorder, anaemia, anasorea, asthma, cough, diarrhea, dysentery, ear diseases, hydrophobia, insect bite, jaundice, pneumonia, renal dropsy, ulcers, bleeding during delivery, headache, leucoderma, rheumatism, scabies, stomach ache and cancer (Murthy *et al.*, 1994).

It is useful in cough, bronchitis, rheumatism, malarial fever, dysentery, asthma, renal and cardiac dropsy, hypertension and diabetes mellitus *A. aspera* can stimulate the immunity, enhance the antigen clearance, potentiate antibody production, elevate thyroid hormone levels, decrease hepatic lipid peroxidation and also possesses spermicidal, chemopreventive, anti-inflammatory, anti-arthritis and hypoglycaemic activities (Paul, 2006). In Chinese traditional medicine, the hot water extract of the plant has been used as an antiarthritic to alleviate arthritic pain. In vitro and in vivo studies of the root extract have found the spermicidal activity. The dried leaf powder
mixed with honey is useful in the early stages of asthma. Oleanolic acid is one of the constituents of *A. aspera* L. *A. bidentata* Blume extract can promote neuronal growth, protect hippocampal neurons against toxicity, and also has anti-stress and anti-apoptosis activities. Both the plants are found to be a source of many secondary metabolites (Tang, 2009).

### 2.7.4. *Acacia nilotica*

**Taxonomical classification**

- **Kingdom**: Plantae
- **Subkingdom**: Tracheobionta
- **Super division**: Spermatophyta
- **Division**: Magnoliophyta
- **Class**: Magnoliopsida
- **Subclass**: Rosidae
- **Order**: Fabales
- **Family**: Fabaceae
- **Genus**: *Acacia*
- **Species**: *nilotica*

*Acacia nilotica* grows to 15-18 m in height and 2-3 m in diameter. The bark is generally slaty green in young trees or nearly black in mature trees with deep longitudinal fissures exposing the inner grey-pinkish slash, exuding a reddish low quality gum. The leaves are bipinnate, pinnae 3-10 pairs, 1.3-3.8 cm long, leaflets 10-20 pairs, and 2-5 mm long. Thin, straight, light grey spines present in axillary pairs, usually 3-12 pairs, 5-7.5 cm long in young trees, and mature trees commonly without
thorns

Flowers in globulous heads, 1.2-1.5 cm in diameter of a bright golden yellow colour, born either axillary or whorly on peduncles 2-3 cm long located at the end of branches. Pods 7-15 cm long, green and tomentose when immature and greenish black when mature, indehiscent, deeply constricted between the seed giving a necklace appearance (Fig. 2.8). Seeds 8-12 per pod, compressed, ovoid and dark brown shining with hard testa (Bargali et al., 2009).

The aqueous extract of AN pods, fruits, bark and seeds have been used traditionally for ailments like diarrhoea, leprosy, asthma, skin disease, ulcer, cancers of eye and ear, tuberculosis and smallpox however, its hypoglycaemic, hypolipidaemic and anti-platelets aggregation effect in diabetic animal is controversial (Sundaram et al., 2007).
Medicinal uses and pharmacological effects

*Acacia nilotica* also has numerous medicinal uses. The medicinal traits and pharmacological activities endorsed to various parts of *A. nilotica* are detailed as follows.

- **Anti-hypertensive and anti-spasmodic activities**

  A decrease in arterial blood pressure is reported by use of methanolic extract of *A. nilotica* pods and provides evidence of anti hypertensive activities independent of muscarinic receptor stimulation. In the *in vitro* studies, *A. nilotica* has inhibitory effect on force and rate of spontaneous contractions in guinea-pig paired atria and rabbit jejunum. *A. nilotica* also inhibits K+ induced contractions in rabbit jejunum advocating the antispasmodic action of *A. nilotica* which is mediated through calcium channel blockade and this may also be responsible for the blood pressure lowering effect of *A. nilotica*, observed in the *in vivo* studies. An aqueous extract of the seed of *A. nilotica* is also investigated on the isolated guinea-pig ileum which exposed the sustained dose-related contractile activity. A dose-related significant elevation of blood pressure is produced by intravenous administration of the extract (Amos et al., 1999).

- **Antiplasmodial activities**

  The ethyl acetate extract holds the highest activity on *Plasmodium falciparum*. Phytochemicals analysis indicated that the most active phase contained terpenoids and tannins and was devoid of alkaloids and saponins. Crude methanolic root extracts of *A. nilotica* reveals significant activity against chloroquine sensitive strain of *Plasmodium berghei* in mice (Jigam, 2010).
• **Antioxidant activity**

Water extract/fractions of *A. nilotica* (L.) in lipid peroxidation assay possess the peroxyl radical scavenging capacity and results prove the antioxidant activity of plant. The bark powder of the plant extracts with different solvents found the scavenging activity using maceration extraction. Another study reveals that *A. nilotica* is easily accessible source of natural antioxidants, which can be used as supplement to aid the therapy of free radical mediated diseases such as cancer, diabetes, inflammation, etc. Furthermore, the high scavenging property of *A. nilotica* may be due to hydroxyl groups existing in the phenolic compounds that can scavenge the free radicals (Kalaivani and Mathew, 2010).

2.7.5. **Elettaria cardamomum**

Cardamom (*Elettaria cardamomum*) which is often regarded as the ‘queen of spices’, is an economically high valued crop. It grows well in cool and humid climate under the shade. Therefore most of the cardamom plantations are established under the forest canopy. *Elettaria cardamomum* Var. *Cardamomum* is native to South India. The seeds contain a volatile oil, which give cardamom its aroma as well as medicinal value. Cardamom grows from 6 to 12 feet in height. It has large, wide, dark green leaves and flowers that vary in colour (one example is white flowers with purple tip). It is its thick stem, which flowers and bears the fruit. Enclosed in the fruit pods are small, brown aromatic seeds. Cardamom is a very popular but also very expensive spice. It is known for its pungent taste and highly aromatic flavour. Cardamom is a natural stimulant and carminative, but it is often used in synergy with other agents to relieve flatulence and
indigestion. Due to its aromatic flavour, it makes a powerful breath freshener and a
fusion of cardamom and cinnamon can be gargled to relieve a sore throat. When
crushed with mint leaves in boiling water it makes an effective hiccup remedy and
when boiled with tea it can be used for depression. Another application for cardamom
is as a diuretic (Oser et al., 1985).

**Taxonomical classification**

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</thead>
<tbody>
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</tr>
<tr>
<td>Species</td>
<td>Cardamomum</td>
</tr>
</tbody>
</table>

![Figure 2.9 Elettaria cardamomum](Oser et al., 1985).

Green cardamom pods are the preferred form of this spice in its native country,
India. This fancier kind of cardamom has been picked while still immature and sun
dried to preserve its bright green color. Green cardamom pods are harder to find and
more expensive in part because of their superior ability to retain aroma and flavor
longer. This premium form of cardamom is all connoisseurs will use in any recipe which calls for cardamom (Rota et al., 2004).

**Cardamom Uses**

Cardamom is stimulant, carminative, digestive. Cardamom is used mainly to treat colds, bronchitis, fevers, inflammatory conditions and liver complaints; however, there is no evidence to support any of these uses. Cardamom is an expensive spice, second only to saffron. This spice has a floral flavor. It is used in curries, sweets, desserts, rice puddings and other rice dishes, milk, kheer, etc. The seeds can be chewed for good flavor in mouth and to get rid of bad breath (Zheng and Wang, 2001).

**Benefits of Cardamom**

Cardamom has been used for medicinal purposes, since time immemorial. The use of this spice is mentioned in the Vedic texts and the ancient ayurveda inscriptions of India. Even the ancient Greeks, Romans and Arab people used this spice for its aphrodisiac qualities and other cardamom health benefits. Apart from these cardamom health benefits, it has been very popular in these countries for culinary and religious purposes too. Green cardamom is more popular than the brown variety, but, both are used in various cuisines across the world. Both are different in fragrance and taste. Green cardamom is used as flavorings in various culinary preparations, especially, tea, coffee, sweet dishes, meat, curries, etc. Brown cardamom is mainly used in curries. Green cardamom is also used as a mastication enhancer, in order to increase saliva and to prevent bad breath. In short, cardamom is mainly used for three purposes as food and drink flavorings, as cooking spices and medicine. The next paragraphs deal with
the medicinal properties and health benefits of cardamom. Read more on cardamom tea (Park et al., 2005).

**Health Benefits of Cardamom**

- Cardamom oils are used for messages in Ayurveda massage parlor. It eases muscle tension and gradually gives a whole physical relief. The volatile oils extracts from cardamom is used for improving metabolism. It is used in the cure of halitosis.

- Cardamom is used for digestive disorders frequently. It helps to relieves gas and heartburn.

- Cardamom reduces the air and water elements, increases appetite and soothes the mucous membrane. Ground cardamom seed mixed with ginger, coriander and cloves is an effective medicinal solution for indigestion.

- *The aromatic cardamom acts as breath freshener too. A few seeds chewed for a brief time can outfight bad breath. It has the power to kill the germs which causes the bad breath.*

- It also cures some genitor-urinary infections. The powdered cardamom seeds mixed with a tablespoon of banana leaf and amla juice acts as an excellent diuretic treatment for cystitis, nephritis [inflammation of kidney], burning micturation and scanty urination.

- It’s a fighter against oral infections. Daily gargle of an infusion of cardamom and Cinnamon protects one from the Flu and bacterial infections like throat infections. The same medicinal mixture can cure pharyngitis too.
• Cardamom powder mixed tea is a delicious drink which cures physical depression. It may help relieve nausea and vomiting. It can help detoxify against excessive caffeine. It is effective in fighting pulmonary disease with copious phlegm. Cardamom tea helps to cure headache caused by indigestion

• The herb is using for treating in sexual dysfunctions like impotency. A pinch of cardamom seeds powder boiled in milk and sweetened with honey is useful in case of premature ejaculation. However, excessive use of cardamom at times may lead to impotency.

• Cardamom also helps in cleansing the body as it has detoxifying properties. It can be helpful in prevention of spasms or convulsions. People use cardamom in foods as a flavoring agent. It helps to remove toxins (Ou et al., 2001).

2.7.6. Coleus amboinicus

_Coleus amboinicus_ is found abundantly throughout India, mostly throughout the tropics and cultivated in homestead gardens. It is a much branched, highly aromatic pubescent, large succulent aromatic perennial herb with hispidly villous tomentose fleshy stem. Leaves are simple, opposite, broadly ovate, crenate, fleshy, light green to green coloured, bitter, acrid, thermogenic with distinctive smells. Flowers are pale purplish in dense whorls at distant intervals in a long slender raceme. Fruits are orbicular or ovoid nutlets. Stems are light green colored, straight to bent shaped and have aromatic smell. Roots are brown to dark brown or blackish brown in color. This plant is very susceptible to wet soil or water stagnation, even if it is for a short period, and should be grown under protection during rainy season without reducing light. This crop requires rich well drained porous soil in sun or partial shade. Minimum temperature required by this species is 10-15°C. _Coleus_ may lower blood sugar levels.
caution is advised if you are taking prescription drugs that may lower blood sugar levels. Patients taking oral drugs for diabetes or using insulin should be monitored closely by their health care provider while using coleus dosing adjustments may be necessary (Rasheed and Haider, 1998).

**Taxonomical classification**

- **Kingdom**: Plantae - plants
- **Subkingdom**: Viridaeplantae
- **Phylum**: Tracheophyta (Vascular).
- **Division**: Magnolophyta (flowering plant).
- **Class**: Magnoliopsida (Dicotyledons).
- **Order**: Lamiales
- **Family**: Lamiaceae (Labiatae) - mint family
- **Genus**: Coleus
- **Species**: Amboinicus

**Figure-2.10**: Plant of *Coleus aromaticus* (Sakanaka et al., 1989).
Medicinal Use:

- Promotes the flow of urine.
- For the expelling of gases flatulence and griping pairs from the stomach and bowels.
- Promotes menstrual flow.
- Strengthens and gives tone to the stomach.
- For indigestion discomfort or pain (Sakanaka et al., 1989).

The leaves are used as appetizer, digestive, carminative, stomachic, anthelmintic, constipating, deodorant, expectorant, lithontriptic, diuretic and liver tonic. They are also useful in cephalalgia, otalgia, anorexia, dyspepsia, flatulence, colic, diarrhea and cholera, especially in children, halitosis, convulsions, epilepsy, cough, chronic asthma, hiccough, bronchitis, renal and vesical calculi, strangury, hepatopathy and malarial fever. It is said to have a properties to cure insect bits, headache, fever and bronchitis (Devi et al., 2010).

2.7.7. Syzygium aromaticum

Cloves are the pink flowering bud of a form evergreen tree (Eugenia aromatica), which are dried until brown and used for medicinal and spicing purposes. Indigenous to the Moluccas spice Islands of Indonesia, cloves also grow naturally in India, the West Indies, Tanzania, Sri Lanka, Brazil and Madagascar. Cloves are an aromatic herb that has many useful purposes. The aroma of the clove is pleasant yet spicy and can be used to make drawers and closets smell nice. Cloves has some medicinal purposes as well and it tastes good in certain dishes like spice cake. Cloves like to grow in hot tropical climates like the islands of Indonesia. The clove plant is an
evergreen tree that can reach a height of thirty or forty feet high. The leaves of the clove are leathery textured and are covered with many tiny depressions. The part of the clove that is used is the flower buds of the clove. The aromatic oils of the clove have a stimulant and irritant effect. Cloves can increase blood circulation and raise a person's temperature slightly. The oils of the cloves have been known to stimulate and disinfect a body as it travels through the body. Clove can be used to promote the flow of saliva and gastric juices (Kumar et al., 2012).

**Taxonomical classification**

Kingdom : Plantae
Phylum : Agiosperms
Unranked : Eudicots
Unranked : Rosids
Family : Myrtaceae
Genus : Syzygium
Species : aromaticum

*Fig-2.11: Plant of Syzygium aromaticum* (Kumar et al., 2012)
Clove oil

Clove oil is an essential oil from the dried flower buds, leaves and stems of the tree *Syzygium aromaticum* (Eastern Hemisphere). or *Eugenia caryophyllata* and *Eugenia aromatica* (Western Hemisphere). There are only small differences between these species and many consider them to be essentially the same. When applied to growing plants in sufficient quantities, clove oil rapidly dessicates green tissue by removing the waxy cuticle of the plant and disrupting the cell membrane. This results in electrolyte leakage from plant cells, causing tissue death. Clove oil is not translocated in treated plants and provides no residual weed control. It is only effective as a post-emergent herbicide and provides burn down of both annual and perennial broadleaf and grass weeds. It is also used as an insecticide and as a scent attractant is a trap for Japanese beetles, wasps, and other insects. Clove oil is a naturally occurring food flavor and is extensively used in fragrance and flavor formulations for its spicy aroma. Clove oil and its primary ingredient eugenol have been in widespread use as flavoring and fragrance agents in the United States since before 1900. The soap and detergent industry is a major user of both materials, and eugenol is typically used in such products at concentrations in the range of 0.05-0.1% (v/v). The Environmental Working Group’s cosmetics database lists 278 cosmetic and personal care products available over-the-counter that contains eugenol in low concentrations (Sofrata *et al.*, 2010). Clove oil is comprised of many different compounds, with the primary ingredients being eugenol (49–87%), β-caryophyllene (4–21%), and eugenyl acetate (0.5–21%). Smaller amounts of α-humulene are also present, as well as trace amounts (<1%) of 25–35 other constituents.
Several factors govern the relative quantities of the different constituents in clove oil, including plant genetics, climate, soil and cultivation techniques, the part of the plant extracted and the extraction method (Alma et al., 2007).

Fig-2.12: Primary chemical components of clove oil (Alma et al., 2007).

Health Effects

Clove oil is considered safe in small quantities (<1,500 ppm) as a food additive. However, clove oil is toxic to human cells. If ingested in sufficient quantity or injected, it has been shown to cause life-threatening complications, including Acute Respiratory Distress Syndrome, Fulminant Hepatic (Liver) failure and Central Nervous System Depression; the lethal oral dose is 3.75g per kg body weight. Traditional uses of clove leaf oil include treating burns and cuts, and it has also found use in dental care as a pain reliever, and undiluted clove oil may be rubbed on the gums for treating tooth
infections and toothache. There are studies from several decades ago that show eugenol to be a contact allergen when used in dentistry (Koch et al., 1973). Clove oil is toxic to the liver and nervous system. In all case reports of acute illness or death, it was ingested (Dobroriz et al., 2004).

**Active Constituents of Clove Oil**

Approximately, 72-90% of the essential oil extracted from cloves has Eugenol. Other essential oil ingredients of clove oil are,

1. Acetyl eugenol
2. Beta-caryophyllene and vanillin
3. Crategolic acid, tannins, gallotannic acid, methyl salicylate (painkiller).
4. Flavonoids eugenin, Kaempferol, rhamnetin and eugenitin
5. Tri terpenoids like oleanolic acid
6. The dried buds of cloves contain about 15-20 percent of essential oils and the bulk of this is eugenol. A kilogram of dried buds provides about 150ml (1/4 of pint) of eugenol (Law et al., 2010).

**Health Benefits of organically certified clove**

Clove is a natural antiviral, antimicrobial, antiseptic and anti-fungal agent. It also holds aphrodisiac and circulation stimulating capacities. The oil of cloves has been used in a variety of health conditions including indigestion, generalized stress, parasitic infestations, cough, toothaches, and headache and blood impurities. In fact, the expert panel German Commission recently approved the use of its essential oil as a topical antiseptic and anesthetic (Kannan et al., 2006).
**Clove may play a therapeutic role in the following conditions (Gupta et al., 2010).**

**Powerful germicidal properties**

Clove is used extensively in dental care for relieving toothache, sore gums and oral ulcers. Gargling with clove oil can also aid in sore throat conditions and bad breath.

**Anti-bacterial**

An effective aid for food poisoning, clove oil effectively kills many forms of bacterial infections from contaminated foods.

**Antiseptic**

Clove oil can be used to reduce infections, wounds, insect bites and stings.

**Anti-fungal**

Clove is also effective in reducing fungal infections such as athletes foot.

**Skin**

Excellent aid for skin disorders such as acne.

**General stress reliever**

Clove oil stimulates the circulatory system, clearing the mind and reducing mental exhaustion and fatigue. It has also been used to aid insomnia, memory loss, anxiety and depression.

**Anti-inflammatory**

Clove oil clears the respiratory passages, acting as an expectorant for treating many upper respiratory conditions including colds, eye styes, bronchitis, sinus conditions, cough and asthma.
Blood Purifier

Not only purifies the blood, but also aids in stabilizing blood sugar levels, and may have benefits for diabertic individuals.

General Immune System Booster

Clove's antiviral and cleansing properties purify the body, augmenting our resistance to disease.

Premature Ejaculation

Some research has shown that clove may be useful as an aid for premature ejaculation.

Indigestion

Clove oil offers a powerful action against gas and bloating. It reduces gas pressure in the stomach, aiding in the proper elimination of food and toxins. It also relieves the discomfort of peptic ulcers. Effective for stomach related conditions including nausea, hiccups, motion sickness and vomiting.

Cancer Prevention

Preliminary studies suggest that clove oil may play a chemo preventative role, particularly in cases of lung, skin and digestive cancers.

Cardiovascular Health

The active essential oil in clove, eugenol, has been shown to act as an effective platelet inhibitor, preventing blood clots.

Traditional Uses of Clove (Bixby et al., 2005).

Clove is very well known as spice as well as herb all over the world. An English name clove, has been derived from the Latin word ‘nail’ as the shape resembles to small sized nails. It is widely used for medicinal as well as culinary purposes. Cloves
are actually the dried flower buds of tree that is member of Myrtaceae family. Clove is an evergreen tree that bears sanguine flowers in clusters. The medicinal uses of this dried bud are as follows:

**Cholera**

The intake of cloves is very much effective in the treatment of cholera. Add some four grams of cloves to boiling water. Boil it, till the half water gets evaporated. Drink this water to prevent from severity.

**Digestive disorder**

Clove boost the digestive system of the body as, it regulates the enzyme flows. Intake of this herb reduces the irritation level in intestine and cures indigestion problem. Mix the powdered cloves with teaspoonful of honey, and consume this mixture before going to bed.

**Teeth troubles**

From ancient era, clove is used in India and china to cure tooth aches. They are highly beneficial in reducing the pain of tooth. Due to its antiseptic properties, it is also guards the tooth from infections. Apply the clove oil which reduces the pain in gums and decayed tooth.

**Headaches**

Ground the cloves into powder form and mix it with salt crystals. Add milk to this mixture, it is very effective remedy for headaches

2.8. **Antibiotics**

Antibiotics are a substance that is naturally produced by a microorganism that can kill or inhibit the growth of other microorganisms at a very low concentration. An antibiotic is a drug that kills or slows the growth of bacteria. Antibiotics are one class
of antimicrobials, a larger group which also includes anti-viral, anti-fungal, and anti-parasitic drugs. Antibiotics are chemicals produced by or derived from microorganisms (i.e. bugs or germs such as bacteria and fungi). The first antibiotic was discovered by Alexander Fleming in 1928 in a significant breakthrough for medical science. Antibiotics are among the most frequently prescribed medications in modern medicine (Filip et al., 2001). Some antibiotics are 'bactericidal', meaning that they work by killing bacteria. Other antibiotics are 'bacteriostatic', meaning that they work by stopping bacteria multiplying. Each different type of antibiotic affects different bacteria in different ways. For example, an antibiotic might inhibit a bacterium's ability to turn glucose into energy, or its ability to construct its cell wall. When this happens, the bacterium dies instead of reproducing. Some antibiotics can be used to treat a wide range of infections and are known as 'broad-spectrum' antibiotics. Others are only effective against a few types of bacteria and are called 'narrow-spectrum' antibiotics (Norberg et al., 2004). Antibiotics are widely used both therapeutically and in animal husbandry. Loesche, Eckland and Burt found an inverse relationship between caries experience and antibiotic usage in children. The present generations of children have been exposed more intensively to antibiotics than their predecessors. The anti-bacterial action of some antibiotics and the increased caries resistance of teeth affected by tetracycline suggests that antibiotics may play an important unintended role in decreasing dental caries in children eating less sucrose and using fluoride toothpaste (Sakanaka et al., 1989).

Antibiotic use in animal production has led to improved feed use efficiency and increased growth rates. In turn, these resulted in reduced food production costs and reduced excrement of manure nutrients which may cause pollution problems. On the
other hand, antibiotic use leads to antibiotic resistance and a possible reduction in effectiveness of treatment options for both animals and humans. This publication addresses these issues (Casewell et al., 2003).

Disease-causing microorganisms including bacteria are the most diverse and numerous organisms on earth. Diverse in their habitat, environmental adaptation and mechanisms of reproduction, they have short generations with high multiplication rates. Such characteristics help develop antibiotic resistance. Resistance has developed to antibiotics used for human treatment but very limited evidence is shown for development of antibiotic resistance because of its use in animal production (Sureshkumar et al., 2006).

**Mode of action**

- Antibiotics inhibit or kill susceptible bacteria in four broad ways:
  - Disruption of microbial cell wall synthesis;
  - Inhibition of DNA replication
  - Inhibition of protein synthesis and
  - Inhibition of cell division, development and differentiation.

Resistance develops when a susceptible bacterium develops an alternative path for its cell functions and processes that are no longer inhibited by the antibiotic. The most common source of antibiotic resistance for microorganisms is genetic modification. The vast majority of drug-resistant organisms emerge as a result of single-or multiple-gene mutations. Resistance to an antibiotic can develop when an organism acquires a foreign gene from another microorganism or picks a free or naked gene source from the environment by a process called transformation. Resistance
mechanisms are often specific to a particular antibiotic and bacterial species, and a specific resistance mechanism may be limited to a specific environment. However, the discovery of similar genes and mechanisms across unrelated bacteria in some cases suggests that such resistance genes have been transferred between bacteria (Aldini et al., 2007).

**Side effects of antibiotics**

Antibiotics can literally save lives and are effective in treating illnesses caused by bacterial infections. However, like all drugs, they have the potential to cause unwanted side effects. Many of these side effects are not dangerous, although they can make life miserable while the drug is being taken. In general, antibiotics rarely cause serious side effects. The most common side effects from antibiotics are diarrhea, nausea, vomiting. Fungal infections of the mouth, digestive tract and vagina can also occur with antibiotics because they destroy the protective 'good' bacteria in the body (which help prevent overgrowth of any one organism), as well as the 'bad' ones, responsible for the infection being treated. Some people are allergic to antibiotics, particularly penicillin. Allergic reactions cause swelling of the face, itching and a skin rash and, in severe cases, breathing difficulties. Allergic reactions require prompt treatment (Darmani et al., 2006).

**Types of Antibiotics**

**Ampicillin**

Ampicillin is a penicillin derivative that inhibits cross linking of peptidoglycan chains in the cell wall of eubacteria. Cells growing in the presence of ampicillin synthesize weak cell walls, causing them to burst due to the high internal osmotic
pressure. AmpR encoded by Mu derivatives and pBR plasmids is due to a periplasmic β-lactamase that breaks the β-lactam ring of penicillin derivatives (Williams et al., 2006).

**Chloramphenicol**

Chloramphenicol inhibits protein synthesis by binding to the 50s ribosomal subunit and blocking the peptidyltransferase reaction. CamR encoded by PBR328 is due to a cytoplasmic chloramphenicol acyltransferase which inactivates chloramphenicol by covalently acetylating it (Fathima et al., 2000).

**Tetracycline**

Tetracyclines are a family of antibiotics used to treat a broad spectrum of bacterial infections. Tetracyclines were discovered in the late 1940s and were extremely popular when they were first discovered. The tetracycline antibiotics have a very broad spectrum of action. Tetracyclines are used to treat mild acne, Rocky Mountain spotted fever, Lyme disease, upper respiratory tract infections, urinary tract infections, sexually transmitted diseases, typhus. Tetracycline inhibits protein synthesis. Tetracycline reversibly binds to the small subunit of ribosomes and interferes with binding of aminoacyl -tRNA to the Acceptor site. Tetracycline is bacteriostatic in bacteria. Tetracyclines can also inhibit protein synthesis in eukaryotes, but are less likely to reach inhibitory concentrations because eukaryotes lack a tetracycline uptake mechanism. TetR encoded by Tn10 and pBR plasmids is due to a membrane protein that actively exports tetracycline out of the cell. When Tn10 is present in multiple copies, cells are less resistant to Tet than when only one copy of Tn10 is present (Okeke et al., 2001).
Antibiotic resistance

Antibiotics are extremely important in medicine, but unfortunately bacteria are capable of developing resistance to them. Antibiotic-resistant bacteria are germs that are not killed by commonly used antibiotics. When bacteria are exposed to the same antibiotics over and over, the bacteria can change and are no longer affected by the drug. Bacteria have number of ways how they become antibiotic-resistant. For example, they possess an internal mechanism of changing their structure so the antibiotic no longer works, they develop ways to inactivate or neutralize the antibiotic. Also bacteria can transfer the genes coding for antibiotic resistance between them, making it possible for bacteria never exposed to an antibiotic to acquire resistance from those which have. The problem of antibiotic resistance is worsened when antibiotics are used to treat disorders in which they have no efficacy (e.g. antibiotics are not effective against infections caused by viruses), and when they are used widely as prophylaxis rather than treatment. Resistance to antibiotics poses a serious and growing problem, because some infectious diseases are becoming more difficult to treat. Resistant bacteria do not respond to the antibiotics and continue to cause infection. Some of these resistant bacteria can be treated with more powerful medicines, but there some infections that are difficult to cure even with new or experimental drugs (Charles et al., 2004).

Antibiotics in Dentistry

Antibiotics have been extensively discussed in past issues, a noted author and clinical expert in Oral Medicine, Dr. Robert Fazio, makes the muddled picture of which drugs to use much clearer. In this section are his antibiotic recommendations which are based on two categories of infections:
- **Localized:** Pain in tooth, infection visible on radiograph, only slight swelling.

- **Spreading:** Moderate to significant facial swelling, swelling closing eye, swollen naso-labial fold, pronounced intra-oral swelling. If the infection is deemed then Fazio believes one should start with the traditional, inexpensive penicillin type drugs. If the infection is categorized then his recommendation is to begin with some "big gun" type antibiotics (usually more expensive) since you have fewer margins for error.

- **Localized Infection, Non-allergy Patients:** penicillin and amoxicillin continue to be the first drugs of choice due to their safety and effectiveness against oral infections. They both have the same spectrum of coverage however amoxicillin is slightly more effective against endodontic and periodontal infections. The usual dosage is 500mg qid. Fazio notes however, that patient compliance with taking medications properly to completion is the key issue in their effectiveness. He cites a study in which less than 50% of patients complied with taking Pen VK 500mg qid but over 75% complied taking amoxicillin 875mg bid. Patients can better remember to take their medication when only required to do so twice a day. Therefore, for the localized, non-allergy patient, the drug of choice is amoxicillin 875mg, bid, dispense 16.

- **Spreading Infection, Non-allergy Patients:** the first drug of choice is augmentin 875mg, bid and dispense 16. Side effects of Augmentin can include diarrhea (Erickson *et al.*, 2007).
Dentist use of antibiotics is characterized by a number of particularities. In effect, antibiotic prescription is empirical, i.e., the clinician does not know what microorganism is responsible for the infection, since pus or exudates cultures are not commonly made. Based on clinical and bacterial epidemiological data, the germs responsible for the infectious process are suspected, and treatment is decided on a presumptive basis, fundamented on probabilistic reasoning. Bacterial infections are common in dental and oral clinical practice; as a result, antibiotic use prescribed for their treatment is also frequent (Vallano et al., 2006).

2.9. Photochemical analysis

Medicinal plants contain some organic compounds which provide definite physiological action on the human body and these bioactive substances include tannins, alkaloids, carbohydrates, terpenoids, steroids and flavonoids. These compounds are synthesized by primary or rather secondary metabolism of living organisms. Secondary metabolites are chemically and taxonomically extremely diverse compounds with obscure function. They are widely used in the human therapy, veterinary, agriculture, scientific research and countless other areas (Vasu et al., 2009). A large number of phytochemicals belonging to several chemical classes have been shown to have inhibitory effects on all types of microorganism’s in vitro (Cowan et al., 1999).

**Steroids**

Steroids are fat-soluble organic compounds found naturally in living organisms. They play a crucial role as essential hormones in both plants and animals. Plants produce numerous steroids and sterols (steroid alcohols), some of which are
recognized as hormones in animals. Plant steroids and sterols are found in wood pulp, leaves, nuts, vegetable oils, corn, rice, and other plant sources (Jones and Roddick, 1988).

The cholesterol-lowering potential of dietary plant sterols has been known for over 50 years. Although people consume plant sterols every day in food, the amounts are often not high enough to have significant blood cholesterol-lowering effect. The major plant sterol is sitosterol (approx. 80%). Others include campesterol and stigmasterol. Dietary intake of plant sterols in a traditional asian diet are 350-400 mg/day and 600-800 mg/day in a strict vegetarian diet. Previous studies have established that only one of the sterols in ester form can result in a statistically significant reduction in cholesterol). Recent studies of plant sterols and esters in humans have shown that maximum cholesterol-lowering benefits are achieved at the doses of 2-3 g per day (Maki et al., 2001).

**Terpenoids**

Volatile terpenoids consist of two groups of biosynthetically related terpenoids, the monoterpenoids and sesquiterpenoids, both of which often co-occur in the volatile or essential oils. These oils are often used for their flavour or fragrance properties, in a wide selection of products ranging from foods and drinks, medicines and cosmetics (Lockwood et al., 2001).

**Tannins**

Tannins are naturally occurring plant polyphenols and are widely distributed in the plant kingdom. Their main characteristic is that they bind and precipitate protein. They can have a large influence on the nutritive value of many foods eaten by humans
and feedstuff eaten by animals. They are responsible for the astringent taste we experience when we partake of wine or unripe fruits, and for the enchanting colours seen in flowers and in autumn leaves. Tannins act as a defence mechanism in plants against pathogens, herbivores and hostile environmental condition (Edoga et al., 2005).

Tannins are generally defined as naturally occurring polyphenolic compounds of high enough molecular weight to form complexes with proteins. These are classified into two groups based on their structural types a) hydrolysable tannins and b) condensed tannins. Methods for quantification of tannins may be based on the chemical properties of tannins or their capability to bind substrates, particularly proteins. Tannins are polyphenols that occur in vascular plant tissues. They have an approximate empirical formula C76H52O46. Tannins exist primarily in two forms, viz., condensed (Catechol) form and hydrolyzable (Pyrogallol) form. Tannin is used for tanning leather, hardening the fibres of paper, preventing corrosion of fishing nets, in manufacture of inks, as a mordant in dyeing and as a styptic on cuts to reduce bleeding. Tannins are the most abundant antioxidants in human diets. The main dietary sources of tannins include some common fruits, vegetables and not edible plans (Han et al., 2007).

Flavonoids

Flavonoids are a group of polyphenolic compounds possessing low molecular weight that exhibit a common benzo-γ-pyrone structure. They are categorized into various subclasses including flavones, flavonols, flavanones, isoflavanones, isoflavanoids, anthocyanidins, and catechins The average human diet contains a considerable amount of flavonoids and the major dietary sources are fruits (i.e., orange,
grapefruit, apple, and strawberry), vegetables (i.e. onion, broccoli, green pepper and tomato), soybeans and different herbs (Hodnick et al., 1988).

One of the prominent and medically most useful properties of many flavonoids is their ability to scavenge free radicals. A free radical is a molecule containing one or more unpaired electrons in atomic or molecular orbitals that includes superoxide (O$_2^-$), hydroxyl radicals (OH-), and H$_2$O$_2$, collectively known as reactive oxygen species (ROS). These ROS may induce oxidative damage to various macromolecules like polyunsaturated fatty acids in cell membranes, carbohydrates, proteins and DNA which results in homeostatic imbalance. The flavonoids are essential constituents of the cells of all higher plants. They resemble in their regulatory properties most of the lipid-soluble vitamins, but serve in addition, due to their color and odor, as communicators with the environment. The effect of flavonoids on plant growth, which is known, is at least partly indirect and associated with the action of the auxins. It was reported that flavonoids can improve the blood circulation and lower the blood pressure (Yaqin et al., 2005).

**Alkaloids**

Alkaloids, first discovered in the beginning of the 19th century based on the examination of plants used in traditional medicine, have evolved to become a class of natural product of exceptional taxonomic and structural diversity, and of substantial chemical, biological and therapeutic significance. Their biogenesis and biosynthesis have challenged chemists since the beginning of the 20th century and only very few pathways are known in detail. Although recent efforts at the enzymatic level have evoked significant improvements in elucidating how alkaloids are produced in nature,
even for many, pharmaceutically significant, alkaloids much remain unknown Geoffrey (2002).

Most alkaloids are well-defined crystalline substances which unite with acids to form salts. In the plant they may exist in the free state, as salts or as $N$-oxides. In addition to the elements carbon, hydrogen and nitrogen, most alkaloids contain oxygen. A few, such as coniine from hemlock and nicotine from tobacco, are oxygen-free and are liquids. Although coloured alkaloids are relatively rare, they are not unknown; berberine, for example, is yellow and the salts of sanguinarine are copper-red. Knowledge of the solubility of alkaloids and their salts is of considerable pharmaceutical importance. Not only are alkaloidal substances often administered in solution, but also the differences in solubility between alkaloids and their salts provide methods for the isolation of alkaloids from the plant and their separation from the nonalkaloidal substances also present. While the solubilities of different alkaloids and salts show considerable variation, as might be expected from their extremely varied structure, it is true to say that the free bases are frequently sparingly soluble in water but soluble in water but soluble in organic solvents; with salts the reverse is often the case, these being usually soluble in water but sparingly soluble in organic solvents (Khokra et al., 2008).

**Saponins**

Saponins are secondary plant metabolites that occur in a wide range of plant species. They are stored in plant cells as inactive precursors but are readily converted into biologically active antibiotics by plant enzymes in response to pathogen attack. These compounds can also be regarded as “preformed”, since the plant enzymes that
activate them are already present in healthy plant tissues. The natural role of saponins in plants is thought to be protection against attack by pathogens and pets. These molecules also have considerable commercial value and are processed as drugs and medicines, foaming agents, sweeteners, taste modifiers and cosmetics (Hostettmann and Marston, 1995).

Saponins are glycosylated compounds that are widely distributed in the plant kingdom and can be divided into three major groups; a triterpenoids, a steroid, or a steroidal glycoalkoloid. Triterpenoids saponins are found primarily in dicotyledonous plants but also in some monocots, whereas steroid saponins occur mainly in monocots, such as the Liliaceae, Droscoraceae and Agavaceae and in certain dicots, such as foxglove, oats (Avena spp.) are unusual because they contain both triterpenoids and steroid saponins Steroidal glycoalkaloids are found primarily in members of the family Solanaceae, which includes potato and tomato. The saponins produced by oats and tomato have been studied in detail in relation to their potential role in the defense of plants against phytopathogenic fungi (Osborn, 1996).

Secondary substances in plants are known for a long time for their medicinal and pharmacological properties. These substances are necessary for the plant to evolve in a hostile environment. The plant can indeed use its secondary metabolites to be protected against several pest animals and pathogenic microbes. Saponins present one of these substances of large action spectrum broad, because of their toxicity to various insects. The mode of action of saponins seems in relation to the property of these molecules to be interacted either with structural cholesterol (membrane), or with metabolic cholesterol (food). The practical application of this type of substances
remains difficult because of easy degradation of these substances, the impossibility of acting by contact; the difficulties of their synthesis and their toxicity to mammals. Saponins present an excellent model of study of natural substances with insecticidal effect due to their large spectrum of action and to the multitude of their physiological effects. It is, however, early to recommend application of saponins as insecticides (Chaieb, 2010).

**Coumarins**

Coumarin is a native inhibitor and its plant growth regulating activity after exogenous application is well known. In a number of model systems using plant organs (or explants) direct application of Coumarin has been found to inhibit auxin-induced enhancement of intact seedlings growth, to decrease root growth and in the same time to decline cell wall elasticity (Letham, 1978).

In order to clarify chemical structure – physiological activity relationship a number of coumarin derivatives were tested. Coumarin, 8-methyl coumarin, daphnetin, and 4-methyl-daphnetin all exhibited similar activity in inhibition of *Avena* roots growth; 3-, 4-, 5-, 6- and 7-coumarin, umbelliferone, esculetin, scopoletin and herniarin were much lesser effective. Methoxylation at 4- and 8- position of coumarin did not change the activity in inhibiting seed germination. Hydroxylation and other substitutions usually markedly reduced the activity. Coumarin had higher efficiency than umbelliferone, esculetin, herniarin and scopoletin in inhibiting barley and lettuce seed germination. Only tetrahydrocoumarin appears to be more effective than coumarin (Manolov, 1989).
Synthetic analogues of coumarin are insufficiently investigated. Some coumarin derivatives (4-hydroxy-3-substituted coumarins) were found to act as anticoagulants in clinical practice. These compounds possessed also plant growth regulating activity – they inhibited stem and root growth of wheat and cucumber, but in a lower degree than those of coumarin. In our paper the plant growth regulating activity of some phosphorus-containing derivatives of coumarin was studied. The aim of this research was to find new highly physiological effective compounds as well as to clarify structure-activity relationship (Price et al., 1987).

Applications

The coumarins are of great interest due to their biological properties. In particular, their physiological, bacteriostatic and anti-tumour activity makes these compounds attractive for further backbone derivatisation and screening as novel therapeutic agents. Weber and co-workers have shown that coumarin and its metabolite 7-hydroxycoumarin have antitumor activity against several human tumour cell lines. Both coumarin and coumarin derivatives have shown promise as potential inhibitors of cellular proliferation in various carcinoma cell lines. In addition it has been shown that 4-hydroxycoumarin and 7-hydroxycoumarin inhibited cell proliferation in a gastric carcinoma cell line (Cooke, 1999).

2.9. Toothpaste

Toothpastes are daily oral care products, the chemical composition of which is constantly changing due to manufacturer’s competition. Toothpastes are recognized as the best source of fluoride, which most effectively protects both deciduous and permanent teeth from caries. However, fluorides are not the only active ingredients in
toothpastes. Also important are the cleaning abilities of toothpaste provided by abrasives the antibacterial qualities, which, in turn, are provided by a variety of substances with different abilities to inhibit the growth of germs in the oral cavity as well as a number of ingredients with specific purposes to solve specific problems. The wide selection of toothpastes and the various ingredients make it difficult for patients to choose the proper toothpaste and complicate the acquisition of dental products by professionals (Joiner, 2010).

Toothpaste is a paste or gel dentifrice used, with a toothbrush, to clean and maintain the aesthetics and health of teeth. Toothpaste serves as an abrasive that aids in removing the dental plaque and food from the teeth, assists in suppressing halitosis, and delivers active ingredients such as fluoride or xylitol to help prevent tooth and gum disease. Most of the cleaning is achieved by the mechanical action of a toothbrush, and not by the toothpaste. Salt and sodium bicarbonate (baking soda) are among materials that can be substituted for commercial toothpaste. Toothpastes are complex mixtures of abrasives and surfactants; anticaries agents, such as fluoride; tartar control ingredients, such as tetrasodium pyrophosphate and methyl vinyl ether/maleic anhydride copolymer; pH buffers; humectants (to prevent dry-out and increase the pleasant mouth feel); and binders, to provide consistency and shape. Binders keep the solid phase properly suspended in the liquid phase to prevent separation of the liquid phase out of the toothpaste. They also provide body to the dentifrice, especially after extrusion from the tube onto the toothbrush (Marinho et al., 2009).

**History of Development**

Dental toothpaste has been used since 500 B.C. in China and India. In 1824, a dentist named Dr. Peabody actually added soap to toothpaste. Many
compounds were added to toothpaste, like chalk and flavors, during the 1850s. In 1892, Dr. Washington Sheffield created the collapsible tube dispenser. After World War II, other agents were used -ultimately resulting in the addition of fluoride. The first ‘toothpaste’ was invented by Egyptians around 3000-5000 BC. It was a mixture of powdered ashes of oxen hooves with myrrh, burned egg shells, pumice and water. In the 1980s, Dr William Engler discovered that fluoride could drastically reduce cavities. Since then, fluoride has been the indispensable ingredient. In our mouth, there are more than 500 types of microorganisms like *streptococcus mutans*, creating sticky plaque from food residues. The microscopic invaders feed on leftover food to produce enamel-dissolving acid which leads to cavities, and volatile sulfur molecules which are responsible for an unpleasant smell. To tackle these problems, different chemicals like fluoride, abrasives, Sodium Lauryl Sulfate (SLS), potassium nitrate and so forth are present in toothpaste. Their key functions are:

- hindering the growth of plaque-forming bacteria
- making teeth more resistant to potential acid attack by incorporating fluoride
- scouring away plaque and food spots by abrasives and
- Relieving the uncomfortable feeling due to teeth sensitivity.

Firstly, the detergent, Sodium Lauryl Sulfate (SLS) is suspected to induce canker sores (small painful oral ulcers) (Figure 2.13). Secondly, many types of toothpaste are too abrasive and cause what is called “flaying of enamel” (Fig-2.14) and teeth sensitivity. Thirdly, baking soda toothpastes may deteriorate the condition of tooth sensitivity and lead to high blood pressure in some people (Davis *et al.*, 2004).
Oral hygiene is the practice of keeping the mouth clean and is a means of preventing dental caries, gingivitis, periodontal disease, bad breath, and other dental disorders. It consists of both professional and personal care. Healthcare professionals recommend regular tooth brushing at least twice a day (morning and evening) and after meals. A toothbrush is able to remove most plaque, except in areas between teeth and raises the pH of the tooth surface neutralizing acids. Flossing is also considered a necessity to maintain oral hygiene. When used correctly, dental floss removes plaque from between teeth and at the gum line, where periodontal disease often begins and
could develop caries. Toothpaste has a long history. This ‘ancient invention’ helps give us bright and clean teeth, as well as confidence. In general, toothpastes are safe to use, but it is always advisable to ask for opinions from dentists and to use the most suitable toothpaste (Herlofson et al., 1996).