CHAPTER II
REVIEW OF LITERATURE

Dental health is an important because oral problems are frequently observed in small animal and these conditions encompass the whole spectrum of problems as seen in man. It is an established fact that dental diseases are in list of most common diseases found in dogs. Surprisingly, 85% of dogs older than 5 years of age have some form of dental disease that needs to be addressed (Wiggs and Lobprise, 1997).

Primary oral disease can be subdivided into conditions affecting to the tooth, periodontium or other oral tissue. Disease that affects tooth structure may result in lesions of periodontal apparatus, oral mucosa or both. Diseases affecting periodontium may result in exfoliation of teeth. Conditions primarily affecting teeth are abrasion, attrition, erosion, fracture, odontoclastic resorption and pulpities. Conditions primarily affecting the periodontium or oral mucosa are chemical or thermal burns, gingival hyperplasia, gingivitis, gingivostomatitis, neoplasia, periapical abscess, periodontitis and ulcers (Ellen et al., 2010).

Periodontal disease (PD) is the principal cause of tooth loss in dogs. It is the most common oral disease in dogs with up to 80% of animals affected. PD seems to be one of the most common oral disorders in small animals. 80% of dogs have some form of periodontal disease. Small and toy breed dogs are particularly susceptible (Carlos et al., 2012).

It is defined as plaque-inducing disease of any part of the periodontium, which includes the gingiva, periodontal ligament and alveolar bone. Periodontal disease is often separated into two conditions: gingivitis and periodontitis (Merin, 2006).

A comprehensive review of the literature relevant to the subject is presented under following subheadings.
1. ANATOMICAL CONSIDERATIONS
2. INCIDENCE
3. PREDISPOSING CAUSES
4. PERIODONTAL DISEASES
5. STAGES OF PERIODONTAL DISEASES
6. SYMPTOMATOLOGY
7. SYSTEMIC EFFECTS OF PERIODONTAL DISEASES
8. PROPHYLAXIS AND CONTROL
9. DENTAL INTERVENTION
10. SURGICAL MANAGEMENT
11. DENTAL EXTRACTION
12. MINERAL COMPOSITION OF DENTAL TARTER
13. MICROBIOLOGICAL FINDINGS

2.1 ANATOMICAL CONSIDERATION

2.1.1 Dental anatomy (Fig. 1)

An attempt to understand the dental disease cannot begin without recognizing the normal dental and periodontal anatomy. Every mammal has its own dental formula similarly; irrespective of breeds dental formula remains same in dogs (West-Hyde and Floyd, 1995).

The canine dental formulas are as follows:

- Deciduous teeth: 2 (I 3/3, C 1/1, PM 3/3) = 28
- Permanent teeth: 2 (I 3/3, C 1/1, PM 4/4, M 2/3) = 42

[I = Incisors; C = Canines; PM = Premolars; M = Molars]

As in most domestic mammals and in human being, dogs have diphyodont dentition, featuring two sets of teeth, a deciduous or primary and a permanent, although edentulous at birth (Harvey, 1992).

Each group of similar teeth has a specific function. Incisors are used for cutting, scooping, picking up objects and grooming. Canine teethes are used for holding prey, display, slashing and tearing when fighting. Premolars are used for holding, carrying and breaking food into small pieces and molars are used for grinding food into small pieces with flat occlusal tables. The teeth have a shock absorbing system to dissipate chewing forces within the skull and the mouth has an incredible blood supply to provide for rapid healing of wounds and abrasions produced from everyday use. The four canine teeth (also called cuspids or fangs) and the four carnassials teeth (the two maxillary fourth premolars and the two mandibular first molars) are of greatest importance. They are termed 'strategic' teeth because they are extremely important in maintaining normal oral anatomy and health (Warrick, 1988).
Fig. 1 DENTAL ANATOMY

Fig. 2 PERIODONTAL ANATOMY
A tooth is comprised of a crown (visible) and a root (anchored into the bone). Every tooth root is held into the surrounding bone (within its alveolar pocket) by the periodontal ligament (PDL), where elastic fibers penetrate into both tooth root and alveolar bone. The periodontal ligament helps in absorption of traumatic forces, but it is extremely hard to break. The junction between crown and root is called the cemento-enamel junction (CEJ) and this region is located just below the bulge at the base of each crown. Gingiva (thickened tough tissue attached to bone surrounding the tooth and a small portion of the tooth root surface) surrounds all teeth and it creates at the base of each crown a sulcus (or trench).

2.1.2 Periodontal anatomy (Fig. 2)

The tissues which surround the teeth and provide the support necessary for normal function form the periodontium (Greek peri- “around”; odont-, “tooth”). The periodontium is comprised of the gingiva, periodontal ligament, alveolar bone, and cementum.

The gingiva is anatomically divided into the marginal (unattached), attached and interdental gingiva. The marginal gingiva forms the coronal border of the gingiva which surrounds the tooth, but is not adherent to it. The cemento-enamel junction (CEJ) is the incidence of crown enamel and the root cementum. The Marginal gingiva in normal periodontal tissues extends approximately 2 mm coronal to the CEJ. Microscopically, the gingiva is comprised of a central core of dense connective tissue and an outer surface of stratified squamous epithelium.

The space between the marginal gingiva and the external tooth surface is termed as gingival sulcus. The normal depth of the gingival sulcus, and corresponding width of the marginal gingival, is variable. In general, sulcular depths less than 2 mm to 3 mm in humans and animals are considered normal. However, the depth of sulcus range from 0.0 mm to 6.0 mm has also been reported. The depth of a sulcus histologically is not necessarily the same as the depth which could be measured with a periodontal probe. The probing depth of a clinically normal human or canine gingival sulcus is 2mm to 3 mm (Manfra, 1990).

Attached gingiva is bordered coronally by the apical extent of the unattached gingiva which is in turn defined by the depth of the gingival sulcus. The apical extent of the attached gingiva is the mucogingival junction on the facial aspect of the mandible and maxilla, and the lingual aspect of the
mandibular attached gingiva. The palatal attached gingiva blends indistinctly with the similarly textured palatal mucosa.

The junctional epithelium forms the attachment to the tooth surface and important in repair to injured attachments. There are also fewer intercellular junctions in the junctional epithelium than oral or sulcular epithelium which may account for its fragility and permeability to migrating cells and fluid. Gingival connective tissue is termed the lamina propria, which consists of two layers. It is densely collagenous with few elastic fibers. The papillary layer lies adjacent to the epithelium and consists of papillary projections which interdigitate with epithelial rete pegs. The reticular layer is contiguous with the periosteum of the alveolar bone. Gingival fibers are densely collagenous bundles of fibers with specific orientations and attachments. They are named according to their attachments or orientation. Their function is to provide for rigidity, structure and attachment of the gingiva. The primary cellular element of the gingival connective tissue is the fibroblast. They provide for renewal and degradation of collagen and other constituents and are the primary regulators of gingival wound healing (Carranza, 1984).

The periodontal ligament (PDL) surrounds the normal tooth root and forms the connective tissue attachment from the root to the alveolar bone proper. In addition to maintaining the tooth’s attachment to the alveolar bone, and the structure of the gingiva in relation to the tooth, the PDL acts as a shock absorber and a means of transmitting occlusal forces to bone. The cells of the PDL are active in ongoing remodeling of cementum and the PDL. They are active in the resorption, formation of collagen, cementum, the fibroblasts of the PDL may develop into cementoblasts and osteoblasts.

Principal fibers of the PDL are densely collagenous and arranged in bundles, which insert into cementum and bone. Their terminal insertions are known as Sharpey’s fibers. Electron microscopic evaluation has established a close association between these collagen fibers and fibroblasts. The principle fibers of the PDL are classified into five primary groups. These groups are, as for the gingival fibers, named for their location and orientation.

The trans-septal groups are inter proximal fibers which insert into the cementum of adjacent teeth. They are a constant finding and will undergo reconstruction even when alveolar bone loss has occurred from periodontal
Review of Literature

diseases. The alveolar crest group insert into the cementum and alveolar crest apical to junctional epithelium. They function to retain the tooth in the socket by countering the coronal thrust of other ligaments. The horizontal group fibers insert at right angles into the cementum and alveolar bone. Their function is as the alveolar crest group. The oblique group is the largest of the groups. They run from the cementum in a coronal direction to insert on alveolar bone. They act to counter vertically oriented stresses. The apical group fibers connect the bone at the fundus of the socket to the apical aspect of the root (Terranova et al., 1990). The tensile strength of these fibers has been reported to be greater than that of steel (Fiorellini et al., 2006).

Cementum is the hard tissue which covers the tooth roots. It has a laminated arrangement and its’ intercellular matrix is calcified. As cementum is formed, the fibers of the PDL are incorporated into it as Sharpey’s fibers. There are two types of cementum: cellular and a cellular. Cellular cementum is most abundant at the apex of the tooth. It is similar in structure to bone. Cementoblasts reside in lacunae and anastamose with one another through canaliculi. Unlike bone, cementum does not remodel. Its growth is by apposition and as with bone and dentin, formation begins with an irregular meshwork of collagen fibers within a ground substance called pre-cementum. Acellular cementum forms a thin layer over the dentin surface of about 20-50 microns near the cervix to about 150 microns near the apex. Histologically, this cementum appears clear. Its junction with the dentin is identified easily as the collagen fibers of the dentin are haphazardly arranged while those of the a cellular cementum are regularly arranged and are roughly perpendicular to the cementum surface (Terranova et al., 1990).

The alveolar process consists of the bone forming the alveoli. It may be anatomically divided into the alveolar bone proper (cribriform plate) and the supporting alveolar bone. The alveolar bone proper consists of a thin layer of dense compact bone into which the Sharpey’s fibers of the PDL insert deeply. Radiographically this bone appears as a thin radiopaque line surrounding the root called the lamina dura. The supporting alveolar bone is comprised of the facial and lingual plates of the compact bone and cancellous trabeculae. Alveolar bone is unique in its elevated rate of metabolism. Studies have shown that the metabolic rate exceeds that of diaphyseal bone (Rogers and Weidman, 1951). It
is in a constant state of flux with regard to height, contour, and density in response to forces exerted upon it. This high rate of metabolism may explain why alveolar bone is more severely affected by metabolic derangements, such as renal osteodystrophy, and why minimal local factors may cause severe destructive changes in periodontal diseases (Terranova et al., 1990).

2.2 INCIDENCE

Emily and Penman (1990) observed that approximately 90 % of dogs beyond 3 years of age were prone to develop periodontal diseases.

Whereas Court et al. (1993) reported 100 % incidence of periodontal disease, 54 % of dental erosion and 32 % of dental caries in 50 canine cases anesthetized for various surgical procedures. It has been estimated that about 85-90 % of middle aged domestic dogs have some degree of periodontal disease due to lack of dental prophylaxis (Gorrel and Rawlinson, 1995 and Hennet, 1995).

Borissov (1999) reported that the occurrence of periodontal disease was common in small breeds of dogs as compare to large breeds.

Butkovic et al. (2001) recorded incidence of dental disease by clinical and radiological examinations in 139 male dogs and 120 female dogs, aged between 7 months to 15 years in 235 pure bred and 24 mongrels dogs. The incidence of oligodontia equal to 45.17 %, periodontitis 44.40 %, fracture 19.30 %, tooth rotation 11.5 % Persisting deciduous teeth 5.40 % and supernumerary teeth 3.86 %. The highest incidence of oligodontia, tooth rotation, retained deciduous teeth and supernumerary teeth was observed in the youngest age group, dental fracture in mid-age group and periodontitis in mid-age and old age group.

Patil (2004) studied 60 clinical cases of oral diseases. Out of which 50 cases (83.33 %) of periodontal disease were studied for prevalence and epidemiology. He further reported that 12 % cases had mild, 48 % cases had moderate and 40 % cases had severe periodontal disease. The age wise prevalence of periodontitis revealed 8% cases in 0 to 3 year age group, 24 % in 3 to 8 year age group and 68 % cases in 8 to 15 year age group of dogs. The periodontal disease was recorded in 54 % male and 46% female dogs. Further, highest percentage of periodontal disease was observed in small breeds of dog (56 %), followed by medium sized (28 %) and large sized (16 %).

Kyllar and Witter (2005) recorded prevalence of dental disorders in total 408 dogs. In this they found dental alteration in 348 dogs (85 %) with periodontitis (60 %), calculus (61.3 %), missing teeth (33.8 %), and abnormal attrition (5.9 %),
furthermore, one each case of caries, tumor and enamel hyperplasia was also recorded.

Sisodiya (2005) observed periodontal diseases in 51 pet dogs. Sex-wise incidence of periodontal disease revealed greater involvement of male dogs (58.82 %) than females (41.18 %). The breed-wise distribution of periodontal disease revealed the highest rate of occurrence in Pomeranian (27.45 %), followed by German Shepherd (19.60 %), Labrador retriever and Nondescript dogs (11.76 % each), Doberman pinscher (7.84 %), Cocker spaniel (5.88 %), Dachshund and Dalmatian (3.92 % each). Other breeds included Collie, Boxer, Great dane and Lhasa apso (1.96 % each). Based on age-wise and grade-wise incidence, periodontal disease was found to be the lowest (3.92 %) in the group of young dogs (< 3yrs) and all belonged to Grade 1. Highest 68.62 % incidences were recorded in the geriatric dogs which also showed higher proportion (23.52 %) of Grade 4 cases. Group of middle aged dogs showed 27.45 % incidences with majority of Grade 1 cases (19.6 %). Maximum proportion of cases belonged to Grade 1 (39.21 %) followed by Grade 4 (25.49 %), Grade 3 (19.60 %) and Grade 2 (15.68 %).

Watson (2006) reported that incidence of periodontal disease were more in dogs which feed on soft diet than dogs which fed on hard diet. While chewing hard diet helps to remove supragingival calculus from teeth in dogs.

Kumar (2006) studied oral and periodontal diseases in 92 dogs. The classification of oral affections in dogs revealed maximum incidence of dental tarter 74 (84.43 %) followed by dental caries-8 (8.70 %), sporadic cases of oral tumor-2 (2.17 %), Gingival hyperplasia-3 (3.27 %), dental fistula-2 (2.17 %), fracture of mandible and nasal tumor-1 (1.09 %). Sex wise incidence of dental disease revealed greater involvement of male dogs (56.52 %) than female dogs (43.48 %). The breed wise distribution of periodontal disease revealed highest occurrence in Pomeranians (42.39 %), followed by German shepherd (20.66 %), Nondescript dogs (13.04 %), Labrador retriever (8.70 %), Cocker Spaniel (5.43 %), Doberman pinscher (4.35 %), Dalmatian (2.17 %), Dachshund, St. Bernard and Boxer (1.09 % each). Based on age wise incidence, periodontal disease was found to be the lowest (7.32 %) in the group of young dogs (< 3yrs). Highest (71.95 %) incidence was recorded in the group of senior aged (> 6yrs) dogs which also showed higher proportion (23.17 %) of Grade-4 cases. Group of middle aged (3-6 yrs) dogs showed 20.73% incidence with majority of Grade-1 cases (8.54%). Maximum proportion of cases belonged to Grade-1 (28.05
Clinical signs of periodontal disease in dogs revealed that halitosis (70.65 %) and anorexia (61.96 %) were principal observed followed by abnormal salivation (38.04 %).

Singh et al. (2009) reported carnassials tooth abscess in doberman pinscher dog. Carnassials abscess occurs mostly in the forth premolar tooth which leads to chronic osteomyelitis of the maxilla and subsequently the abscess. The case was treated by extraction of tooth followed by flushing of sinus tract by normal saline and povidone iodine under general. Extraction of the affected tooth provides better drainage and prevents recurrence of infection.

Bansod et al. (2012) studied on surgico-therapeutic management of oral affections in 65 clinical canine cases. The diagnosis was made on the basis of history, clinical observations, cultural examination and histopathology of oral tumors. Dental scaling is effective method for maintaining oral hygiene and to prevent periodontal disorders. Surgical excision of epulis and oral tumors is the best method to treat the affections. Haemato-biochemical parameters like TEC, TLC, DLC, TPC, Hb, and PCV did not showed significant changes during the study.

2.3 PREDISPOSING FACTORS

2.3.1 Diet

Pacharinsak et al. (1977) observed that presence of dental calculus in 96.6 % cases of dogs which fed a soft diet and 4.4 % dogs which fed on hard diet.

Jensen et al. (1995) evaluated canine cases for plaque, stain and calculus in which they divided five groups according to baseline plaque index scores; groups were randomly assigned to treatment or control dietary regimens. Dental cleanings were done on day 0. Dogs in the treatment group were fed a food formulated to reduce accumulation of plaque, stain and calculus. Control group dogs were fed a commercially available dry dog food. No other foods, treats or snacks were given to either group. They graded 22 teeth for plaque accumulation on day 7 and for stain and calculus accumulation on day 21. Six trials were conducted and the results reported as a combined mean for all treatment and control groups. Dogs fed with the treatment food had significantly less plaque, stain and calculus accumulation (p ≤ 0.001) than dogs fed the control food. Plaque, stain and calculus accumulation can be reduced by dietary meals.
Harvey et al. (1996) reported the association of calculus, gingival inflammation and periodontal bone loss with diet (dry food only or other than dry food only) and with access to other chewing materials were differences seen in dogs fed dry food only compared with those fed other than dry food. There was progressively less accumulation of calculus, less gingival inflammation and less periodontal bone loss in dogs that were given access to more types of chewing materials (rawhides, bones, biscuits and chew toys etc.) compared with dogs given access to fewer or no chewing materials. When the effects of individual chewing materials were analyzed, access to rawhides overall had the greatest apparent periodontal protective effect and this effect was more apparent in dogs fed with dry food compared with those fed other than dry food.

Rawlinson et al. (1997) observed that dogs kept on standard dry diet and dry main meal regimens suffered equally with gingivitis, plaque and calculus. However, Watson (1997) opined that soft diets and pet foods increase frequency and severity of periodontal disease by promoting bacterial plaque formation in dogs.

2.4 PERIODONTAL DISEASES

Groove (1983) reported that the periodontal disease was an oral infection that results from the chronic retention of bacteria at the junction of tooth and the gingiva and surgery was indicated when pocket depth is 5 mm or greater and bleeding on probing does not resolve after thorough tooth cleaning.

Shafer (1983) observed caries was a microbial disease of the calcified tissue of the tooth is characterized by demineralization of the inorganic portion and destruction of the organic substance of the tooth.

Bojrab et al. (1990) stated that the classic facial swelling ventral to the eye having sudden onset be considered as a periapical abscess of the upper fourth premolar tooth. Retrobulbar swelling could be associated with a periapical abscess of the maxillary first molar, while swelling of the muzzle on one side could be associated with periapical abscess of second or third premolar. Mandibular swelling when associated with dental problem could be most often related with periapical abscess causes bacterial contamination of pulp, which later could undergo necrosis. They further stated that it is usually caused by dental caries, trauma, fracture of the tooth extending into the pulp and advanced periodontal disease extending to the apex of the tooth.
Waner and Nyska (1991) observed that gingival hyperplasia as an adverse side effect in dogs treated with phenytoin (calcium channel blockers) or cyclosporine.

Wiggs and Lobprise (1997) stated that once the furcation was exposed, it allows for increased plaque, calculus, and food accumulation and therefore increases susceptibility to periodontal disease.

Groove, (1982) stated that periodontal disease were the most common chronic infection in dogs and human, affecting tooth supporting tissues and leading to tooth loss. Gorrel (2004) reported that changes in the furcation were classified on a scale ranging from 0 to 3, wherein, grade 3 lesions the probe passes freely through the furcation, from the vestibular part to the lingual/palatal tooth.

Kyllar and Witter (2005) opined that loosening of teeth, following tooth loss was often elicited by inflammatory response in the gingival tissue, which leads to progressive loss of collagen attachment of the tooth to the underlying alveolar bone. Periodontal probing depth above 3 mm means loss of clinical attachment of the junctional epithelium with bone destruction (periodontitis) and periodontal pocket formation (Gioso, 2007).

Reiter and Harvey (2012) stated that periodontal disease was a collective term for a number of plaque-associated inflammatory conditions that affect the periodontium of the tooth. Gingivitis is inflammation of the gingiva. Periodontitis is the term used when the inflammatory reactions also involve the periodontal ligament, root cementum and alveolar bone. The end result of periodontitis is loss of the tooth due to progressive destruction of its attachment apparatus.

Carlos et al. (2012) reported that dental plaque was the primary cause of periodontal diseases, several additional factors contribute to dental plaque accumulation (e.g. teeth overcrowding, malocclusions, soft foods and absence of oral hygiene) or the decreased resistance to infection (e.g. metabolic diseases, nutritional disturbances and immunodeficiency).

2.5 STAGES OF PERIODONTAL DISEASES

2.5.1 Gingivitis

Gingivitis is inflammation of the gingiva and the condition is reversible, if plaque is removed by home or professional oral hygiene procedures. In addition to toxins and tissue-destructive enzymes produced by periodontopathogenic bacteria, the host’s response to plaque leads to the release of agents from damaged neutrophils that can cause injury to the body’s own tissues. Inflammation may spread along the
periodontal space and ultimately progresses to periodontitis, which is diagnosed as loss of attachment (gingival recession, resorption of alveolar bone, and formation of periodontal pockets). The periapical region of the tooth root may become affected, leading to retrograde pulpal infection. Thus, endodontic disease can occur as a result of severe periodontal disease. Eventually the tooth becomes mobile and is lost due to spontaneous exfoliation or professional extraction. The healthy non pigmented canine gingival is coral pink with a smooth and regular texture, and its gingival margin is knife-edged (Radice, 2006).

Periodontal disease begins with the emergence of bacteria which, through its metabolites, cause inflammation of the gingival tissue, called gingivitis. This is the first defense of the tooth, without much pathogenicity and without damaging the structures of the support periodontium. Such inflammation is similar to that seen in other connective tissues. Vasodilatation, leukocyte marginalization, cell migration, production of prostaglandins and destructive enzymes also occurs, making the gingiva red, swollen and painful, and may cause halitosis. At this stage the possibility of regression of the disease remains through the proper management of the oral health of the animal with measures such as brushing, promoting removal of the etiological agent (bacterial plaque). At this moment it is also possible to use mouthwash in conjunction with brushing to obtain increased efficiency of bacterial removal.

Periodontal disease can remain in this state or progress to the loss of insertion of the gingiva to the tooth, thus, the loss of the junctional epithelium adhesion and consequently the formation of periodontal pockets characterizing the beginning of the pathologic stage called initial periodontitis (Clarke, 2001).

2.5.2 Periodontitis

Periodontitis refers to inflammation and destruction of the elements of the periodontium. Diseases of periodontal tissues are most commonly the result of an accumulation of plaque and calculus and the proliferation of pathogenic organisms sub gingival within the sulcus. Occlusal trauma may also incite periodontal disease, moreover, Numerous systemic conditions also contribute to the development of periodontal diseases. Chronic destructive periodontal disease is caused bacterial plaque accumulation, in healthy individuals. Classification is according to its etiology and clinical morphology. General classifications include periodontitis caused by local plaque accumulation and occlusal trauma, idiopathic juvenile forms, idiopathic adult periodontal atrophy and periodontal atrophy from disuse (Carranza, 1984).
Carlos et al. (2012) classified gingivitis in four different stages from mild gingivitis, in which a slight gingival margin erythema is seen, though moderate gingivitis, when gingiva is swollen and bleeding on probing, to severe gingivitis, in which the gingiva is inflamed, hyper plastic or retracted, with obvious erythema and edema and with spontaneous bleeding on probing.

2.5.2.1 Initial periodontitis

Initial periodontitis is a sequel of the untreated gingivitis. It is the phase that begins with loss of the junctional epithelium insertion considered the first irreversible phase of the disease, and from this point it becomes only possible to stabilize it. This phase is the extension of the inflammatory process toward the supporting periodontium (periodontal ligament, cementum and alveolar bone) and leads to progressive destruction of the reported tissues (Harvey and Emily, 1993; Hennet et al., 2006).

The gingiva is still in its normal topography and may have slight gingival recession in some breeds, but when it is very sore it may bleed on touching. There is mild inflammation in the periodontal ligament and little evidence of bone loss. Intensive halitosis is presented. There is also the formation of dental calculus, commonly called tartar, which is nothing more than the mineralization of dental plaque by salts of the saliva that makes it easier for the adherence of new microorganisms with more pathogenic features, subsequently, increasing the severity of injuries caused to the periodontal tissues. The amount of calculus should not be used for the classification of the disease, since it is not the etiological agent, but the bacterial plaque. Large amounts of calculus are not indicative of the stage of the disease, and the diagnosis must be established in the gingival poll to assess the loss of adhesion of the epithelium (Gioso, 2007).

2.5.2.2 Moderate and severe periodontitis

Moderate and severe periodontitis are the most advanced stages of periodontal disease and differ only in the degree of injury. In these stages dental plaque is completely different from the initial one, having only a small amount of non-motile gram-positive coci and large percentages of motile gram-negative spirochetes, virtually absent in healthy individuals (Nisengard et al., 2006). This phase shows severe inflammation, eventually cyanotic with bleeding in response to the minimum stimulus, greater accumulation of bacterial plaque, intense halitosis in mild (in moderate) or large (in severe) tooth mobility (Harvey and Emily, 1993), and in most
cases, there is also receding gingiva and a large accumulation of dental calculus.

Moderate periodontitis include 25 and 50 % loss of supporting periodontium, creating the need for treatment and care for the maintenance of the teeth in the socket.

In severe periodontitis there is a loss of more than 50 % of the supporting periodontal tissue and furcation may be exposed in multi rooted teeth and in many cases leading to exfoliation of teeth (Harvey and Emily, 1993).

Carlos et al. (2012) observed that periodontitis stage commences with attachment loss and was characterized by several alterations in periodontal tissues such as apical migration of the junctional epithelium with formation of resorption. Stage 1 periodontal disease (PD) was characterized by gingivitis only. The stage 2 PD was characterized by sings of deepening sulcus and radiologic signs revealing up to 25 % attachment loss. The Stage 3 PD is present when 25-50 attachment loss exists around a root. The stage 4 PD occurs when the measurement of sulcus depth and radiological sings show an attachment loss of > 50 %.

### 2.6 SYMPTOMATOLOGY

Anon (1985) conducted an enormous survey of pet animals in Japan and found halitosis in 21 % of 2593 dogs while calculus was noted in 38 % of 2600 dogs.

Waner and Nyska (1991) observed gingival hyperplasia in 38% cases in 128 cases of periodontal diseases.

Kesel (2000) reported that most obvious clinical sign was halitosis, followed by ptyalism, anorexia, behavioral alterations, altered gingival color, gingival bleeding, tooth mobility, periodontal and periapical abscesses, nasal discharge, sneezing, osteomyelitis, contact ulcers, intranasal dental migration and nasal fistulas.

Rawlinson (2003) graded periodontal disease on four point scale and stated that Grade 1 consisted of only gingivitis, Grade 2 involved gingivitis, mild gingival recession, tartar formation and up to 25 % loss of supporting tissue, Grade 3 reflected severe gingivitis, moderate to severe gingival recession, heavy tartar, deep periodontal pockets, mild tooth mobility, furcation exposure and 25-50 % loss of supporting tissue. However, Grade 4 showed all the symptoms of Grade 3 disease with greater than 50 % loss of supporting tissue.

Sisodiya (2005) reported that chief complaint and other problems revealed during history recording were halitosis (76.47 %) and anorexia (52.94 %). Kumar (2006) also reported that chief complaint and problems revealed during history recording was halitosis (70.65 %).
Kortegaard et al. (2008) studied periodontal disease in 98 Beagles, remarked the predominance of bone loss, reaching values of 0.1 mm in 20% of one year old dogs. This proportion reaches 84% in three year old animals. In this last group, 44% of the animals suffered bone losses larger than 4 mm.

2.7 SYSTEMIC EFFECTS OF PERIODONTAL DISEASES

De Bowes (1996) Studied on 45 mixed-breed dogs having moderate to severe periodontal disease. The dogs were then euthanized and samples of several organs were rated based on degenerative, inflammatory, and other changes using a 0 to 5 scale for each dog (where “0” represented normal and “5” indicated the most severely affected). When the two sets of data were combined, the overall periodontal score and the individual renal, liver, and cardiac muscle abnormality scores were found to be correlated. A highly significant result was that severe microscopic glomerular mesangial thickening in dogs with increasingly severe periodontal disease. Interstitial change in the kidneys, some myocardial abnormalities, and some liver parenchymal abnormalities were also documented. In association with PD in dogs, haematobiological changes.

Pavlica et al (2008) studied 44 dogs having moderate to advance periodontal disease along with cardiac and hepatic disorders in 26 males and 18 female.

Niemiec (2008) studied 38 dogs having moderate to severe periodontal diseases. Numerous pre and post treatment tests were performed, including a complete blood count, serum chemistry panel, urinalysis and urine culture, and microalbuminuria test. He found that attachment loss and globulin level were correlated. The more severe the attachment loss, the higher the globulin level. Alanine amino transferase level also increased with increasing severity of periodontal disease. Gingival index and alkaline phosphatase level were also significantly correlated, as were attachment loss and alkaline phosphatase and attachment loss and blood glucose. There was no significant change in indicators of renal damage such as creatinine, microalbuminuria, and so on, although blood urea nitrogen was increased postoperatively, perhaps because of the effect of a long period of on renal vessels in some dogs.

De Bowes et al. (1996) reported that PD was the most common oral disease in dogs as it may affect both health and quality of life. It was considered a factor that predisposes patients to bacteremia. However, clinical manifestation of bacteremia was not well correlated with the causative agent. Although in dogs, kidney disease was considered a consequence of low-grade bacteremia associated with PD.
2.8 PROPHYLAXIS AND CONTROL

2.8.1 Home care

Kenneth (1991) reported that routine preventive procedures such as brushing the teeth should be a regular aspect of the care to pets.

Bonnier et al. (1994) conducted a survey of 51 dog owners which were treated for periodontal diseases for 6 months. At that time, they had received a toothbrush, dentifrice, instructions and demonstrations of brushing. The owners were suggested to brush the dog's teeth once daily. At the time of survey, 53% of the clients were still brushing several times a week and 38% were no longer brushing them at all.

Rocken et al. (1996) reported that polishing after every scaling might extend the required interval between prophylaxis treatments in dogs earlier suffering from periodontal diseases.

Gorrel and Rawlinson (1996) reported that tooth brushing every other day did not maintain clinically healthy gingiva in dogs. The daily addition of a dental hygiene chew to a regimen of tooth brushing every other day reduced the gingivitis scores and reduced the accumulation of dental deposits (plaque, calculus and stain). Daily tooth brushing should be recommended to the dog owner irrespective of dietary regimen. Providing a dental hygiene chew daily seemed to give an added benefit when tooth brushing was less frequent and provided the pet owner with a useful adjunct for homecare.

Kyllar and Witter (2005) observed that follow up studies were necessary to test the effectiveness of pet owner education, training and alerting of veterinarians for improved dental hygiene care in a given dog population.

Roudebush et al. (2005) reported that successful treatment and prevention of periodontal disease in pet animals require a multidimensional approach to identify and eliminate exacerbating factors, provide scheduled professional examinations, care plan and implement a dental homecare program. Over the years, many therapeutic and preventive interventions have been developed or advocated for periodontal diseases but evidence of efficacy or effectiveness is highly variable. Accordingly, the main objective of this systematic review is to identify and critically appraise the evidence supporting various aspects of homecare for prevention of canine periodontal disease.
2.8.2 Dietary means and other chewing activities

Simone et al. (1994) studied effect of dry experimental food and a commercial dry dog food on oral malodor. Dogs fed the experimental food developed significantly less oral malodor ($p < 0.01$) than a commercial dry food.

Jensen et al. (1995) carried out evaluations for plaque, stain and calculus in 120 dogs. After dental cleaning dogs in the treatment group were fed a food formulated to reduce accumulation of plaque, stain and calculus. Control group dogs were fed a commercially available dry dog food. No other foods, treats or snacks were given to either group. Twenty–two teeth were graded for plaque accumulation on day-7 and for stain and calculus accumulation on day-21. After completion of six such trials, it was conducted that dogs fed the treatment food had significantly less plaque, stain and calculus accumulation ($p < 0.001$) than dogs fed the control food.

Stookey et al. (1996) conducted a clinical trial in dogs to determine the impact of a popular snack-type biscuit and an experimental biscuit coated with 0.6 % sodium hexametaphosphate (HMP) upon calculus formation. Study began with a dental prophylaxis (scaling and polishing). The dogs were provided a single daily feeding of dry chew followed 4 hours later by either no snack or a snack comprised of two or four conventional biscuits or two HMP–coated biscuits. As compared to the no-snack regimen, feeding two or four conventional bone-shaped biscuits exerted no significant effect upon calculus formation, while the similar feeding of two HMP –coated biscuits significantly reduced calculus formation by 46 per cent.

Watson (1997) observed the effects of chewing raw hide of cereal biscuits on dental calculus in 67 dogs. The dogs were maintained on dry kibbled food and given the other items as supplements. The observation periods were three weeks. Chewing raw hide led to removal of supragingival calculus fro teeth, although the effect was better for some teeth than others.

Philippe (2001) studied the effectiveness of an enzymatic raw hide dental chew to reduce plaque in beagle dogs. Following a professional teeth cleaning procedure, 11 dogs were offered a rawhide dental chew b.i.d. for 7 days, while 11 other dogs were fed the same diet without receiving the chew device. Dogs in the treatment group had significantly less plaque formation during the trial period as compared with dogs in the control group. The raw hide dental chew provided in the study decreased plaque formation in the short term and might be beneficial in the prevention of periodontal disease associated with attachment loss if provided on a long-term basis.
2.8.3 Dental prophylaxis and cleaning

Golden (1990) described a wide range of dental equipment and materials used in veterinary dentistry and compared the contribution of an ultrasonic dental scaler with rotor and hand scaling for removal of supragingival dental calculus. It also concluded that the most effective working angle for dental scaling was 45-90 degrees to the tooth surface with use of pull stroke, whereas, for subgingival curettage, the opposite end of the curette angled against the lining of the gingival sulcus was effective.

Emily and Penman (1990) stated that the most important part of the treatment of periodontal disease should be directed to the prophylaxis, the supragingival scaling, subgingival curettage and polishing of the teeth. Plaque and all other debris containing bacteria, food particles and epithelial cells must be removed from the teeth in an effort to stop progression of periodontal disease. Then the tooth surfaces must be restored to their natural perfect smoothness leaving no rough surfaces to deter the adherence of further plaque. In another study, they advised the use of ultrasonic, sonic and rotosonic scalers for the removal of supragingival calculus. However, they cautioned that while doing subgingival curettage, one should take care to avoid thermal injury to both soft and hard tissue, since cooling water did not reach the oscillation tip of the machine in the gingival crevices.

Bonnier et al. (1994) conducted a telephone questionnaire survey of 51 dog owners. All dogs had undergone periodontal treatment months or more previously. Pet owners had received a tooth brush, dentifrice, instructions and also witnessed a demonstration of brushing. The owners were asked to brush the dog’s teeth once daily. At the time of survey, 53% of the clients were still brushing several times a week and 38% were no longer brushing at all.

Gorrel (2004) reported the importance of maintaining oral hygiene in pet dogs. Prevention and treatment of periodontal disease consists of maintenance and professional periodontal therapy. Pet owners perform oral hygiene maintenance also called home care. This can be accomplished through regular tooth brushing and adjunctive measures, such as feeding coarse diets and dental hygiene chews and using chemical anti plaque agents. Professional periodontal therapy was done under general and it involves dental scaling, tooth polishing, tooth extraction and other operations. However, the benefits of such therapy will be short lived unless regular home care is performed; otherwise periodontal disease will progress. It is advised that pets be accustomed to dental home care as early in life as possible since it helps in prevention
of gingivitis and periodontitis. It is also easier to train young puppies and kittens to accept dental home care than middle aged or older animals.

2.8.4 Ultrasonic dental scaling

Brine et al. (2000) reported that the surface roughness of tooth enamel were quantitatively evaluated following scaling with four power scalers at three different tip forces. Ceramic and tooth samples were evaluated for surface roughness utilizing surface profilometry. Applied tip forces were produced with a horizontal balanced arm holding the scaler hand piece and load weight and were measured using a load cell. The power scalers evaluated were the ultrasonic piezoelectric, ultrasonic magnetostrictive (ferromagnetic stack), sonic and rotosonic. The results of this study indicate that the type of power scaler and applied tip force used determines the post-scaling roughness of ceramic and tooth enamel surfaces.

Lyon (2000) observed no thermal damage in scaling with ultrasonic dental scaler to tooth due to simultaneously irrigation with water from scaling tip.

Verez-Fraguela et al. (2000) studied dental pulpal damage due to application of an ultrasonic scaler commonly used in clinical veterinary dentistry. Using methods developed in preliminary studies, they examined six dogs. The radiographic thickness of the dentin and pulp cavity was measured. The ultrasonic scaler was applied to maxillary and mandibular premolar teeth for 30, 60 or 90 seconds, without the use of water as a coolant. The temperature of the room, the pulp canal on untreated incisor teeth, the cheek, the gingival sulcus and the dentin of the affected teeth were recorded using a probe with a thermistor attached to a resistivity meter and inserted in the dentin to a depth of 1 mm. Two weeks following scaling, the teeth were extracted for microscopic examination. In another dog serving as a control, the temperature of the dentin were increased to between 45°C (113°F) and 47°C (117°F) and the premolar teeth were removed for microscopic examination 15 days later. They concluded that the application of an uncooled ultrasonic scaler for 90 seconds did not increase the temperature of the dentin. However, damage comparable with acute pulpits resulted as a consequence of the ultrasonic effect, similar to the effects produced by the 45-47 ºC heat applied in the control animals.

Kozlovsky et al. (2005) observed that gingiva exposure to air-polishing slurry delivered by air polishing device caused localized trauma because of epithelial erosive changes with severity, positively correlated with instrumentation time and design principles of the applied air polishing device.
Review of Literature

Sisodiya (2005) studied 51 clinical cases of pet dogs for periodontal diseases and found ultrasonic dental scaler in combination with hand instruments to be very effective in terms of efficiency, minimum time and lower dose of anesthesia. Ninety degree angle of scaler to the tooth surface was found to be the most effective working angle for supragingival scaling. Whereas for subgingival scaling opposite end of the hand piece angled against the lining of the gingival sulcus was found effective.

2.8.5 Use of Chlorhexidine

Golden (1990) used Chlorhexidine calculus scaling gel to determine its value in assisting animal dental prophylaxis as compared to untreated teeth. A total of 105 animals were tested. This gel saved some amount of time on animal full mouth prophylaxis in many cases, especially in heavy calculus groups. The gel helped to reduce total actual scaling time.

Robbinson (1995) observed that rarely a chemical agent was so effective with few contraindications as was Chlorhexidine. It has many oral applications, the main ones being the control the plaque and gingivitis. Due to the constraints on oral hygiene in animals, its benefits and indications are especially appropriate to veterinary dental cases.

Philippe (2002) reported effectiveness of a dental gel to reduce plaque in beagle dogs. Following a professional teeth cleaning procedure, a dental gel containing Chlorhexidine was applied in 11 dogs b.i.d. for 7 days, while 11 other dogs received a control dental gel applied in same manner. Dogs in the treatment group had significantly less plaque accumulation during trial period compared with dogs in control group. Application of dental gel decreases plaque accumulation in the short-term and found to be beneficial in reducing the severity of gingivitis and associated periodontal disease on a long-term basis.

2.9 ANESTHESIA FOR DENTAL INTERVENTION

Anesthesia is used in dogs during dental surgery to immobilize and to reduce the intensity of pain. There are different ways to give the from intravenous or intramuscular, sedation to general and each has its advantages and disadvantages.

Akusawa et al. (1972) used ketamine at the rate of 5 to 8 mg/kg body weight intravenously for dental surgery in dog and observed 7-12 minutes period with good induction and recovery. Dental procedures like scaling, polishing of teeth, tooth extraction, treatment of periapical abscesses and dental fistulas were performed under ketamine.
Ploumes (1976) studied ketamine intravenously at the rate of 10 mg/kg body weight and recorded mean duration of deep surgical as 10±7 minutes and an average recovery period of 50±7 minutes.

Nguyen (1994) observed rapid and complete recovery, low incidence of hangover, nausea and vomiting in propofol. Recommended propofol as the first choice for minor clinical interventions of shorter duration as well as the professional dental prophylaxis in dogs where hospitalization was not required.

Gross et al. (1997) studied that infra orbital and inferior alveolar nerve block effectively provides analgesia for procedure like non-invasive tooth pulp stimulation in dogs.

Sap et al. (1997) recommended medetomidine @ 30 mcg/kg I/M as a pre-anaesthetic sedative prior to intravenous administration of ketamine @ 2-3 mg/kg for undertaking dental interventions lasting for 20 to 70 minutes in 60 dogs.

Sarkate et al. (1999) used propofol successfully for induction and maintenance of anaesthesia in canine patients ageing from 1 month to 10 years age. Various surgeries like tooth extraction, treatment and radiographic studies in periodontal disease were performed under propofol.

Kristensen et al. (2003) evaluated a propofol as total intravenous in dogs undergoing dental procedure. Longer procedure requires general inhalant. Isoflurane was one of the newest and safest types of inhalation used in small animal practice.

Kumar (2006) used diazepam @ 0.5 mg/kg b.wt. and Ketamine HCl @ 10 mg/kg b.wt. Mixture given intravenously (I/V) about 30-45 min. after premedication with atropine sulphate @ 0.05mg/kg b.wt subcutaneously for general anesthesia. General was maintained by I/V administration of 1/3rd induction dose of Diazepam–Ketamine mixture as per the requirement. All dogs showed signs of moderate depression of central nervous system and lack of excitability during the induction of anesthesia.

2.10 SURGICAL MANAGEMENT

Alexander and Reiter (2009) reviewed that mechanical/instrumental therapy of PD can be categorized in two different concepts: (a) closed treatment (scaling, closed root planning, and polishing); and (b) open treatment. Closed treatment was indicated, when pocket depths do not exceed 4-5 mm, and consists of debriding the tooth and root surfaces of plaque and calculus as well as root planning and gingival curettage without reflecting a soft tissue flap. Open treatment was indicated when pocket depths
exceed 5-6 mm and is performed following reflection of a gingival or mucoperiosteal flap.

Reiter and Harvey, (2012) stated that professional scaling was necessary when accumulation of calculus was moderate. Gingivitis and mild or moderate periodontitis (periodontal pockets of up to 5 mm) can be managed effectively by scaling followed by frequent oral hygiene in an otherwise healthy dog. When periodontitis was extensive, or when complicating factors exist such as systemic illness, preventive procedures alone were insufficient. The most commonly indicated periodontal treatment in dogs was extraction. It was also the most reliable means of preventing further local deep seated periodontal infection and its systemic consequences. Some severely affected teeth can be successfully retained in the mouth by a combination of scaling, periodontal surgery and conscientiously applied oral home hygiene

2.11 DENTAL EXTRACTIONS

Bojrab et al. (1986) observed oro-nasal fistula in dogs due to periodontal disease, periapical abscess in conjunction with excessive trauma associated with dental extractions and they suggested graft technique for the correction of this fistula.

Bojrab et al. (1990) advised the extraction of tooth in cases of severe caries with gross decay of teeth invading the pulp cavity, fracture of crown or root with contamination associated structure and subsequently necrosis of pulp tissue, periapical abscess, advanced periodontal disease with tooth mobility and following destruction of two third of supporting alveolar bone. They further suggested extraction in cases of deciduous teeth and when tooth was located in fracture line of maxilla or mandible.

Lewis et al. (2005) reported the treatment option for the condition like generalized gingival enlargement in dog. The combined use of scalpel blade, electrosurgical equipment and a 12-fluted bur on a high-speed hand piece with water irrigation allowed for accurate excision of excess gingival tissue and contouring of remaining gingiva. Surgery coupled with professional dental cleaning and periodontal therapy can decrease the recurrence of this condition. In addition, home oral hygiene was an important component of the treatment plan.

Scheels and Howard (1993) observed that tooth extraction was most commonly performed dental procedures. A sound understanding of tooth root morphological and anatomic features were important for proper extraction. Tooth extraction techniques using sound surgical principles were permit efficient procedures, minimize trauma and discomfort to the animal patient, and encourage rapid healing. The keys to
success were controlled forces and patience during the extraction process.

Fitch (2003) reported that principles of surgical extraction of the maxillary canine tooth include mucoperiosteal flap development, removal of the buccal alveolar bone, root elevation, alveolar curettage, lavage, alveoplasty and primary wound closure. Sharp dental elevators and luxators to stretch, tear and sever the periodontal ligament expedite the extraction process.

2.12. MINERAL COMPOSITION OF DENTAL TARTER

2.12.1 Mineral Composition of Calculus and Plaque

Du Pont (1997) stated that periodontal disease (both gingivitis and periodontitis) was initiated when oral bacteria adhere to the teeth in a substance called plaque. Dental plaque is a biofilm which adheres tenaciously to intraoral hard tissues and made up of almost entirely of oral bacteria, contained in a matrix composed of salivary glycol proteins and extracellular polysaccharides.

Michael et al. (2000) reported that, dental calculus was mineralized plaque. Calculus is a hard substance formed by the interactions of salivary and crevicular calcium and phosphate salts with existing plaque. Calculus provides a roughened surface to enhance plaque attachment and accumulation and chronically irritates gingival tissues. Dental plaque and calculus was not easily removed by normal tongue actions, water drinking or forced water spray, but can be affected by mechanical and chemical means.

Jin and Yip (2002) reported calcium and phosphorus are responsible for making plaque harder while Watson (2006) studied that calcium salt in saliva deposited in the plaque produce calculus which can form above and below the gingival crest. Calculus provides rough surface favoring accumulation and maturation of more plaque.

Gioso (2007) stated that calculus most frequently occurs in fourth premolar and first superior molar teeth, as close to them are the openings of the parotid ducts and zygomatic glands, however, over time, almost all teeth can be affected.

Lavy (2012) observed that calcium and phosphorus were most abundant elements in saliva of dogs. Dogs had high salivary pH values would promote the precipitation of calcium salts, leading to enhanced calculus formation which might lead together with plaque accumulation to gingivitis and periodontal diseases.

2.12.2 Supragingival and subgingival calculus

Carranza (1984) reported that calculus is an adherent calcified or calcifying mass that forms on the surface of teeth. Ordinary calculus consists of mineralized
bacterial plaque. It is classified according to its relation to the gingival margin as supragingival and subgingival calculus. Supragingival calculus is coronal to gingival margin and usually white or whitish yellow color and has a hard, clay-like consistency and is easily detached from the tooth surface. The color is affected by contact with food pigments. It may localize on a single tooth or a group of teeth or may be generalized throughout the mouth. Supragingival calculus occurs most frequently and in greatest quantity on the buccal surfaces of the maxillary molars. In extreme cases calculus may form a bridge-like structure along adjacent teeth or cover the occlusal surface of teeth without functional antagonists Subgingival calculus refers to calculus below the crest of the marginal gingiva, usually in periodontal pockets and is not visible on routine oral examination. Determination of the location and extent of subgingival calculus requires careful examination with an explorer. It is usually dense, dark brown or greenish black and hard or flint-like in consistency; it is firmly attached to the tooth surface.

2.13 MICROBIOLOGICAL FINDINGS

Coignoul and Cheiville (1984) reported that bacterial cultures of ground calculus material contain large numbers of *Streptococci* and *Actinomycetes*. Other bacteria commonly present include: *Actinobacter* spp., *Corynebacterium* spp., *Eikenella corrodens*, *Moraxella* spp., *Pseudomonas* spp. and *Staphylococcus* spp. Many other bacterial and fungal species were found in individual calculi.

Corner *et al.* (1988) reported that the main bacteria involved in formation of dental plaque were *Streptococcus* spp., *Staphylococcus* spp. and *Actinomyces* spp.

Harvey *et al.* (1996) cultured aerobic and anaerobic flora from subgingival pockets of 49 dogs with severe gingivitis and periodontitis. The susceptibility of each isolate to four antimicrobial agents (Amoxicillin plus clavulanic acid, Clindamycin, Cefadroxil and Enrofloxacin) currently approved for veterinary use in USA was determined. Amoxicillin-clavulanic acid had the highest in-vitro susceptibility activity against most of isolates (96 %), most of aerobes (94 %) and all anaerobes tested (100 %). For gram negative aerobes, Enrofloxacin had the highest in-vitro susceptibility activity. For bacteria associated with treatment of gingivitis, which typically are mixed aerobic/anaerobic and gram positive/gram negative organisms, the antimicrobial of choice use based on these susceptibility test is the amoxicillin plus clavulanic acid.
Polkowska et al. (2002) isolated microorganisms from sub gingival pockets in 69 dogs of different races, 3-16 year old, with confirmed periodontopathic lesions. *Escherichia coli* (21.42 %), *Proteus* spp. (17.85 %), *Streptococcus* spp. (17.85 %), *Staphylococcus* spp. (10.71 %), *Candida* spp. (7.14 %), *Pseudomonas* spp. and *Corynbacterium* spp. (3.57 %) were isolated form mineralized dental plaque.

Sisodiya (2005) cultured aerobic flora from sub gingival pockets of 41 dogs with periodontal disease. In the study *Escherichia* spp. (12.19 %), *Streptococcus* spp. (7.32 %), *Staphylococcus* spp. (7.32 %), *Pseudomonas* spp. (4.88 %) and *Corynebacterium* spp. (2.44 %) were isolated from dogs with mineralized dental plaque. Antimicrobial drug sensitivity test of these sample show Amoxicillin had the highest in-vitro susceptibility activity (60.71 %), followed by Cloxacillin (57.14 %), Sulphadiazine (53.57 %), Enrofloxacin (46.42 %), Tetracycline (35.71 %), Cefotaxime (28.57 %), Chloramphenicol (21.42 %) and Gentamicin (17.85%). Based on these susceptibility tests amoxicillin was the antimicrobial drug of choice.

Swerts et al. (2005) stated that the main bacteria involved in the formation of dental plaque were *Streptococcus* spp.