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Review Paper

Application of Calcium Phosphate Materials in Dentistry: A Review

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ABSTRACT

Calcium phosphate materials are similar to bone in composition and having bioactive and osteoconductive properties. They have different forms, as cements, composites and coatings, which are used in many dental applications. This article reviews the latest update of their applications in dentistry the studies of improving the mechanical properties of these materials. Notable research is highlighted, regarding application of calcium phosphate into various fields in dentistry and improvement of their mechanical properties. This article deals with most common types of these materials including, calcium phosphate, hydroxyapatite and tricalcium phosphate.
Keywords: Calcium phosphate materials, Dentistry, Hydroxyapatite, Tricalcium phosphate

INTRODUCTION

Calcium phosphate materials are bioactive materials that show a positive interaction with living tissue that includes also differentiation of immature cells towards bone cells. In contrast to bioinert materials, there is chemical bonding to the bone along the interface, thought to be triggered by the adsorption of bone growth-mediating proteins at the biomaterials surface. Hence there will be a biochemically-mediated strong bonding osteogenesis. In addition to compressive forces, to some degree tensile and shear forces can also be transmitted through the interface ("bony ingrowth"). The stable phases of calcium phosphates depend considerably upon temperature and the presence of water, either during processing or in the use environment [1].

Calcium phosphate materials have received a lot of research attention in recent years due to their chemical similarity to calcified tissue (bones, teeth). They are attractive biomedical materials owing to their excellent biocompatibility. The first calcium phosphate materials were used in the 1920s. They were used as bone substitute or bone graft to promote new bone formation [2].

In 1971, Monroe and his colleagues reported a method for the preparation of a calcium phosphate, principally mineral calcium-fluor-apatite, and suggested the possible use of this apatite ceramic as dental and medical implant materials [3]. The first dental application was reported by Nery et al. [4] more than many years later using a synthetic porous material obtained by sintering a "tricalcium phosphate reagent" that was originally described by the authors as "tricalcium phosphate" but later demonstrated to consist of a mixture of hydroxyapatite and tricalcium phosphate [5].

Applications of calcium phosphate include repair of periodontal defects, augmentation of alveolar bone, sinus lifts, tooth replacement and repair of large bone defects caused by tumors [5-13]. They are used in tissue engineering for bone or dentine regeneration [13-17]. Calcium phosphates are also used in the form of injectable cements [18-19] or as coatings on titanium and titanium alloy implants to combine the bioactivity of the calcium phosphates and the strength of the metal [20-21].

The purpose of the present paper is to review the use of calcium phosphate materials in dentistry. Emphasis will be given to the hydroxyapatite and tricalcium phosphate. This review summarizes brief history, dental applications, and methods for improving their properties.

Hydroxyapatite

Hydroxyapatite is the most documented calcium phosphate ceramic, and can be used in bulk form or as a coating. This material can be classified according to its porosity, phase, and processing method. It is widely preferred as the biomaterial of choice in both dentistry and orthopaedics due to its favorable osteoconductive and bioactive properties [22. Synthetic hydroxyapatite is similar in composition to the mineral component of bone and teeth. Table 1 shows the structural similarities between hydroxyapatite, enamel, dentine and bone [23]. This similarity makes it the most clinically used as biomaterial for medical and dental applications [24].

Table 1. Chemical and structural comparison of teeth, bone and hydroxyapatite (HA)

Composition, wt%	Enamel	Dentine	Bone	HA
Calcium	36.5	35.1	34.8	39.6
Phosphorous	17.1	16.9	15.2	18.5
Ca/P ratio	1.63	1.61	1.71	1.67
Total inorganic (%)	97	70	65	100
Total organic (%)	1.5	20	25	--
Water (%)	1.5	10	10	--

Although hydroxyapatite has favorable bioactive and osteoconductive properties that result in rapid bone formation in a host body and strong biological fixation to bony tissues [25], it possesses low mechanical strength and fracture toughness, which is an obstacle to its applications in load-bearing areas [26]. Typical properties of dense hydroxyapatite are given in Table 2 [27]. Thus, the enhancement of the mechanical properties of hydroxyapatite would extend its scope of applications. Hydroxyapatite is either used as a bioactive coating on implants or reinforced with tough phases such as metal or ceramic phases, in order to achieve the mechanical characteristics needed for biomedical applications.

Table 2. Typical properties of dense hydroxyapatite

Properties	Amount
Theoretical density	3.156 g/cm^3
Hardness	500-800 Vickers, 2000-3500 Knoop
Tensile strength	40-100 MPa
Bend strength	20-80 MPa
Compressive strength	100-900 MPa
Fracture toughness	1 MPam^{½}
Young's modulus	70-120 GPa

Hydroxyapatite has been used successfully in clinical and animal studies for endodontic treatment including pulp capping, repair of mechanical bifurcation perforation, apical barrier formation and repair of periapical defects [28-31]. Jean et al. [28] suggested that the degree of mineralization of reparative dentine formation obtained with tricalcium phosphate-hydroxyapatite was quicker and thicker when compared with that produced by calcium hydroxide. Additionally, hydroxyapatite has been used as filler for reinforcing dental resins [32,33], coating in both orthopaedic and dental implant [34,35], restoration of edentulous atrophic ridges [36], perio-infrabony pockets [37], periodontal defects [38], under and around failing sub-periosteal metal implants [39], ridge augmentation prior to implantology for metal prosthetics [40].

IMPROVING THE PROPERTIES OF HYDROXYAPATITE

Hydroxyapatite composites

Combinations of hydroxyapatite with synthetic polymers or metallic agents are called hydroxyapatite composites. They have been developed and studied in purpose to improve the mechanical properties of porous hydroxyapatite. Many reinforcements including particles, platelets, whiskers, long fibers, partially stabilized zirconia, metal dispersoids, and polymers have been used in hydroxyapatite to improve their reliability [41-44].

Deng et al. [45] added nanocrystalline hydroxyapatite to a polylactide solution to form solvent-cast composite matrices and found a steady increase in tensile modulus as hydroxyapatite loading increased from a low of 1.66 GPa for polymer without hydroxyapatite up to 2.47 GPa for 10.5% hydroxyapatite content. Wang et al. [46] combined polyamide, a bioinert polymer, with both microcrystalline and nanocrystalline hydroxyapatite and compared resulting bending strength and tensile strength. As the ceramic content of each composite increased, so did the bending strength.

For both bending and tensile strength, the addition of nanocrystalline hydroxyapatite increased the properties over those with microcrystalline hydroxyapatite. It was theorized that the smaller crystals of the nanocrystalline hydroxyapatite resulted in higher surface areas and thus greater surface energy, surface activity, and thus bonding between the polymer and the hydroxyapatite.

Abu Bakar et al. [47] examined the effect of varying amounts of hydroxyapatite added to polyetheretherketone as an injection-molded composite by varying hydroxyapatite content between 0-40% by volume. Results indicate that Young's modulus increased from

approximately 3-15 GPa as hydroxyapatite content increased from 0-40% but tensile strength decreased from 80-44 MPa along the same increase in hydroxyapatite content.

Balac et al. [48] attempted to understand the effect of hydroxyapatite particle shape and volume fraction in a polylactide/collagen/hydroxyapatite composite scaffold using finite element analysis and found fewer stress concentrations throughout the matrix with an increased hydroxyapatite volume fraction but a reduced dependence on this as the hydroxyapatite particles were modeled as spherical, suggesting yet another design consideration for the composite scaffold. Hydroxyapatite matrix composites containing 20-30% Fe-Cr alloy long metal fibers showed the highest values of fracture toughness and fracture strength for hydroxyapatite based materials as reported by Suchanek and Yoshimura [49].

Ramires et al. [50] tested titanium oxide and hydroxyapatite composites, formed by sol-gel method, for biocompatibility and cell response. Their results showed that the combination was biocompatible and excellent at promoting cell activity. Volceanov et al. [51] investigated the influence of zirconia addition to a hydroxyapatite matrix on mechanical strengths and the interaction mechanism between zirconia and its polymorphs with calcium phosphates after sintering at 1250^{o}C. Their results highlighted that there were improved mechanical properties for hydroxyapatite matrix composites cured in air at 1250^{o}C. Some authors added small amounts of P-glass into hydroxyapatite ceramic to improve sinterability and mechanical properties of the dense body, as well as biological properties [52-54].

Ferraz et al. [52] fabricated glass-hydroxyapatite composite coatings, using a plasma spraying technique, and experimented it *in vitro* with osteosarcoma cells. Their findings showed favorable cellular responses. Others claimed that the inclusion of phosphate based glasses produced significant improvement in mechanical properties [55, 56].

Hydroxyapatite coatings

Bioactive calcium phosphate ceramics as coatings on bioinert metallic substrate have received worldwide attention in both orthopaedic and dental implant due to their biocompatibility and their ability to bond directly to bone [34, 35, 57]. However, there are several factors that may influence the performance of any hydroxyapatite coating such as: coating thickness, chemical composition, crystallinity, phase purity, cohesive and adhesive strengths, and resorption resistance. Adhesion strength of the coating to the implant surface appears to be a property that needs to be maximized to avoid cracking, shearing off, and chipping of the hydroxyapatite coating during emplacement of the implant. The ideal hydroxyapatite coating would be one with low porosity, strong cohesive strength, good adhesion to the substrate, a high degree of crystallinity and high chemical purity and phase stability [58].

In 1960s, the concept of biological fixation of load-bearing implants using bioactive hydroxyapatite and calcium phosphate coatings was proposed as an alternative to cemented fixation. Since Furlong and Osborn first began clinical trials using the hydroxyapatite-coated implants in 1985 [59], it has been reported that hydroxyapatite coatings can successfully enhance clinical success, and a less than 2% failure rate was reported during a mean follow-up study of 10 years [60,61]. Hydroxyapatite is stable in a body fluid, whereas tricalcium phosphate is rather soluble in the fluid [62]. Many studies have indicated that the dissolution of well-crystallized hydroxyapatite in the human body after implantation is too low to achieve optimum results. On the other hand, the dissolution rate of tricalcium

phosphate ceramics is too fast for bone bonding. To achieve an optimum dissolution rate of bone graft materials, research has focused mainly on biphasic calcium phosphate ceramics composed of hydroxyapatite and tricalcium phosphate [63, 64]. It is generally known that tricalcium phosphate is more soluble than hydroxyapatite at physiologic pH and more susceptible to bioresorption [65]. Partial dissolution of the calcium phosphate macrocrystals followed by an increase in the calcium and phosphate ion concentrations in the local environment is thought to be important for the excellent osteoconductivity and tight chemical bonding of the bioactive ceramics with bone [66]. Although greater, unpredictable solubility of the tricalcium phosphate coating may cause earlier failure of a hydroxyapatite/tricalcium phosphate-coated implant at the bone-implant interface [67], gradual resorption of this coating and replacement with new bone might be desirable to prevent the late complications of calcium phosphate coatings [68].

Since the clinical success of orthopaedic and dental implants depend on the osseointegration at the bone-implant interface; surfaces of bone-contacting devices would be desirable to be compositional, structural and functional analogous to that of human bone. Surface composition containing calcium and phosphate; display good cytocompatibility and enhanced bone contact and greater new bone apposition, particularly calcium. Okamoto et al. [69] reported that a significantly higher number of cells adhered to hydroxyapatite than to uncoated titanium. Wong et al. [70] compared the osseointegration of commercial implants in the trabecular bone of mature miniature pigs for 12 weeks. Their results showed excellent osseointegration of the hydroxyapatite coated implant. Likewise, Cao et al. [71] showed successful osseointegration of hydroxyapatite coatings with surrounding bone tissue when a hydroxyapatite coated implant was placed within living bone. Also, the success or failure of hydroxyapatite coated orthopaedic implants; depends on the control and consequences of cell behaviour post implantation [72]. Thus, the first and essential step for bone tissue-implant interface studies is *in vivo* tests using osteoblast cells due to the important role in which they play in the osteointegration of the implant. They have the ability to synthesise and produce extracellular matrix and to control its mineralization and thus regulate the "ingrowth" of bone to the implant. Rouahi et al. [73] examined the growth of Saos-2 cells on discs of microporous and non-porous hydroxyapatite in comparison to titanium. The surface morphology was found to have an effect on the behaviour of the cells. Richard et al. [72] cultured cells on calcium-deficient hydroxyapatite thin films produced using electrodeposition. Areas of the coating with two different morphologies and compositions were examined and the results were compared to those for cells cultured on cell culture plastic. In this study cell morphology, cell viability, cell proliferation and gene expression were examined over 28 days. The differentiation of osteoblast cells was found to be enhanced on the calcium phosphate coating compared to the titanium plate. Yang et al. [74] reported that cell proliferation and type I

collagen synthesis were higher on porous surfaces than on dense ones. This is related to greater protein absorption and to the increased surface area available for cell attachment. Wang et al. [75] carried out a study to determine the effect of the phase composition of calcium phosphate ceramics on osteoblast behaviour. The compositions studied were pure hydroxyapatite, a 70/30 mixture of hydroxyapatite and tricalcium phosphate and a 35/65 mixture of hydroxyapatite and tricalcium phosphate and pure tricalcium phosphate. In their study, the phase composition of the ceramics did not have a significant affect on the expression of the osteonectin and production of bone sialoprotein and osteocalcin in SaOS-2 cells.

Histologically comparing osseous apposition to hydroxyapatite coated implants and titanium implants has demonstrated mineralization of bone directly on hydroxyapatite surfaces with no fibrous tissue layer formation. However, a predominately fibrous tissue interface was observed on titanium implants, with only minimal areas of direct bone contact [76]. In addition, in an animal study hydroxyapatite-coated implants showed an increased coronal bone growth that was not observed with titanium implants [77]. Maintaining a bony osseous crest is essential clinically because it may prevent peri-implant saucerization and subsequent pocket formation [78, 79]. Other histometric studies in animal models have also exemplified that bone adapts in much less time to hydroxyapatite-coated implants than to titanium implants [80, 81].

Another area of recent advance is the use of drug releasing layers on hydroxyapatite coatings. These layers are designed to supply drugs, for example antibiotics and antiresorptive drugs, locally to the bone surrounding the implant. Drug releasing layers have been produced from numerous different polymeric and ceramic materials. The benefits of these drug release coating layers have been shown by a number of researchers [82, 83]. Ogiso et al. [82] used the antiresorptive drug zoledronate grafted to a hydroxyapatite coated implant. *In vivo* studies in rats showed an increase in mechanical fixation of the implants. Martins et al. [83] found that their collagen-hydroxyapatite composite paste had potential for use in sustained antibiotic release.

Biomimetic process (definition ?)

Some authors reported deposition of long and thin needle-shaped crystals of enamel-like calcium phosphate onto a bioactive glass in a supersaturated calcifying solution containing recombinant porcine amelogenins [84, 85]. It has been realized that nucleation and growth of calcium phosphate crystals *in vivo* are modulated by specific proteins in mineralizing tissues, intrinsically by functional groups in proteins. Other authors reported that some functional groups have the ability to induce bone-like apatite nucleation through a biomimetic way [85, 86]. A self-assembled monolayer (SAM) technique is an effective way to fabricate charged surface terminated with polar head groups [87]. The deposition of bone-like apatite could improve the biological properties for potential restorative

application. Thus, biomimetic strategies developed to design new materials, which are expected to improve biological and mechanical performance for biomaterials [88, 89].

Many researchers used bovine and human serum *in vitro* to analyze protein adsorption on biomaterials [90, 91]. The reactions occurring at the surface of biomaterials in contact with protein containing solutions have also been studied with Dulbecco's Modified Eagle's minimum essential medium supplemented with 10% Nu-Serum [92], which contains growth factors, hormones and vitamins. A step further to simulate *in vitro* the real condition of biomaterials immersed into body fluids is the immersion in cell-containing solutions. Osteoblast cells have often been used to understand the influence of the presence of biomaterials on cells, different tests can be done. Usually cell morphology, adhesion and proliferation are examined. Then, cell activity can be tested by the amount of some specific enzymes produced. For example, osteoblasts which are synthesizing bone matrix produce alkaline phosphatase. Another important protein that can be evaluated is osteocalcin. This is a non-collagenous extracellular matrix protein, and its presence is indicative of the beginning of bone mineralization.

Calcium phosphate cement systems

Calcium phosphate cement was discovered by Brown and Chow in the 1980's. This type of cement can be prepared by mixing a calcium phosphate salt with water or with an aqueous solution to form a paste that reacts at room or body temperature, giving rise to a precipitate containing one or more calcium phosphates, which sets by the intercrossing of the crystals of this precipitate.

This cement consists of two components, one basic and one acid, which react when mixed with water, producing one or more products with an intermediary acidity [93, 94].

In 1982, LeGeros et al. [95] presented preliminary studies on the possibility of developing apatitic calcium phosphate cements, with the rationale that such cements would have the unique combination of the following properties: (i) compatibility with the tooth mineral; (ii) adjustability of composition (with or without F~, Mg2+, Sr2+, etc.); and (iii) esthetics.

Calcium phosphate cements have been evaluated as one of the potential materials for bone tissue engineering. An advantage of calcium phosphate cement is that they can be directly injected into the bone defect and allowed to set in situ. Calcium phosphate cements also are biocompatible and resorbable; they can be synthesized with a macroporous structure having micropores that are very crucial for cellular growth and infiltration [96, 97].

In 1987, Brown and Chow developed a novel class of low temperature setting calcium phosphate cements from precursors such as dicalcium phosphate dihydrate, dicalcium phosphate anhydrous, and tetra calcium phosphate [98]. These low temperature apatites, are receiving a great deal of attention due to their ability to set at physiological temperature to form hydroxyapatite that resembles biological apatites without the addition of any additives [99, 100]. This is highly advantageous because acrylic cements currently used for orthopaedic applications require high temperature for setting and use of toxic reagents [99]. Another advantage of calcium phosphate cement is that during the setting reaction only a small amount of heat is released as compared to polymethylmethacrylate cements and also the volume of calcium phosphate cement remains constant during the setting reaction [99].

Upon mixing with water or aqueous solution, the calcium phosphate cement dissolves and precipitates into a less soluble calcium phosphate. During precipitation, the calcium phosphate crystals increase in size and gets inter-locked thus providing structural rigidity to the cement. Hydroxyapatite thus formed in aqueous solution is poorly crystalline [99]. When used for *in vivo* applications, a thick paste of calcium phosphate cement can be formed in the presence of water or aqueous solutions which can be injected or sculpted during surgery into the defect site and self hardens to form hydroxyapatite in situ [100-102]. Hence these biomaterials do not require shaping and can be prepared at operating room conditions. They provide excellent contact between the bone and the graft. Since most of the current orthopaedic implants are available in hardened form, the moldability and in situ hardening of calcium phosphate cement along with its osteocompatibility make it a desirable alternative for current orthopaedic implants. Moreover, since the calcium phosphate cements are fabricated at room or at body temperatures, also they can be used as drug delivery vehicle for antibiotics, anti tumor drugs, anti inflammatory drugs, and growth factors [103, 104].

However currently available calcium phosphate cement systems are far from ideal properties due to the discrepancies in the setting time, mechanical properties, and *in vivo* response of the cements [105]. Also, they are used under development for furcation sealing [106], root surface desensitization and root apex sealing or root canal filling [107,108]. The abilities of self-setting, fair compressive strength and biocompatibility suggest that calcium phosphate appears superior to pure calcium hydroxide, thus this material may have potential for dentine regenerating pulp capping or lining materials [109, 110]. Calcium phosphate cement systems also have been used as bone fillers and to deliver bioactive agents due to its osteoconductivity, osteotransductivity, and suitable mechanical properties [107-114].

Tricalcium phosphate

Tricalcium phosphate exists in many polymorphs (α, β, γ and super-α) [115]. The only two polymorphs phases (α and β) are used as biomaterials. These phases have received much attention [116]. However, despite the extensive research since the early 1970s, there is still lack of clarity concerning this material. The use of resorbable tricalcium phosphate materials is preferred since they will be in the long term replaced by bone.

Clarke et al. [117] reported a method of preparing tricalcium phosphate ceramic and suggested its use as a bone graft material. Levin et al. [118] reported that the first dental application of a tricalcium phosphate ceramic in periodontal defects in dogs. Koenigs et al. [119] used resorbable form of tricalcilum phosphate ceramic to induce apical closure. Formation of mineralized tissue occurred within the root canal, but was incomplete. Roberts and Brilliant [120] used tricalcilum phosphate ceramic to induce apical closure in human permanent pulpless teeth with large open apices, but found it to be no more affective than calcium hydroxide. Brown and Chow [121] tested a tricalcilum phosphate and brushite combination. X-Ray diffraction revealed a conversion to HA in a few minutes with compressive strengths of up to 500 psi. Coviello and Brilliant [122] tested the apical barrier of 101 teeth. They found that no difference in healing between cases treated with tricalcium phosphate or calcium hydroxide. Gruninger et al. [123] tested a combination of tricalcilum phosphate, hydroxyapatite and sodium fluoride as a bone implant material. They determined the material to be neither toxic nor mutagenic, and not resorbable. They encouraged the evaluation of these materials as root canal filler. Functionally graded

coatings consisting of fluorine-substituted apatite (FA) and beta-tricalcium phosphate (β-TCP) were also produced by Wong et al. [124]. The coating produced had four layers, the outermost layer containing FA + 50 wt% TCP, the next FA + 40 wt% TCP, + 30 wt% TCP and finally the innermost FA + 20 wt% TCP. The HA component of the coating is expected to enhance early-stage bone ingrowth and bone bonding, whereas the remaining porous FA component aims achieve long-term fixation of an implant. Tricalcium phosphate materials mostly behave as osteoconductive materials, which permits bone growth on their surface or into pores, channels or pipes [125]. Trialcium phosphate is biocompatible material and useful for inducing hard tissue formation [126,127]. It has been used as capping agent [126], cleft palate [128], apical barrier [122], apexification [129], vertical bone defect [130], and implants coating [65]. Tricalcium phosphate is a resorbable phase calcium phosphate and exhibits some good properties. It has also been shown to support bone growth [1131]. However, it is difficult to sinter, shows poor mechanical strength and low resistance to crack-growth propagation. Further, the rate of resorption of tricalcium phosphate is fast and uncontrolled [132]. Unpredictable solubility of the tricalcium phosphate coating may cause earlier failure of coated implant.

CONCLUSION

The applications of calcium phosphate materials in dentistry still limited and need further investigations to improve their properties and extend their clinical use.

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تطبيق موادِ فوسفاتِ الكالسيومِ في طبِ الأسنان: استعراض

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ملخص

تتشابه مركبات فوسفات الكالسيوم في التركيب مع المركبات الأساسية للعظام ، وتمتلك موادها الأساسية خاصية القدرة على تدعيم و التئام الأنسجة العظمية ، كما أن مركبات فوسفات الكالسيوم لها أشكال مختلفة منها المادة الإسمنتية والطلائية المستخدمة كثيرا في تطبيقات طب الأسنان.

بين هذا البحث أخر التطبيقات العلمية التي أجريت لتطوير الخواص الميكانيكية والأنواع الشائعة لمركبات فوسفات الكالسيوم مثل كالسيوم فوسفات، هيدروكسي أبتيت وفوسفات الكالسيوم الثلاثية واستخداماتها.

كلمات مفتاحية: مركبات فوسفات الكالسيوم، طب الأسنان، هيدروكسي ابتيت، فوسفات الكالسيوم الثلاثية

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Risk Factors and Seasonality for Cryptosporidiosis Among Yemeni Children

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ABSTRACT

Few studies have been conducted on risk factors and seasonality for cryptosporidiosis from developing countries. The current study was conducted to determine prevalence, risk factors and seasonality for cryptosporidiosis among children in Sana'a city, Yemen. Using cross-sectional approach, a sample of 1253 diarrheic children aged 6-<12 years with mean 8.6+1.7 year were surveyed over a period of one year. Single fecal specimens were collected and modified Kinyoun's acid-fast staining of formalin- ether concentrate feces were examined for detection of Cryptosporidium. The rate of infection was 13.8% (173 of 1253), and mild oocysts-excretors of them represented the highest percentage(43.4%). Results indicated that, use of public and/ or well water for drinking, contact with animals, and mother's illiteracy were the risk factors that significantly associated with infection($P<0.05$) in diarrheic children. A higher incidence of infection was recorded during the rainy summer season through July to September. In addition, 13 specimens were collected from children undergoing chemotherapy for cancer; Cryptosporidium was detected in feces of 5(38.5%) and 6 (46.2%) children by Kinyoun's and immunochromatographic (ICT) techniques respectively.
Keywords: cryptosporidiosis, Yemeni children, risk factors, seasonality

INTRODUCTION

Cryptosporidium is a coccidian oocysts-forming protozoan which completes its life cycle both in human and animal. It is transmitted through zoonotic and anthroponotic transmission or via contaminated water or food, causing cryptosporidiosis[1]. This coccidian found in the brush border of the enterocytes of the small intestine in many vertebrate hosts, including humans. It has been found in association with diarrhoeal diseases especially among children in most parts of the world [2]. Approximately 12 species of the genus *Cryptosporidium* are now recognized; two species, *C. parvum* and *C.*

hominis are the major causing agents of human cryptosporidiosis [3]. The disease is recognized as a cause of self limited diarrhea in immunocompetent individuals or it is severe and even fatal in immunocompromised patients as those with HIV infection and patients receiving chemotherapy for cancer [4]. Contamination of drinking water by *Cryptosporidium* oocysts can result in major waterborne outbreaks of cryptosporidiosis [5]. It is now increasingly considered an important food-borne pathogen causing a disease of socioeconomic significance worldwide [6]. The potential for environmental contamination with this coccidian depends upon a variety of factors including the geographic distribution of the parasite, its seasonality, climate, number of infected hosts, human and/or animal activity, number of infective oocysts excreted, socioeconomic and ethnic differences in behavior, sanitation, safety of drinking water sources and supplies [7,8].

Cryptosporidium is under-diagnosed in most Yemeni hospital laboratories and few studies have estimated the problem of cryptosporidiosis, besides the lacking reports of its seasonality. Characterization of the epidemiology of cryptosporidiosis may identify geographic and sociodemographic risk factors that may contribute to the disease. The present study was designed to estimate some personal, familial, environmental risk factors and seasonality associated with cryptosporidiosis among diarrheic Yemeni children over a period of one year. Additionally, it was an attempt to assess the proportion of infection among diarrheic children undergoing chemotherapy for cancer in national oncology centre in Sana'a city.

SUBJECTS AND METHODS

This study was conducted during the period from February 2009 through to January 2010 in Sana'a city. Using Cross-sectional approach; 1253 fecal specimens were collected randomly from children with diarrhea, 724(57.8%) males and 529(42.2%) females, attending three Governmental hospitals; Al-Gomhoree, Al-Thawra, and Al-Sabeen. Children were aged six to less than twelve years. Information about each child were collected by means of questionnaire, filled with assistance of his parent when necessary. Data requested included some socio-demographic and environmental data as, name, age, gender, parent's education, crowding index(number of residents/room), animal contact, and drinking water source. Fresh single fecal specimen was collected from each child in a labeled plastic covered cup, about one ml of each specimen was placed in a labeled-tight bottle containing 3ml of 10% formalin and kept until being processed. To diagnose *Cryptosporidium* oocysts in fecal specimens, each specimen was subjected to formol-ether concentration technique. A thin smear was prepared from the sediment and examined using modified Kinyoun's acid fast staining technique [9]. The intensity of infection was estimated for positive samples by counting the number of oocysts in 100 different high power fields (hpf).Then the number of oocysts was divided by 100. Number of oocysts less than 3 /hpf was considered a mild infection, 3 to 8/hpf moderate, and more than 8 heavy [10]. In addition, 13 fecal samples were collected randomly(during January 2009) from diarrheic children aged 6-<12 years, undergoing chemotherapy for cancer in national oncology centre in Sana'a city. Each sample was subjected to formol-ether concentration technique and examined using both modified Kinyoun's method **[9]**, and Immunochromatographic assay for the identification of *Cryptosporidium* oocysts [11].

Modified Kinyoun's acid-fast staining technique (Kinyoun's cold method)
After concentration of fecal specimen in formol-ether technique, a thin smear was prepared from one drop of each fecal sample sediment and it was fixed in absolute methanol for 1 minute. Smear was stained with cold Kinyoun's carbol fuchsin for 5 minutes, the stain was rinsed off in 50% ethanol for about 3 seconds and then the stain rinsed off in clean tap water. Smear was decolorized using 1% sulfuric acid until no more color flooded from the smear. Decolorizer was rinsed off in tap water. Smear was counter stained with 0.3% malachite green for about 1 minute. Counter stain was rinsed off in tap water and blot to dry. Smear was examined microscopically using high dry objective to identify the oocysts and oil immersion objective to see the internal morphology. In positive sample, *Cryptosporidium* oocysts appeared as acid fast densely stained pink to red spherical structures measuring 4-6µm in diameter against a green background [9].

Immunochromatographic assay (ICT, Xpect^{Tm})
Qualitative chromatographic immunoassay was performed *in vitro* using Xpect^{Tm} REMEL,^{Inc}; USA kit(contains 20 test devices) according to the manufacturer′s instructions. Briefly, fecal specimen was added to conjugate containing colored microparticles linked to murine monoclonal antibodies specific for *Cryptosporidium* antigen. The specimen was considered positive if a complete red line of any intensity appeared at the *Cryptosporidium* test position [11].

Statistical analysis (MstatC): Chi-square (X^2) test was used for testing the association between categorical variables. A value of $P<0.05$ was considered significant. Arithmetic mean and standard deviation were used as descriptive measures.

RESULTS

From table (1); out of 1253 fecal specimens, 173 (13.8%) were positive for *Cryptosporidium* oocysts. The higher percentage of infection was among children aged 9 to<12 years (15.4%) compared to 12.0% among those aged 6 to < 9 years, but the difference was not statistically significant (X^2=0.33, $P > 0.05$). The relation of infection to gender, there was no significant difference between males and females. Percentage of infected children was significantly increased as the mother's educational level decreased(X^2= 8.45, $P < 0.05$). Similarly, Percentage of infection increased as the level of father's education decreased. However the difference was not significant (X^2 = 3.26, $P > 0.05$). It is clear from the table that, percentage of infection increased insignificantly as the crowding index increased. (X^2 = 1.63, $P> 0.05$). Relating to the presence of animals, percentage of infection was 10.4% among children who lived in compounds with no animals compared to 27.6% among those who lived in contact with animals, and the difference was significant (X^2 =8.52, $P < 0.05$). Concerning source of drinking water, children who drank public and /or well water were strongly associated with the risk of infection (24.6%) than those who drank tap water (10.4%) (X^2 = 19.9, $P< 0.05$). Among 13 children who were under chemotherapy for cancer; *Cryptosporidium* was detected in feces of 5(38.5%) and 6 (46.2%) children by Kinyoun's and ICT techniques respectively.

Relating to intensity of infection (Figure 1), mild infected children (<3 oocysts/ hpf) represented the highest percentage (43.4%) whereas, heavy infected children (> 8 oocysts / hpf) represented the lowest one (22.5%).

Monthly seasonal proportion of *Cryptosporidium* infection gradually increased from a minimum in March to a maximum between July and September 2009, then decreased in October. Peak was observed in September (Figure 2).

Table (1): Distribution of *Cryptosporidium* infection among children with diarrhea according to socio-demographic and environmental factors.

Variable	No. examined	*Cryptosporidium spp.*		Chi-Square X^2 (p.value)
		No.	%	
Age				0.33(0.564)
6-	598	72	12.0	
9- <12	655	101	15.4	
Gender				0.00(1.000)
Males	724	99	13.7	
Females	529	74	14.0	
Mother's education			19.3	8.45(0.015)*
Illiterate or read and write	579	112	10.6	
Primary or preparatory	482	51	5.2	
Secondary or university	192	10		
Father's education♥				3.26(0.195)
Illiterate or read and write	476	89	18.7	
Primary or preparatory	447	55	12.3	
Secondary or university	284	29	10.2	
Crowding index#				1.63(0.442)
< 2	139	12	8.6	
2-4	723	102	14.1	
> 4	391	59	15.1	
Presence of animals				8.52(0.004)*
Yes	246	68	27.6	
No	1007	105	10.4	
Drinking water source♥♥				19.9(0.000)*
Tap water	791	82	10.4	
Sieved water	104	3	2.9	
Public and / or well water	358	88	24.6	
Total	1253	173	13.8	

*P < 0.05, # No. of residents per room.

♥Excluding 46 children whose fathers were dead .

♥♥[Sieved water=filtered and/or bottled water, Public water= Pipes water outside home].

N.B. Room size = approximately 4x4 meter .

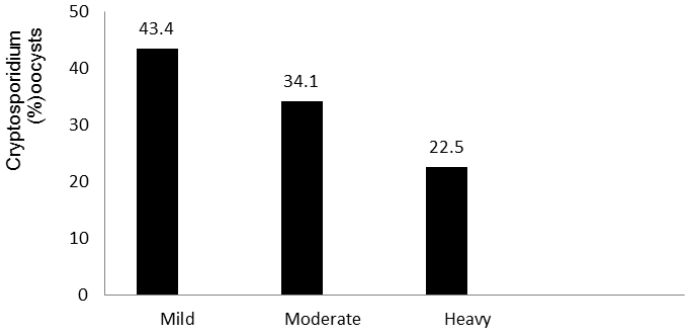
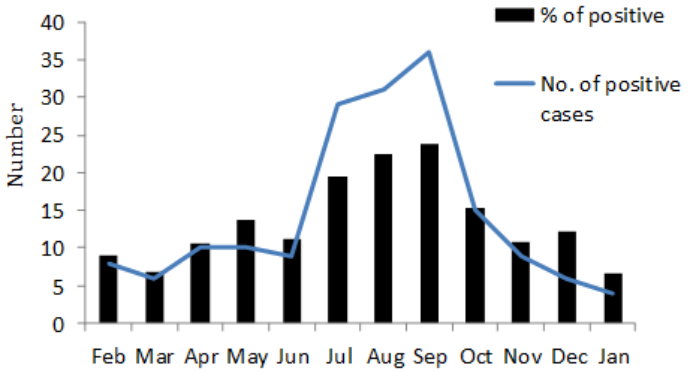


Figure (1): Distribution of *Cryptosporidium* infected diarrhoeic children according to intensity of infection.



Figure(2):Seasonality of cryptosporidiosis among children February 2009 to January 2010

DISCUSSION

Cryptosporidium is a leading cause of persistent diarrhea in developing countries. It can cause illness lasting longer than one to two weeks in previously healthy children or indefinitely in immunocompromised ones [12]. Prevalence data of *Cryptosporidium* are still underestimated in pediatric populations, due to a poor clinical valuation of pathognomic symptoms and to the absence of advanced laboratory tools in diagnostic routine panels[13]. This is first report of risk factors and seasonality for cryptosporidiosis in diarrheic children from Yemen. In the current study, 13.8% of diarrheic children had cryptosporidiosis. This rate is consistent with previous studies that reported 14% and 15% from Korea and Nigeria respectively [14,15]. Data from 16 case-control studies(1994-2003) indicate that, the average overall prevalence of infection in diarrheic immunocompetent patients in developing countries is 12.7% [16]. Slightly lower infection rates were reported from Kuwait(10%), [17] and from Palestine (11.6%) [18]. To the contrary, higher rates were reported form Jordan and Egypt, 37.3% and 27.9% respectively[19,20]. The rates of infection may have differed according to multiple factors; including type of the study, hospital or community based, socioeconomic, sanitary and environmental conditions. In addition to these the parasitological methods applied in each study could influence the outcome of results [21].

The relation of infection to socio-demographic and environmental factors**,** it is evident from table (1) that, percentage of infection increased insignificantly as the age increased. Thus, those aged 6-<9 represented the lowest percentage whereas, those aged nine to less than twelve years represented the highest percentage. It was reported that, percentage of infection increased gradually as the age increased and a strong tendency was observed that, the older the age the higher the infection rate. This suggested that, as children grow, they probably become active, energetic and are more susceptible to infection [14].

Considering gender, percentages of infection among boys and girls were similar. in agreement with the present work, uniform gender distribution of cryptosporidiosis had been reported by many surveys, where males and females were equally susceptible [22,23].

Regarding mother's education, percentage of infected children increased significantly as the mother's education level decreased. Nearly similar results were obtained from a study done among primary school diarrheic children in Egypt where, children of non-educated mothers had a higher risk of infection than those of educated mothers and the difference between the two groups was statistically significant[24]. Generally, the effect of maternal education on prevalence of parasitic infections is explained by Mata to include mother's knowledge of primary health care and the appropriate procedures for storage of food and water and handling of children's feces which is presumably a reflection of maternal education to decrease prevalence of parasites [25]. Illiterate fathers have low income, bad personal hygiene beside their ignorance about the prevention of intestinal parasitic infections [26].

Crowding index among children was insignificantly associated with the infection. This agrees with a previous study that reported no statistical difference between crowding index and cryptosporidiosis among household members. This was ascribed to two explanations; having a larger household size consisting of several working individuals may relate to increase household income and thus a higher standard of living, or, working household members are likely to use a more modern flush toilet at their place of work, thus minimizing their contribution to the household toilet [27].

Presence of animals was significantly associated with cryptosporidiosis. It has been an evident proof that the transmission of *Cryptosporidium* oocysts is increased through direct contact with animals[28]. The present result goes in accordance with a previous study in Egypt where, percentage of infection detected in animals attendants was 31.3% and it was deduced a positive association between percentage of infected animals and their attendants[29]. To the contrary, contact with cattle and home pets were not associated with cryptosporidiosis among diarrhoeic individuals in England [30]. This suggests that, animals may play a role in the spread of infection but other sources are not less important[28].

Concerning the source of drinking water, the majority of houses in Sana'a city had tap water connection inside their houses but potable water was not available all the time, as a result people tend to use public taps and / or wells as alternative sources of water supply. In the present study, use of public and/ or well water for drinking was statistically associated with infection. This is in agreement with another study that reported a high prevalence of human cryptosporidiosis. This was explained by the presence of polluted animals and / or humans excreta that may possibly contaminate the public taps[14].

Relating to intensity of infection (Figure 1), the majority of infected children in the present study was of mild degree(<3 oocysts/ hpf). Intensity of intestinal infection with *cryptosporidium* varies from host to another. It has been suggested that, excretion of oocysts by individuals is a host characteristic determined by the host immunity. The

severity of disease may be emphasized by the concomitant infection with other intestinal organisms[10,31]. Mild excretors children may be well-nourished and have a higher level of immunological resistance in whom replication of parasite is prevented to some extent [10].

In the current study, the highest proportion of infection occurred during the rainy summer season through July to September (Figure 2). Nearly similar result was reported during the rainy summer season (June–October), from Nepal [32]. In contrast, in Kuwait and Jordan, high incidence rate was reported in rainy winter season(January- April) [17,19]. Seasonal and temporal trends of infection varied from country to country. A seasonal incidence of infection is sometimes present, possibly corresponding to rainfall peaks, increased pollution from farm waste, or calving and lambing activities[13,33].

It can be concluded that, cryptosporidiosis is a health problem in Sana'a city and symptomatic children represent a small part of infection, further studies should be directed to asymptomatic infections, and study of *Cryptosporidium* genome may allow us to better understand host specificity and associated risk factors. Improvement of environmental sanitation especially proper sewage, and safe water supply are recommended. Ongoing public health measures and health education programs should be go on to focus on the proper care of domestic animals and the importance of hygienic practices.

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عوامل الإختطار والموسمية المرتبطة بالإصابة بخفيات الأبواغ الصغيرة بين الأطفال اليمنيين

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ملخص

قليلة تلك الدراسات التي أجريت على عوامل الإختطار والموسمية المرتبطة بالإصابة بخفيات الأبواغ الصغيرة في البلدان النامية. هدفت هذه الدراسة (للمرة الأولى) لتحديد مستوى الإصابة، عوامل الإختطار والموسمية المرتبطة بالإصابة بخفيات الأبواغ الصغيرة بين الاطفال في مدينة صنعاء باليمن. أجريت دراسة مقطعية على 1253 طفلا من الذكور والإناث يعانون من الإسهال تراوحت أعمارهم من ست سنوات إلى أقل من 12سنة ولفترة عام كامل. جمعت عينات برازية واحدة من كل طفل وطفلة وتم فحصها بطريقة الفورمالين-إيثر للترسيب بالطرد المركزي وطريقة التلوين البارد بصبغة كينيون زيل نيلسين المعدلة للكشف عن كيسات خفيات الأبواغ (الكربتوسبوريديم). معدل حدوث العدوى بخفيات الأبواغ بين الأطفال كانت 13.8% وكانت شدة الإصابة البسيطة هى الأعلى بين العينات الموجبة من الأطفال (43.4%). أظهرت النتائج أن مصادر مياه الشرب من الحنفيات العامة والأبار، الإحتكاك بالحيوانات والأمية في الأمهات مثلت عوامل إختطار هامة (وبدلالة إحصائية) لإنتشار العدوى بين الأطفال، وقد سجل معدل أكثر إرتفاعا للعدوى في الفصل المطير بين شهري يوليو وسبتمبر. بالإضافة الى ذلك، جمعت عينات برازية من 13طفلا يخضعون للعلاج الكيماوئي لإصابتهم بالسرطان (تراوحت أعمارهم من ست سنوات إلى أقل من 12سنة) لتحديد نسبة الإصابة بخفيات الأبواغ. وبإستخدام طريقتي صبغة كينيون المعدلة والفحص المناعي الكروماتوغرافي وجد أن نسبة الإصابة بينهم 38.5%، 46.2% على التوالي.

كلمات مفتاحية: الإصابة بخفيات الأبواغ الصغيرة، أطفال يمنيين، عوامل إختطار، موسمية

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Missed Miscarriage Runs without Complete Evaluation: A Retrospective Study

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ABSTRACT

The causes of missed miscarriage are often unknown. The aim of this study was to know the rate of missed miscarriage and to assess whether the underlying causes are identified at time of termination. This study was a retrospective carried out in Al-Saba'een Hospital – Sana'a during a year (from Jan. 1st to Dec. 31st 2010).
The hospital records were reviewed for all women admitted with miscarriage. The women with missed miscarriage were identified and their demographic and clinical data were obtained. The histopathological results noted when available. Of the 621 miscarried women, 225 patients were diagnosed as having missed miscarriage giving the rate of 36.2% of the overall miscarriages. Only 17.3% of these cases the underlying etiologies were diagnosed whereas in the remaining 82.7% patients the causes of loss were undetermined (p=0.0002). The histopathological study was performed only in 18.7% of patients.We concluded that missed miscarriage more frequently runs without complete evaluation of the underlying causes. It is a neglected and invisible issue and more efforts are needed to translate the theoretical knowledge into proven practice.
Keywords: missed miscarriage, medical termination, first trimester miscarriage

INTRODUCTION

Spontaneous miscarriage is a common complication in early pregnancy and represents a heavy gynecological emergency workload to both medical and nursing staff [1].The estimated prevalence of miscarriage is 10 – 20 % of all clinically

recognized pregnancies[2]. Missed miscarriage is a variety of miscarriage and refers to early fetal demise or blighted ovum with retention of products of conception [3]. More than one causative factor of miscarriage may be operative. In clinical practice the exact cause is not determined in the majority of cases[4]. However, the extensive investigation can decrease the incidence of unexplained missed miscarriage. Unfortunately in the most of low-income countries, the issue of karyo type analysis, screening for the most related infectious causes, autoimmune, endocrine disorders and other possible factor are either not available or simply not undertaken. In these situations, the collected information derived from simple investigation are insufficient to identify the causes, and therefore to guide efforts to prevent the recurrent miscarriage as well as to improve the quality of care. In our country most cases of missed miscarriage frequently run without understanding of the underlying cause . The purpose of this study was to assess the rate of missed miscarriage and to assess whether the underlying causes are identified at time of termination in order to provide the appropriate evidence-based recommendation

PATIENTS AND METHODS

A retrospective medical review of the total miscarriages being admitted to Al-Saba'een Maternity Hospital, Sana'a – Yemen was performed during a year (from Jan. 1st to Dec. 30th 2010). A list of all women having missed miscarriage was created. The data collected included the age, gravidity, diagnosis at time of admission, gestational age, management and complications . The hospital number was used to retrieve the patients' charts for collecting the information about the detailed histories, presenting symptoms, ultrasonographic data, the results of investigation and other relevant information. Our standard approach is detailed medical and obstetrical history-taking searching for the possible risk factors, physical examination, laboratory analysis including hemoglobin level, blood group, Rh-factor, bleeding time, urinalysis for pregnancy test and possible urinary tract infection. Screening for toxoplasma, syphilis, rubella and for coagulation profile are performed in selected cases. A repeated ultrasonography is performed within the ward to confirm and identify the type of miscarriage and to exclude any concern for ectopic pregnancy or other related condition. Once documented, the termination method depends mostly on the gestational age. Surgical intervention is undertaken for the first trimester miscarriage. For the second trimester missed miscarriage a woman is given Misoprostol (200 µg) by a nurse vaginally into the

posterior fornix 6 hourly. Digital examination is performed initially by a resident doctor and with each repeated dose. The repeated doses of Misoprostol is often determined based on the individual response or a maximum of 48 hours has elapsed.

For women received Misoprostol, pulse rate, blood pressure and temperature are monitored hourly. An intravenous line is not routinely used. Parenteral analgesia is given in the form of intramuscular injection of Tramadol every 6 hours or as required. The products of conception when passed are inspected visually and submitted for pathologic examination only in selected cases. The need for further uterine evacuation is determined either by digital examination or ultrasound whichever feasible. Rh anti-D immunoglobulin is offered to all Rh-negative women. The women are observed in the ward 2 hours before discharge.

Statistical analysis

The data were analyzed using SPSS(release 11.00, Chicago ,Inc ,USA).The data were presented as mean+ SD, or proportion as appropriate .A p value of<0.05 was considered statistically significant.

RESULTS

A total of 621 women were presented to gynecological department during the study period with different kinds of miscarriage. Two hundred twenty-five women were having the missed miscarriage, making the rate of missed miscarriage as 36.2%. The distribution of cases among age groups shows that it was common among the age groups of 30 – 34 years in 32.4% followed by age group 20 – 24 years in 28% of cases. As regard gravidity, missed miscarriage was occurred more frequently (58.2%) in gravida 2 – 4. It is noted that the frequency was the least among nulliparous women (3.1%) and in women aged less than 20 years (1.8%). With respect to gestational age, 68.4% of missed miscarriage were occurred during the first trimester whereas the remaining cases (31.6%) occurred during the second trimester (13 – 18 weeks). More than two thirds (69.4%) of cases had previous histories of miscarriages. Prior one miscarriage was recorded in 36.9% while prior three times miscarriages were recorded in 12.9% of cases. Table 1 shows the detailed demographic characteristics. The most frequent clinical presentation was spotting vaginal bleeding in 38.2%. Only 5.7% of cases presented with moderate vaginal bleeding. Also, a large proportion of women (36%) had lower abdominal pain.

A notable finding was the presence of sepsis in 11 cases (4.9%).The underlying causes of loss were identified only in 17.3% (p =0.0002).

Twenty women (8.9%) had acute pyelonephritis and five cases (2.2%) had bacterial vaginosis (BV). Uncontrolled diabetes mellitus was the only underlying disorder in 2 cases (0.88%). Four cases (1.8%) had submucus fibroid and three cases had cervical incompetence. Almost all of the first-trimester miscarriages (68.4%) were terminated by surgical intervention (dilatation and curettage) whereas for the second-trimester miscarriage a prior cervical ripening using misoprostol vaginally and the uterine evacuation was performed thereafter. Table 2 summarizes the clinical findings and outcome.

Table (1): Demographic data (n = 225)

	No (%)
Age, year	
< 20	4 (1.8)
20 – 24	63 (28)
25 – 29	60 (26.7)
30 – 34	73 (32.4)
> 35	25 (11.1)
Gravidity	
1	7 (3.1)
2 – 4	131 (58.2)
≥ 5	87 (38.7)
Gestational age, week	
< 9	50 (22.2)
9 – 12	104 (46.2)
13 – 18	71 (31.6)
Prior miscarriage	
0	69 (30.6)
1	83 (36.9)
2	44 (19.5)
≥ 3	29 (12.9)
Hb levels (g/dl)	
< 10.5	8 (3.6)
> 10.5	217 (96.4)
Rh(-ve)	32 (14.2)

Table (2): Clinical findings and outcome (n = 225)

	No. (%)
No symptoms	93 (41.3)
Vaginal bleeding	
Spotting	86 (38.2)
moderate	13 (5.7)
Lower abdominal pain	81 (36)
Sepsis	11 (4.9)
Identified causes, total	39 (17.3)
UTI	20 (8.9)
BV	5 (2.2)
Cervical incompetence	5 (2.2)
Uncontrolled DM	2 (0.88)
Submucus fibroid	4(1.8)
Trauma	3(1.3)
Unknown causes	186 (82.7)
Serological findings	
Toxoplasma, total	52 (23.1)
IgG (+ve)	46 (88.46)
IgM (+ve)	6 (11.54)
CMV	21 (9.4)
Rubella	16 (7.1)
Method of termination	
Surgical	154 (68.5)
Medical	71 (31.5)
Histopathological study	42 (18.7)

UTI: Urinary Tract Infection; BV: Bacterial Vaginosis; DM: Diabetes Mellitus; CMV: Cytomegalovirus. Note: some women had more than one symptom at the same time.

DISCUSSION

The prevalence of miscarriage varies among regions. Several factors may contribute to such variations including the overall risk factors in each community,, reproductive behaviors like fertility rate or contraception use, maternal demographic factors, and health setting among other factors [5].In this study it is noted that the prevalence of missed miscarriage rises with increasing maternal age and parity which is consistent with other studies [6,7]. Similarly, it was common (68.4%) during the first trimester and decreased with increasing gestational age as previously cited by many studies [6,7].

The prevalence of acute pyelonephritis observed in this study is similar to other study [8] but the prevalence of bacterial vaginosis (BV) of 2.2% is lower than reported in the previous studies. It has been reported to be 29.3% in women seeking termination [9]. Many factors could have contributed to the

low prevalence in our study. Testing for BV is often limited to symptomatic women who present with vaginal discharge taking into accounts that many women deny such symptom and refuse vaginal and swab collection due to cultural and/or religious reasons. Bacterial Vaginosis is implicated with late miscarriage, preterm birth, PID and postpartum endometrisis [10]. However, further studies to assess the prevalence of BV and other lower genital tract pathogens in early pregnancy are needed. The seroprevalence of Toxoplasmosis found in this study was 23.1%. This finding is in line with that reported in the United Arab Emirates (22.9%) but lower than that found in Jordan (47.1%) and Egypt (58.1%) [11].

In our hospital records, the positive serological tests for toxoplasma, cytomegalovirus and rubella were not considered the underlying causes of loss in this series because these findings in asymptomatic women could not show evidence of association [12,13]. However, promotion of health education program to prevent infection during child bearing age should be addressed. Our results demonstrated that the infectious disease was the cause of loss 11.11% of cases, which are similar to other study [14].The causes of the missed miscarriage were identified only in 17.3% of our cases whereas in the remaining 82.7% of cases nothing revealed by the investigation that might help in the explaining why miscarriage did occur.In setting with low-income resources, several factors can lead to this event. First, unavailability of karyo typing, autoimmune, thrombophilia and other relevant causes screening may compromise the currently failing protocols of investigation. To date, the investigations are directed by the opinion of the providers who may have no interest or enough time to investigate for all likely etiologies. The second important factor is the lacking of post miscarriage follow-up care schedule., it is likely that such practice if implemented can allow the investigation for the underlying causes of loss, discuss the circumstances of the miscarriage, the possibility of recurrence, contraceptive option and promote emotional adjustment. Follow up visit one week post miscarriage is considered the best time desirable to provide the women an opportunity to express feeling concerning their pregnancy loss and to receive the appropriate support [15]. Moreover, it is reported that psychological morbidity including anxiety and depression may follow miscarriages similar to that experienced in stillbirth [15] and the follow-up discussion can ease the maternal sense of responsibility for the loss [14].

Because the etiology of previous miscarriage may influence the recurrence rate [14] and many causes are amenable to medical treatment, a complete evaluation following miscarriage will provide the best estimate to

prevent further loss. Also a better data on the missed miscarriage aetiologies are needed for basic research and thus recognition of the prevalence of each etiology among community. However, many hospitals now have an early pregnancy assessment unit (EPAU) as an out patient dedicated area where the management of early pregnancy loss can be provided efficiently. We, thus recommend offering such unit to relieve the pressure on the hospital, ease the services accessibility and promote more sophisticated investigation to help ascertain the underlying cause of loss. It has been shown that the admission to the hospital can be avoided in 40% of women with further 20% requiring shorter hospital stay [3]. Furthermore, the registration of miscarriages can be improved within the unit which is considered an opportunity to guide the efforts for further analysis and prevention.

Although surgical evacuation of the uterus is the traditional method used for the firs-trimester missed miscarriage termination , several published studies suggest that the medical termination in the first trimester is accepted as safe and effective alternatives [16-18]. Our result shows that all women with first-trimester missed miscarriage (68.4%) were treated by dilatation and curettage (D&C) under general anesthesia. The possible explanation of this finding is that most cases were referred to the hospital from different rural areas where the facilities do not conform to minimal medical standards. They sought hospital help only when they had already developed complications. Another possibility is that the providers might prefer the surgical method to shorten the duration of hospital stay particularly in setting with heavy workload like ours. However, medical method can improve the patients choice and preference after having the appropriate counseling of each method. Taking in account that in setting where there is a high risk of infection or the facilities for the immediate surgical intervention are lacking, this recommendation may not be applicable.

Though the value of submitting tissues passed at miscarriage for histopathologic study has never been universally agreed [19], it is recommended to confirm the diagnosis of miscarriage and exclude the possible ectopic or molar pregnancy [3]. One study in Jordan (2002) [20] found among 293 patients diagnosed and managed as first trimester miscarriages that the partial mole was present in 17%, complete mole in 1%, and absence of chorionic villi in 7%. These results suggest that the pre-operative diagnosis of miscarriage is not always correct and the value of the histopathologic study of the products should not be ignored particularly in setting where the prevalence of gestational trophoblastic disease is high such as in Yemen. Our data show that only 18.7% of cases, their evacuated

tissues had sent for histopathologic examination. This indicates that there is a poor understanding of its clinical importance in identifying the cause of loss among general practitioners and attendant staff.

Some limitations of this study are noted. First, being a retrospectively designed, there might be missing data in the patients records which could affect the final results. Second, a part from the complications noted at admission, the post miscarriage complications were not determined. It is possible that patients had late complications but owing to the lacking of the follow-up care, the provider who managed the case might not be notified.

CONCLUSION

Only 17.3% of our cases, the underlying disorders had identified. It's time to reconsider the current approach in this issue by broadening the investigation to involve more specific maternal and fetal etiologies. More investigation will improve the detection of the causes and decrease the rate of unexplained loss. The need for EPAU is a pressing
issue to translate the advances in health knowledge for this group of women into proven practice as well as to improve the basic registration and analysis.

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Formulation and Evaluation of Molexicam Orally Disintegrating Tablet (ODT)

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ABSTRACT

The aim of the present study was to develop and evaluate an oral disintegrant tablet of meloxicam. Drug delivery systems became sophisticated and pharmaceutical scientists acquire a better understanding of the physicochemical and biochemical parameters pertinent to their performance. Over the past three decades, mouth dissolving or orally disintegrating tablets have gained considerable attention as a preferred alternative to conventional tablets due to better patient compliance.

Orally is the most preferable route of drug administration which has some limited to drug candidate that show poor permeability across the gastric mucosa and those, which are sparingly soluble. A large majority of the new chemical entities and many new existing drug molecules are poorly soluble, thereby limiting their potential uses and increasing the difficulty of formulating bioavailable drug products, so lastly the purpose of this study was to grow mouth dissolve tablets of Meloxicam.

Meloxicam is a non steroidal anti-inflammatory drug (NSAID) which a newer selective COX-1 inhibitor. Different five formulations were prepared in his study and evaluated. These tablets were prepared by direct compress procedure.

Results: The results indicate that formulation number five is the best formula were friability is 0.65% < 1%, wetting time is 5.5 sec. and disintegration time is 18 sec.

Dissolution test indicate that more than 75% of drug dissolve in the first 5min. and assay test is 99.1% which is within the pharmacopeia limit (90-110%). The systematic formulation approach helped in understanding the effect of formulation processing variables.

Keywords: Oral disintegrant tablet; Meloxicam; NSAID, Formulation.

INTRODUCTION

Tablets that are fast disintegrate or dissolve rapidly in the patient's mouth, are convenient for young children, aged and patients with swallowing

difficulties [1]. For these formulations, the small volume of saliva is usually sufficient to result in tablet disintegration in the oral cavity [2]. The medication then be absorbed partially or entirely into the systemic circulation from blood vessels in the sublingual mucosa, or it can be swallowed as a solution to be absorbed from the gastrointestinal tract (GIT) [3].

The bioavailability of some drugs may be enhancing due to absorption of drugs in oral cavity and also due to pregastric absorption of saliva containing dispersed drugs that pass down into the stomach. The amount of drug that is subject to first pass metabolism is reduced as compared to mouth dissolving tablets [4]. Orally disintegrating tablets contain wide variety of pharmaceutical active ingredients covering many therapeutic categories. The time for disintegration of orally disintegrating tablets are generally considered less than one minute. Orally disintegrating tablets are characterized by high porosity, low density and low hardness. When administered, an in-situ suspension is created in the oral cavity as the tablet disintegrates and is subsequently swallowed [5]. Recently, the Nomenclature and Labeling committee at USP has approved the Orally Disintegrating Tablets terminology.

Meloxicam (Figure 1) is a nonsteroidal anti-inflammatory drug, used to relieve the symptoms of arthritis, primary dysmenorrhea, fever and as an analgesic, especially where there is an inflammatory component [6].

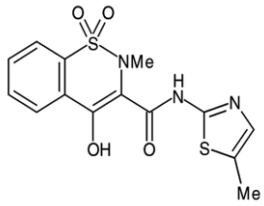


Figure (1): Chemical structure of Meloxicam

Meloxicam inhibits cyclooxygenase (COX) synthesis. responsible for converting arachidonic acid into prostaglandin H2. the first step in the synthesis of prostaglandins, which are mediators of inflammation. [7].

A primary advantage of the meloxicam family of drugs is their long half-life which permits once-day dosing [8]. In gastric disease, lower dose of meloxicam is required 7.5 mg/day. Meloxicam is safer than other NSAID's [9]. The fundamental approach used in the progress of the fast-dissolving or mouth dissolving tablet is the use of a super disintegrants. Sodium starch glycolate, pregtnalized starch and croscarmellose were screened in the present study. A different approach used in developing mouth dissolving tablets is maximizing the pore arrangement of the tablets [10]. NSAIDs are the most recurrently prescribed by physicians for inflammatory disorders. NSAIDs exert their effect through inhibition of cyclooxygenase-II, the main form of isozyme associated with inflammation but the simultaneous inhibition of cyclooxygenase-I and the resulting gastric and renal dysfunction limit their frequent use [11-12].

In this study, an attempt has been made to formulate and evaluate Meloxicam as Orally Disintegrating Tablet.

MATERIALS AND METHOD

Materials:

Meloxicam (Active Ingredient), Croscarmellose (Disintegrant), Sodium starch glycolate (Disintegrant), Lactose-DCL, Mannitol (Diluents), Citric acid (Taste masking), Povidone (Binder) sucrose, Sodium Saccharine (Sweetening agent) and Magnesium stearate , Talc (Lubricant).

All these ingredients and chemicals which used in this study are from Biopharm Co. Ltd.

Method

All ingredients were weighed as per required quantity and store separately. To maintain uniformity the particle size, each material was passed through # 100 mesh-sized screen before mixing [13].

Table (1):Composition of different batches of Meloxicam oral disintegranting tablets

MATERIALS	F1	FII	FIII	FIV	FV
Meloxicam	7.5mg	7.5mg	7.5mg	7.5mg	7.5mg
Lactose DCL	100mg	78.5mg	57mg	82.5mg	100mg
Magnesium stereate	1mg	1.5mg	4mg	4mg	1mg
Sucrose	4mg	-	57mg	50mg	-
Mannitol	77.5mg	70mg	57mg	10mg	70mg
Citric acid	-	7.5mg	7.5mg	7.5mg	7.5mg
Povidone	-	3mg	-	0.5mg	4mg
Croscarmellose	10mg	20mg	10mg	16mg	20mg
Sod. Saccharine	-	-	-	2mg	-
Sod. Starch glyconate	-	-	-	20mg	-
Camphor	-	10mg	-	-	-
TALC	-	2mg	-	-	-

Tablet formulation

Direct compression method was done by using single-punch tablet machine (Cadmach, Bhopal India) and the granules were converted into tablets.

Evaluation tests

All the physico-chemical tests were performed according to the British Pharmacopoeia (BP.) and United State Pharmacopoeia (USP). [17 and 18]

First calibration curve of meloxicam was done using HPLC (Shimadzu) and Figure (2) illustrates the relation between concentration of meloxicam and area under the curve.

I. Hardness test

The crushing strength or hardness of the tablets was measured with help of a Monsanto hardness tester and expressed in kg/cm2 [18].

II. Uniformity of Weight

Weight variation test is done with 20 tablets. It is the individual variation of tablet weight from the average weight of 20 tablets [17].

III. Friability

The friability of tablets using 10 tablets as a sample was measured using a Roche Friabilator. Tablets were rotated at 25 rpm for 4 minutes or up to 100 revolutions. The tablets were then reweighed after removal of fines and the percentage of weight loss was calculated [17].

IV. Disintegration Time

Disintegration time for MDTs was determined using USP disintegration apparatus with (pH 6.2, 900 ml at 37°C) as the disintegrating medium. To comply the test all tablets should disintegrate within 3 minutes [18].

V. Dissolution Time

Dissolution Study of tablets on the basis of disintegration data, formulation I, II and III, IV, V, were chosen for dissolution study, as it was showing least disintegration time i.e. 52 seconds. In vitro dissolution study on prepared tablets was performed in (pH 6.2) using USP type II (paddle) apparatus operated at 50 rpm (900 ml) for 30 minutes (37 ± 0.5°C) and Figure 3.Illustrate the results of dissolution profile test for formulations (F1,FII,FIII,FIV,FV) [14].

VI. Wetting Time

The wetting time of the tablets was measured using a very simple process. Five circular tissue papers of 10-cm diameter were placed in a Petri dish with a 10-cm diameter. Ten milliliters of water containing a water-soluble dye (eosin) was added to the Petri dish.

A tablet was carefully placed on the surface of tissue paper. The time required for water to reach the upper surface of the tablet was noted as the wetting time. All tests are summarized in Table 2.

RESULT

Table (2): Evaluation of Meloxicam Orally Disintegrating

Parameter	FI	FII	FIII	FIV	FV
Weight variation (mg)	203.7	198.4	206.3	204.9	200
Friability (%)	0.55	0.75	0.63	0.84	0.65
Disintegration time (sec)	14	16	50	140	18
Hardness (kg/cm^2)	4.33	3.866	3.533	3.866	3.4
Drug content (Assay)%	97.5	97.9	97.5	97.9	99.1
Wetting time (sec)	4.5	5.2	6.3	6.8	5.5
Water absorption ratio	48%	45%	41%	40%	44%

The above figure 2 of calibration indicate that the linearity of meloxicam at different concentration and the regression equation (r^2) = 0.99

DISCUSSION

Mona Nagar et al [15]. Are doing formulation and evaluation of fast-dissolving tablet by direct compression method using crospovidone as superdisintegrant and also Prasanthi et al [16] doing formulation and characterization of fast-dissolving tablets of raloxifene hydrochloride prepared by direct-compression method by incorporating super disintegrants like crosscarmellose sodium and sodium starch glycolate.

Water insoluble diluents such as microcrystalline cellulose and dicalcium phosphate were not used in this study because they expected to cause an unacceptable feeling of grittiness in the patient mouth. Along with the soluble diluents, lactose-DCL and mannitol were selected as soluble diluents considering its advantages in terms of availability, low cost and relative moisture insensitivity. Povidone and sodium starch glycolate were used as a binder at a concentration of 3-5%. The crushing strength of the tablets was adjusted from 3. 4 to 5.7 kg/cm^2. Sublimation agents such camphor was used in formulation III to increase porosity of the tablets.

Figure (2): Calibration curve of meloxicam

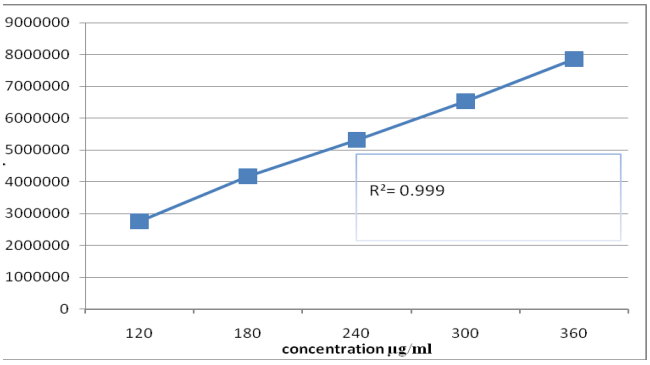
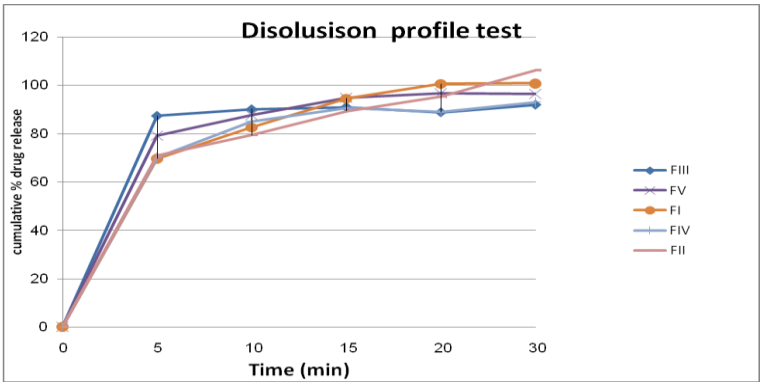


Figure (3): Dissolution profile of meloxicam orally disintegrating tablet formulations as cumulative % release Vs. time



Camphor-containing tablets show faster disintegration or shorter disintegration time but more hygroscopic and as result of tablet compress the porosity was reduced.

The results shown in Table 1 indicate that concentration-dependent disintegration was observed in batches prepared using camphor as a sublimation agent. The porous structure is responsible for faster water uptake; hence it facilitates wicking action of croscarmellose in bringing about faster disintegration. In the first few attempts FII, sublimation of camphor

was performed from granules prior to compression into tablets. FI, FI1I, FIV and FV were changed in the concentration of the croscarmellose as disintegrant and povidone as binder to prepare good mechanical integrity, and short disintegration time was less than 60 seconds in all formulation except FIV more than 60 seconds as result of used sodium starch glycolate as binder. The results showed in Table 2 reveal that croscarmellose resulted in faster disintegration.

Citric acid was added to the other formulation to improve the bad taste except FI show very bad taste.

Mannitol was used as filler because it has a negative heat of solution and imparts a cooling sensation when sucked or chewed to improve better taste F4 show unpleasant taste because the amount of mannitol is very low.

As illustrated in Figure 2 the dissolution profile for all formulation F1,FII,FIII,FIV and F At the following time intervals 5, 10,15, 20 ,25, 30 minute indicate good release where more than 70% of the drug was release at the first five minute.

CONCLUSION

We can conclude thatcroscarmellose , sodium starch glycolate and povidone considerably affect the various parameters such as waiting time, disintegration time, and percentage friability.

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تحضير وتقييم تركيبية دوائيه للميبيلوكسكام على شكل أقراص ذائبة في الفم

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ملخص

تهدف الدراسة الى تطوير وتقيم أقراص ذائبة في الفم لصنف الميلوكسكام وتعتبر طريقة ذوبانية الادوية في الفم وامتصاصها من التطورات الجديدة التي تستخدم كبديل للادوية التي لها مشاكل في القناة الهضمية سواء كان الامتصاص اوفي تاثرها بالاس الهيدروجيني او الاستقلاب المبكر وتعتبر طريقة تعاطي الادوية فمويا افضل وأكثر الطرق يعتبر الميلوكسكام من المسسكات غير الاسترودبة التي تعمل تثبيط للمساعد الانزيمي (COXI)

الطريقة: تم غمل خمس تراكيب مختلفة لصنف الميلوكسكام وتم عمل اختبارات تقييم للتراكيب الخمس وكانت التركيبة الخامسة هي افضل التراكيب حيث كانت نتائج الاختبارات كتالي :

حيث كانت الهشاشة (0.65%)وهي اقل من (1%) وكان زمن الابتلال 5.5 ثانية وكان زمن تفتت القرص (18) ثانيه بينما اوضحت دراسة الذوبانية التي تم خلال نصف ساعة ان اكثر من75%من الدواء يذوب في الخمس الدقائق الاولى وكانت نسبة المادة الفعالة في القرص هي 99.1% وهي ضمن المدى المحددمن قبل دستور الادويه (90 - 110)

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Stratigraphic Sequence and Structural Evolution of the Sana'a Basin

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ABSTRACT

The stratigraphic sequence of the Sana'a basin ranges in age from Precambrian to Recent with some periods missing. Lithological outcrops of the Sana'a basin ranging in age from Jurassic to Quaternary, while the subsurface data reveals the occurrences of the Precambrian rocks.

Current research discusses the sedimentary and structural evolution of the Sana'a basin and indicates that significant tectonic phases occurred during the Jurassic, Cretaceous, Tertiary and Quaternary periods. Structural effects of these tectonic phases include uplift and subsidence for several times. However, the Sana'a basin formed during the Jurassic time under an inherited and reactivated structural control from the old N-S trend. Field studies indicate that the Sana'a basin was subjected to compression stage during the Paleocene time which resulted in the formation of an anticline with N-S axis, and then at the end of the Paleocene the area is affected by extensional faults to form half grabens such as Wadi Dhahr, and Haddah half grabens.

During the Tertiary Sana'a area has been affected by huge of volcanic activities especially in the southern part of the Sana' a basin to form the Yemen Plateau, then the major tectonic trends were reactivated by extensional stage which coincided with the NS - NW and ENE - WSW trend. However, most of these faults and fractures are filled by volcanic dykes of different composition. In Quaternary time another volcanic activity has occurred to form a lot of plugs and cones intruded into the old rock units.

Keywords: Structural Evolution, Extensional Faults, Tawilah Sandstone, Sana'a Basin, Yemen.

INTRODUCTION

The Sana'a basin is about 3200 km^2 in area with flat alluvium deposits covering an area of about 500km^2. (Fig.1). It is intermountain plain within the Yemen plateau and is surrounded by irregular topographic features. The

elevation of the Sana'a area ranges from 2150m in the plain to 3760 m in highest peaks in the Arabian Peninsula as in "Jabal Al-Nabi Shuaib" to the west of Sana'a city**.**

The Sana'a plain slopes gradually from 2350m in the southern part to about 2150m in the northern part. The bedding of the sedimentary and stratified volcanic rocks dips gradually from zero in the north, as in the Thomah area, to about 15^0 in the south, as in Al-Quthi area. (Italconsult, 1973). The major tectonic elements of Yemen are controlled by the main trends of the Gulf of Aden, the Red Sea, and the Najid fault systems (Fig.2).

The Sana' a basin is not studied structurally in detail and there is only limited studies from seismic and drilling information's. The basin area consists of crystalline basement rocks overlain by sediments of the Jurassic to Recent (Fig.3). Here, the basement rocks are considered only so far as they may influence the development of younger structures. The structural style of extensional basins depends not only on the orientation of the controlling stress regime relations to the zone of crystal extension and the amount of extensional stress, but also on the availability of pre-existing basement heterogeneities and on the lithological heterogeneities within the sedimentary basin fill which can be reactivated by tension. However, during the evolution of the Sana'a basin, the stress regime governing its development can change with time where the orthogonal extension may give way to trans-tensional faulting and or trans-compression deformation. The Sana'a basin is located close to very active and more complicated structural trends where oceanic floor spreading is going on now in the Red Sea, to the west, and the Gulf of Aden to the south. Two other active boundaries: the Zagrous Thrust, to the east, and the Dead Sea strike slip fault to the north (Khanbari, and Huchon, 2010) (Fig.2). These boundaries represent the major tectonic trends and the most important structural elements, which have controlled the formation of any reactivation structures, occurred in nearby areas. As mentioned before, the structural trends which controlled the formation of the Sana'a basin are inherited from the Proterozoic trends which have been rejuvenated during the early Jurassic time where a deep depression was formed with a NW-SE trend. The Sana' a basin is subjected to different tectonic trends of compression and extensional regimes. The extensional regime is the most dominant structures in the area and obscured all old structures (Al-Ubaidi and Al-Kotbah, 2003 and Khanbari, 2004). Several field trips of the Sana'a area are carried out and field measurements of faults and fractures are made. Investigation of rock units, faults and fractures in the study area were delineate all over the area, and detail recognize of faults and fractures show the main structures of normal faults with extensive fractures of three trends such as, E-W, NW-SE and N-S to NNW-SSE. More detail will be described below.

Structures

The Sana'a basin shows evidences of rejuvenated old structures, particularly those with NW-SE trend. The faults and fractures of the ancient Najd fault system have resulted in the formation of deep basin where the basement surface has subsided to more than 1800m, as in the Arhab and Al-Hatarish wells of the northern part of the Sana'a basin. In general, the Sana'a basin has been subjected to at least four trends of tectonic faults. Field observation shows that the Gulf of Aden trend had dissected the Sana'a basin into half grabens such as the Haddah, Wadi Dhahr and Wadi Al-Quthi faults. The Wadi Dhahr faults (Plate 1.B) belong to the Cretaceous time which affected in the cretaceous sedimentary rocks and not continues in the tertiary volcanic, while the Haddah and Wadi Al-Quthi faults are Tertiary faults. The maximum vertical displacement of extensional faults is recorded around Sana'a city such as in Haddah fault and reaches to more than 300m. This study is coinciding with

several studies of (Al-Kotbah, and Al-Ubaidi, 2001, Al-Ubaidi and Al-kotbah, 2003, Al-Subbary et al, 1998, Khanbari, 2004 & 2010). The main trends of faults and fractures measured in current study as shown in Dhudan area (plate 2.A) are coincided and control by the major tectonic elements of Yemen and the rejuvenation of the old regional structures of the Arabian Peninsula.

The structures in the study area are dominant by normal faults (plate 2.C) and fractures of extensional regime with accommodation structures associated with normal fault (plate 2.E & F), such as the tilting blocks of hanging wall, rollover anticline and sometimes drag folds. These accommodation structures are result of the internal compression stress due to the movement of fault blocks. However, the old tectonic trends play the main role in formation of tertiary faults and fractures which reveal clear effect in the old rock units outside the study area.

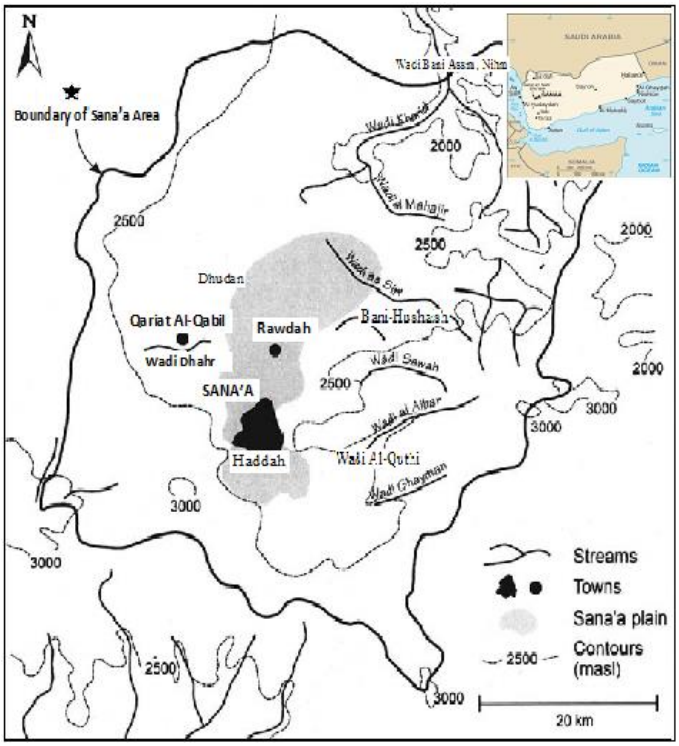
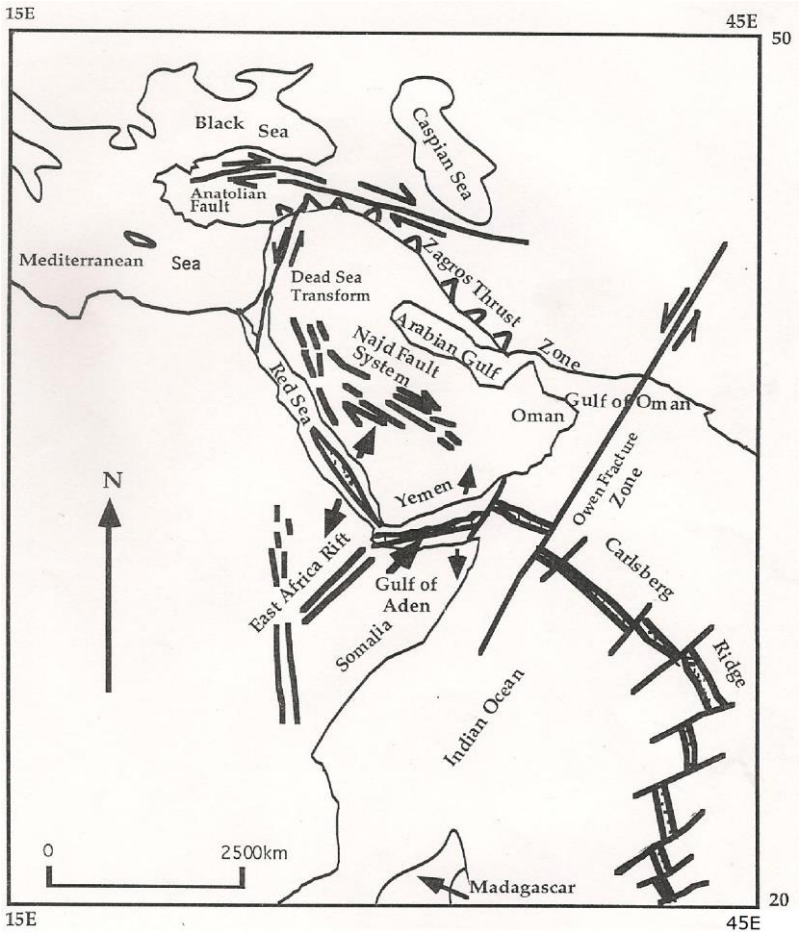


Figure (1): Location map of the study Area (Modified After Richard Helmer and Ivanildo Hespanhol, 1997 & WEC, 2001)

Strike Slip Faults

It is not easy to recognize the strike slip faults in the Sana'a area because of the intensive extensional faults dissecting the Tertiary volcanic rocks and the similarities of the rock units. Also there is no contrast in lithologic rock units or marker beds to recognize the horizontal displacement. However, from several field trips and detail survey, horizontal striations are observed and recorded in several locations within the Sana'a basin; these

horizontal striations are recorded in the Tertiary outcrops in the Sana'a zoo and in Khawlan area while vertical slickensides are recorded in the Cretaceous Tawilah sandstones in Wadi Dhahr area (Plate 2.B). These slickensides are strong support to our view that, Sana'a anticline is just an accommodation structure with strike slip faults. The horizontal movement has an E-W direction and the Sana'a anticline is formed an oblique to the major strike slip fault. Further evidence for horizontal movement probably support by the occurrence of the folds formed in different locations in volcanic rocks such as the recognition of thrust faults which recorded in Naqil Yasleh area. All these evidences indicate that the area is subjected to compressional tectonic which reflected in present of strike slip fault.



Figure(2): Regional Tectonic Map of the Arabian Plate, (After Al-Kotbah 1996).

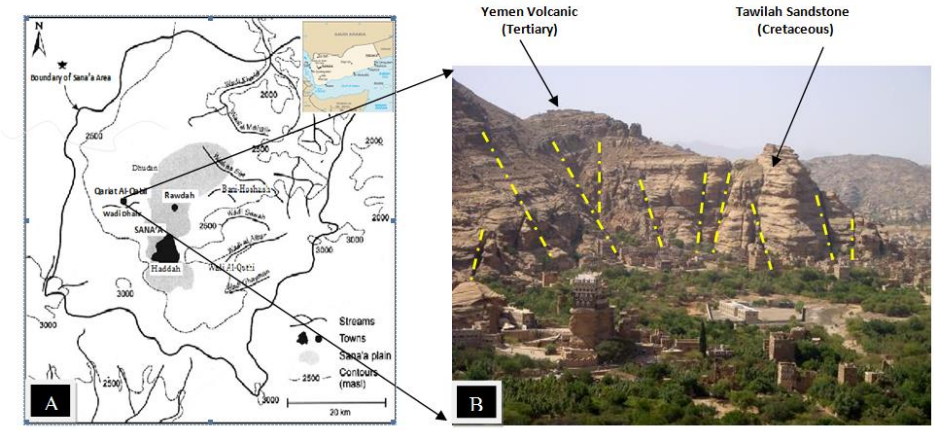


Plate 1.

A. Map showing the major features of the Sana'a basin, (After Richard Helmer and Ivanildo Hespanhol, 1997)
B. Panoramatic view of the Tawilah Group, at Wadi Dhahr Indicate the main fractures along the succession.

Folds

In general, Sana'a Basin as a part of the whole Yemen plateau is subjected to compression uplift during the late Tertiary time and the Sana'a anticline is formed as accommodation structure associated with strike slip fault. The Sana'a anticline is most likely related to horizontal movement and is just an accommodation structure associated with major tectonic movement. The Sana'a anticline is of N-S axis and plunging to the south with steep dip. The locations of fold axis in most areas of the Sana'a basin are eroded away and represent the Sana'a plain now. The anticline of Sana'a area is of symmetrical type with low angle of two limbs. In the north, the fold axis becomes horizontal such as in Thomah and Arhab areas. In addition to this big fold, there are small folds associated with extensional faults as resulting of tilting blocks and local compression (Al-Subbary, et al., 1999).

GEOMETRICAL ANALYSIS OF FAULTS AND FRACTURES

Detailed analyses of faults and fractures have been carried out to deduce their geometrical structures and trend of extension. The strike and dip of fault and fracture planes were measured using the Brunton compass. More than sixty fault and fracture planes are measured in addition to the major faults mapped. The plotting of fault and fracture planes are plotted as poles on the lower hemisphere equal area net (Fig. 5), by using the computer program, the Fabric, version 1.8 (Strakcy, 1977). The plotting shows four trends of faults and fractures detected in the area. The dominant Trends of faults are NW-SE and ENE-WSW and these trends are most probably synchronous with the rifting of the Red Sea and the Gulf of Aden. The other two trends are rejuvenated from old tectonic movements such as the N-S and the NE-SW direction. All these faults and fractures show very steep to moderate dips which may indicate these faults and fractures extend to a great depth. Some faults and fractures are passages of igneous dykes of different compositions. The slip

movement of these faults is very steep. The principal stress axis is nearly vertical with occasional slight oblique component.

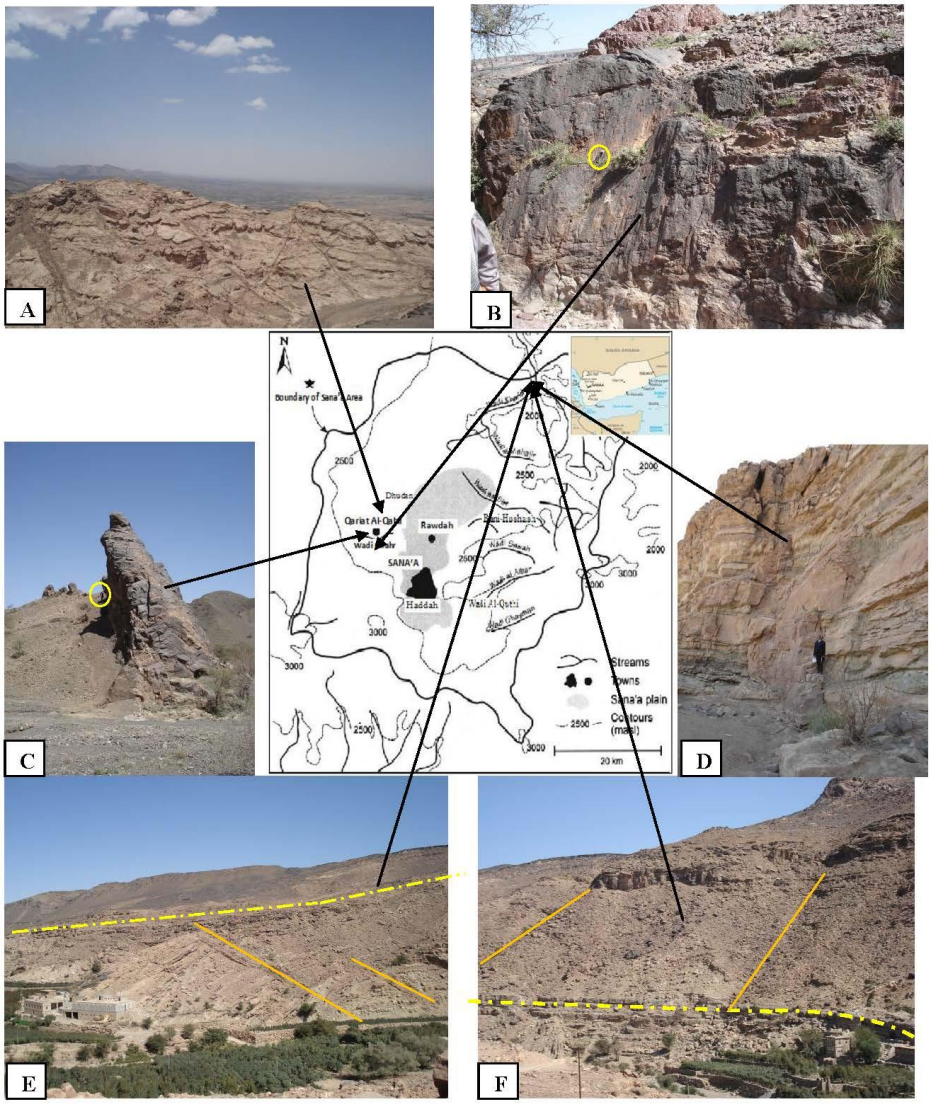


Plate 2.

A) Deferent trends of fractures in Dhudan Area, Hamdan. **B)** Vertical slickenside's, Tawilah Group in Wadi Dhahr. **C)** Basaltic dyke intruded the Tertiary volcanic in Wadi Dhahr, Hamdan. **D)** Escarpment of normal fault resulted in the uplift of Amran Group in Wadi Bani Assim. **E)** The contact between the Amran group and Tertiary volcanic rocks reveal normal faults affected in Amran Group in Wadi Shaiban, Nihm. **F)** Escarpment due to normal fault resulted in the exposed of Tawilah Group and Amran Group in Wadi Bani Assim, Nihm.
Yellow circle shows the scale

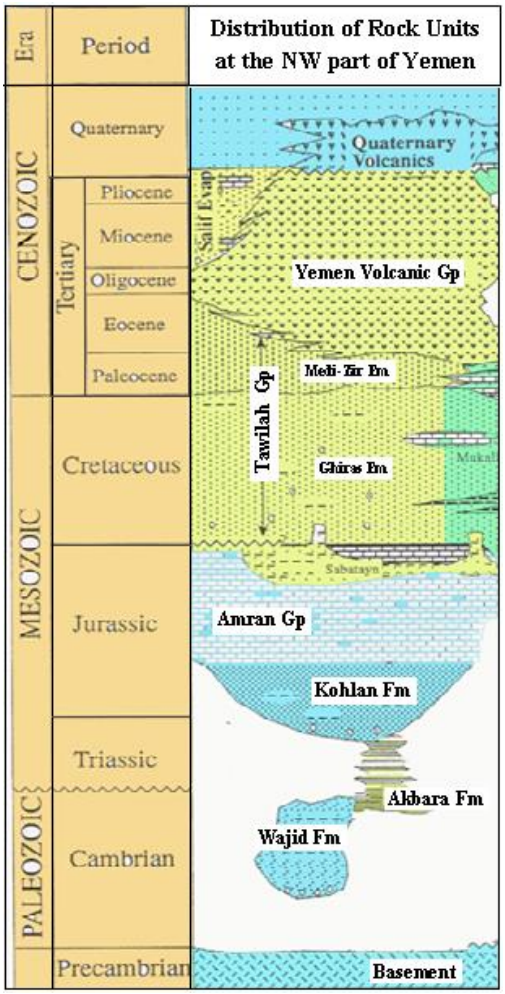


Figure (3): Simplified Stratigraphic Sequence of NW Yemen (After Al-Subbary 1995)

The stratigraphic sequence of the Sana'a basin is obtained from previous field studies and data. The stratigraphic sequence ranges in age from Precambrian to Recent with some periods missing. The Phanerozoic rocks of the Sana'a basin mainly consists of sedimentary and volcanic rocks. The sedimentary rocks in the Sana'a basin are exposed as outcrops ranging in age from Jurassic to Quaternary, while the subsurface data reveals the occurrences of the Precambrian rocks as in the Arhab well. The stratigraphic column (Fig.3) summarized the different rock units of the NW Yemen. The Kohlan Formation is a siliciclastic unit and is exposed in the Jabal Salab (Al-Wosabi, 2001 and Al-Wosabi, & Wasel, 2010) in Nehim area, and recorded in Sana'a basin from subsurface data of Arhab and Al-Hatarish wells (Fig.6 & 7). The maximum thickness is about *45-50m* thick (Sawas, 1996), and ranges in age from lower to middle Jurassic (Bydoun, 1982, Diggens, et al., 1988). The Kohlan Formation consists of course to medium grained sandstones together

with, conglomerates in the lower pan with interbedded shales and siltstones with plant remains. It is light grey to white or pinkish in color and it fines upward and passes conformably into carbonates of the Amran Group (Geukens, 1966)

The Middle Jurassic-Early Cretaceous rocks, represented by the Amran Group exposed in the northern part of the Sana'a basin as in Thomah area and Naqil bin Ghaylan. This group consists mainly of limestones and gypsum with intercalated shales in some horizons as in Wadi Al-Ahjur Formation. Throughout Sana'a area the Amran Group is recorded from subsurface only and at different depths depending on the vertical displacement of faults (Fig.7). The thickness of the Amran Group ranges from 320m in the northern part of Sana'a basin to 100m thick in the southern part as recorded in well DS1 & DS2 (Fig.6). Most recent aquifer delineation study of Sana'a Basin carried out by Hydrosult, 2010, indicated that the thickness of Amran Group decreases as we move toward south. This can be probably confirmed the southern edge of the Basin. This thickness decrease of Amran Group indicates the edge of the basin.

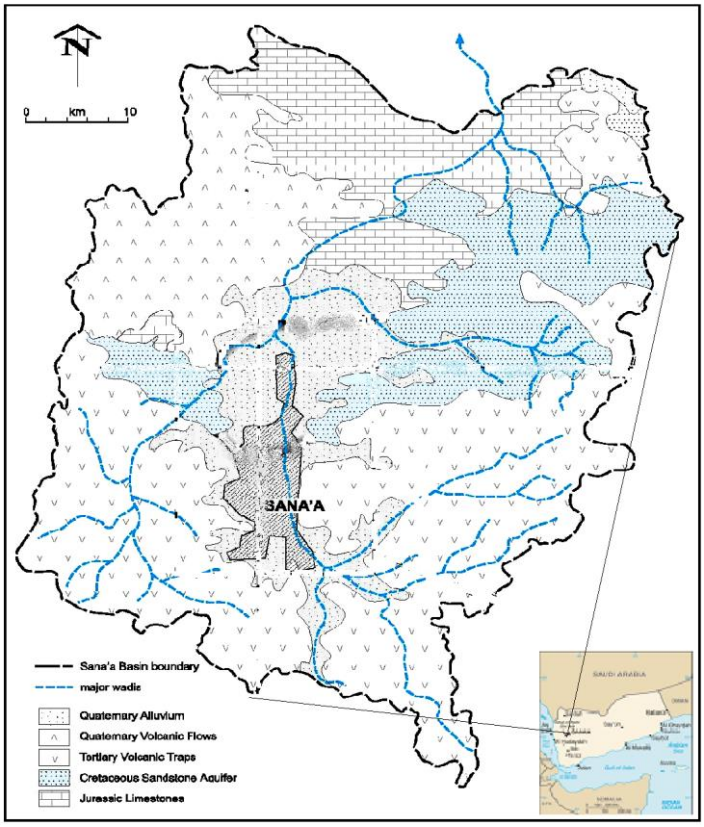


Figure (4): Regional Geology of the Sana'a Basin (after Stephen Foster et al 2003).

Figure (5): Stereonet plot of Fault trends of Sana'a Basin

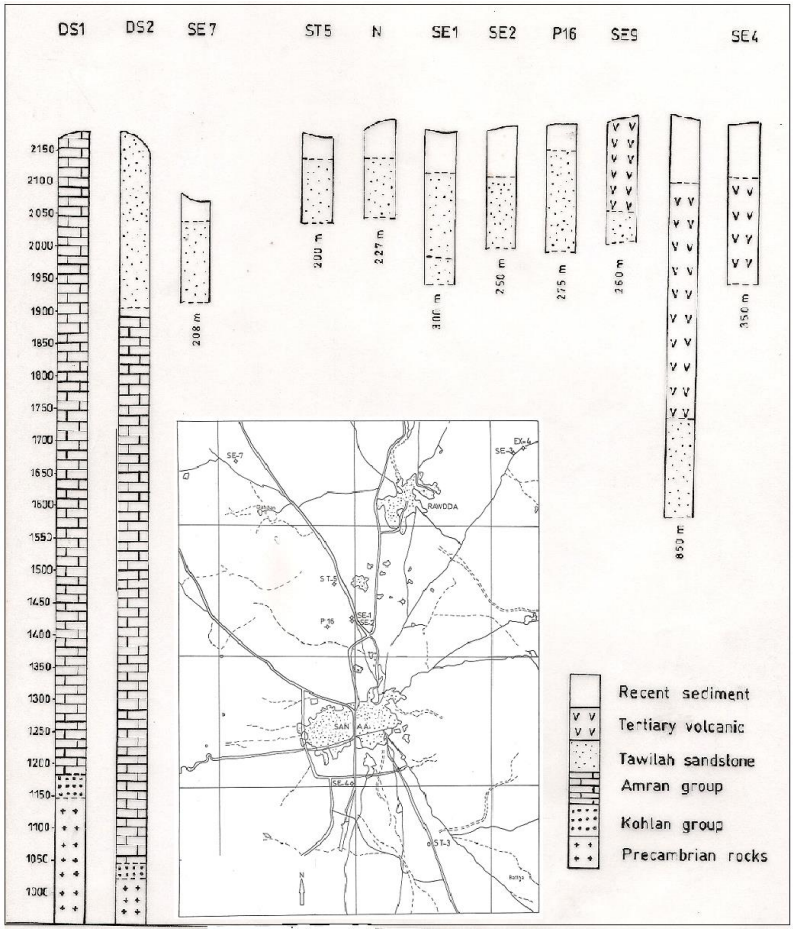


Figure (6): Subsurface lithologic logs of boreholes in Sana'a Basin along with location map. (Based on Kruscman, 1996).

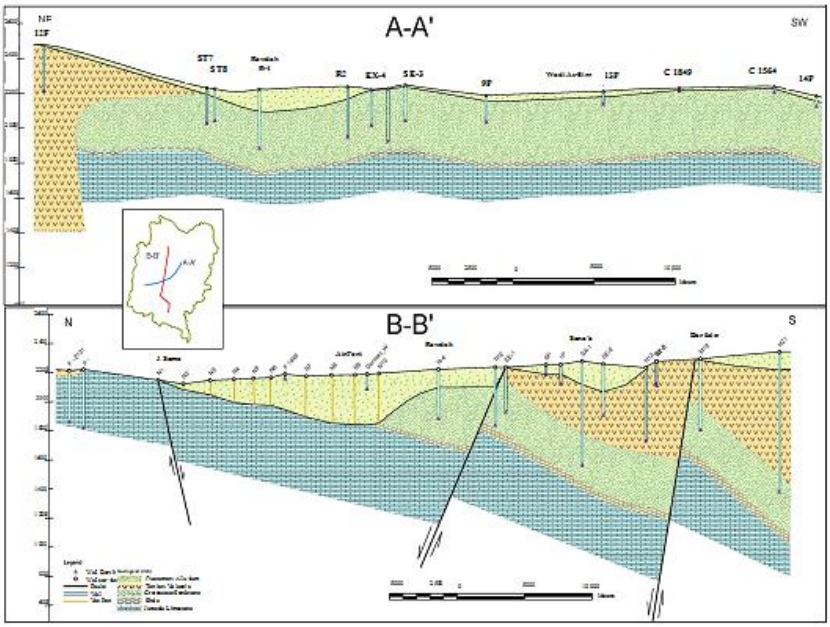


Figure (7):Hydro-geological Cross-Section across the Sana'a Basin, (After Hydrosult, 2010)

Stratigraphic Sequence in the Sana'a Basin

The age of the Amran Group is middle Jurassic-Early Cretaceous (Geukens, 1966 and El-Anbaawy (1985). The principal lithofacies is well cemented, limestone and dolomite intercalated with marls and shale containing macro and micro fossil. These fossils include skeletal marine mollusks, echinoderms, coral reefs, stromatoperids and foraminifer (Lamare, et al., 1930). El-Anbaawy, 1985 described very distinctive interval algae-rich in the Amran Group and named it Wadi Al-Ahjur Formation which represents the beginning of sea regression.

The queries in the Amran Group are particularly evaporating dominant in the Sabatain Formation (Bydoun, 1964, El-Anbaawy, 1985, which is raised to group by Al-Thour 1992). It consists of salts and lenses of gypsum with interbedded with marls and shale (Fig.3).

The Tawilah Group is a clastic dominated sequence exposed in a large area around Sana'a region, especially the northwestern part as in Wadi Dhahr and in the northeasterner part of the basin such as in Bani-Hushaish area (Fig.4). The age of this group ranges from Late Cretaceous to Eocene (Al-Subbary, et al., 1993). The thickness of the Tawilah Group reaches to more than 400m thick in the Al-Ghiras area and thins westward to 150m which may point toward the source area (Al-Subbary, 1995). Beds with a nodular texture and distinct multicolored horizons indicate that pedogenic processes were responsible for important hematite concentration in the uppermost paleosol accumulations of the Tawilah Group (Al-Subbary, et al, 1998).

The Tertiary volcanic is called as Yemen Volcanic Group which consists of alternating lava flows of basalt, andesitic or trachyitic porphyries. These Tertiary volcanic rocks formed today the Yemen plateau which reaches to more than 3660m above sea level such

as Jabal Al-Nabi Shuaib to the west of the Sana'a. All studies reveal that the Yemen volcanic are occurred as series of eruptions during stages of volcanic activity, and thickness is excess to 2000m thick, while some different studies determine the age of Yemen Volcanic and give wide range of Oligo-Miocene age, (Menzies et al., 1991, Baker, et al., 1993 and Al-Kadasi, 1994). The Quaternary volcanic rocks are dominated by alkali basalt. It occurs widely in the study area and particularly to north and northeastern part, and the age determination is about 5ma (Al-Kadasi, M., 1994). The Quaternary volcanic can be recognized two types of eruptions; the first eruption involves the cinder cones eruption which is explosive type volcanic, and are found in the north and northern part of the Sana' a basin (Fig.4). The second eruption is the lava sheet rocks and occurs along the Sana'a-Amran road to the northwest part of the Sana'a basin. The Quaternary deposits are mainly alluvial sediments and conglomerates which reach in thickness to more than 30m thick in the middle of the Sana'a basin such as in the Sana'a university campuses

Historical Evolution of the Sana'a Basin

Historical evolution of the Sana'a basin started in early Cambrian following the old tectonic trend in the N-S and NW direction. These two trends were probably reactivated from Hijaz and Najid orogenies representing the oldest and dominant tectonic trends affected Yemen and the Arabian Peninsula (Al-Kotbah, 1992). During the Cambrian-Ordovician, the initial main trend of the Sana' a basin has formed and the continental clastic sediments were deposited the Kohlan Formation. During the Jurassic time subsidence increased and formed deep depression of NW-SE trend. During this time the Amran group was deposited given rise to a thickness of more than 1600m as measured in Arhab and Al-Hatarish wells (Fig.6). The main trend of the Sana' a basin parallels to the Al-Jawf-Marib basin which was probably belonged to the same age and both were formed by the same tectonic movement rejuvenated from the Najid trend (Fig.2), and this may require more detail studies. During the Cretaceous time the Sana' a basin was subjected to uplifting and received a lot of clastic rocks of Tawilah Group. Current study indicated that, both Amran and Tawilah Groups were affected by tectonic movement of E-W trend resulted in the formation of extensional faults such as the Wadi Dhaher and Al-Sabbeen faults (Al-Kharpy, 1996). This movement is recorded for the first time in the Sana'a basin based on field observations and subsurface data (Fig.7). The extensional faults, which strike E-W, are more likely a proof that the Gulf of Aden is an old trend and was formed before its opening.

Most probably the rift of Aden was formed during the Cretaceous time and had been an exposed continent receiving no sediments. The Wadi Dhahr faults were confirmed as having formed during late Cretaceous where they crossed cut the Tawilah Group prior to the development of the Tertiary Volcanics (Plate 1.B).

In general, Yemen was subjected to a major volcanic activity during the Tertiary time to a state-wide series of volcanic eruptions. This volcanic activity resulted in the formation of Yemen plateau which stands today to more than 3660m above sea level. However, the Sana'a stratigraphic sequence was intruded by these volcanic rocks and covered all old sedimentary rocks of the Sana'a area. At the final stage of volcanic eruption, the Sana'a area was subjected to a compression stage where the Sana'a anticline was formed whose axis trends N-S. This axis dies out in the north with steep plunge in the south, then another stage of extensional faulting resulted which shaped up the present area, and represents an extensional tectonic regime contemporaneous with the opening of Gulf of Aden and the Red Sea (Khanbari and Huchon 2010). This stage produced the most dominant structures

where it obscured all old structures. The extensional faults include the Haddah, Aser and Wadi Al-Quthi faults. The vertical displacement of Haddah fault reaches more than 300m. All these faults are striking E-W. However, a horizontal movement has affected the Tertiary volcanic in an E-W direction and was created by reactivated faults in this direction. After the volcanic quiescence these major faults and fractures were subjected to a late volcanic activity occurred where a lot of dykes and plugs (Plate 2.C) of different trends (the dominant trends are N-S, NW-SE and E-W) and composition have intruded all the stratigraphic sequence from Precambrian to the Tertiary rocks, along N-S fractures of the present area of the Sana'a city, the rocks were eroded away forming the intermountain plain of Sana'a Basin.

The quaternary post tectonic movement is accompanied by a volcanic activity intruded older rocks with a very distinctive morphology characterized by a distribution of scatter cones, cinders, dykes and plugs and occasionally spread as lava flow in the low lands.

Subsurface Geological Cross-Section

a. Northeast - Southwest Cross Section (A-A')

This cross-section has NE-SW direction and constructed based on data of well logs (12P, ST-7, ST-8, R-4, R2, EX-4, SE-3, EX-3, 9P, 13P, C1849, C1564 and 14p) (Fig.7 A-A'). It extends from Al-Maleka Village (Bani-Hushaish) located northeast of the basin to Wadi Hamadan located southwest of the basin. It shows the lithostratigraphical sequence of the geological units from the Jurassic Amran limestone at its base followed by Cretaceous Tawilah Sandstone Group and Quaternary Alluvial Deposits at its top. Tertiary Volcanic Flows exist at the northeast part of this cross-section.

The cross-section did not show any structural elements disturbing the different stratigraphical units. It shows the following aquifer system:

- Aquifer 1: Quaternary Alluvium
- Aquifer 2: Quaternary and Tertiary Volcanic
- Aquifer 3: Tawilah Cretaceous Sandstone and
- Aquifer 4: Jurassic Amran limestone

This sub-surface cross-section confirmed that:

- The alluvial aquifer has attained its maximum thickness at the area between airport and Al-Rawdaa and
- The geological sequence has been intruded by volcanic rocks at the south-western part of this cross-section.
- No structural element were detected along this cross-section as all the faults are of E-W direction

b. North –South cross section (B-B')

It is the most important cross-section. It has N-S direction and constructed based on data of well logs (F-2131, P, F1445, German well, R-4, TP2, SE-1, 6P, 1P, SE-1, SE-4, H12, ST-3, SE-5, M-18, HZ1) and geoelectrical data (Vertical Electrical Sounding VES, N_1 to N_{10}) (Fig.7 B-B'). It extends from Jabal Al-Sama (Arhab) on the North to Dar Salm on the South. It shows the stratigraphical sequence of the geological units from the Jurassic Amran limestone at its base followed by Cretaceous Tawilah Sandstone Group and Quaternary Alluvial Deposits at its top. The Tertiary Volcanic flows and Amran Limestone Group are exposed at the most northern part of this cross-section (i.e. beyond the limit of this cross-section).

A set of normal faults of approximately E-W directions have been detected along this cross-section. The first structural fault has been detected at the southern part of this section (Dar Salm Fault, south of Sana'a city). It is showing a down throw side toward north of about 350 to 400m. The second structural fault has been detected at the central part of the cross-section (Al-Jeraf Fault, North of Sana'a city**)**. The third structural fault has been detected at the most northern part of the cross-section (Jabal Al-Sama Fault). This fault is located at the contact between the recent alluvial deposits and the Jurassic Amran limestone.

It is indicated from the cross-section that these normal faults represent a full graben structure. This graben structure accommodates an appreciable thickness of the alluvial deposits especially at the area between Al-Rawda and Jabal Al-Sama.

As mentioned earlier, Sana'a basin was subjected to compression uplift during the late Tertiary time to form the Sana'a anticline. The Sana'a anticline is of n-s axis and plunging to the south with steep dip. The location of fold axis in most areas of the Sana'a basin is eroded away and represents the Sana'a plain recently.

This cross-section provides useful information and helped in resolving and confirming the following issues:

a. The use of the additional borehole logs and the geophysical resistivity (vertical electrical sounding ves) data confirm that the tawilah sandstone aquifer has been completely eroded at the area located between the airport and al-rawdaa.
b. The sana'a basin has been subjected to tectonic activities which play a major role on the hydro geological regime.
c. The cross-section indicated that the sub-surface as well as surface faults are having the trend.

SUMMARY AND CONCLUSION

This paper discussed and investigated a basis for prediction of subsurface structures within the Sana'a basin which is suitable for the containment of the main source for drinking water of the Sana' a city. However, the understanding of the tectonic setting within the Sana'a basin is of high importance, since such a study has proved beneficial and received much attention in the last few years. This study is considered the first attempt to establish a detailed structural study. Stratigraphically, the Sana' a basin has a geological column ranging in age from Precambrian to Recent. These stratigrathic units from top to bottom as follow:

Quaternary (volcanic rocks and wadi deposits)
Tertiary volcanic (sheeted volcanic and basal basalt)
Tawilah Group (clastic rocks)
Amran Group (carbonate rocks)
Kohlan Formation (clastic rocks)
Precambrian rocks (Basement rocks).

Four tectonic movements are recorded from field relationships and structural analysis of the faults and fractures in addition to correlation of units. These are summarized as follow:

1. The Jurassic tectonic movement resulted in the formation of the Sana'a basin. This tectonic movement is a reactivation of the old trend of the Najid fault system. The

formation of the Sana' a basin is contemporaneous with the formation of the Marib-Al-Jawf basin of NW-SE strike.

2. The second tectonic movement occurred during the Cretaceous time with an E-W trend. It is herein proved that this trend had existed prior to the opening of the Gulf of Aden.
3. The third tectonic movement affected the Sana'a basin, is the volcanic activity that had occurred during the Tertiary time and resulted in the formation of Yemen plateau.
4. The fourth tectonic movement accompanied by a volcanic activity took place during the Quaternary time where all older rocks were injected by dykes and plugs of different trends and is still active now.

The use of the additional borehole logs and the geophysical resistivity (vertical electrical sounding) data in the subsurface geological cross section confirm that the tawilah sandstone aquifer has been completely eroded at the area located between the airport and al-rawdah as clearly indicated in cross-section b-b'.

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التتايع الطباقي والتطور التكتوني في حوض صنعاء

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ملخص

التتابع الطباقي للصخور في حوض صنعاء تتراوح أعمارها من عصر ما قبل الكمبري إلى العصر الحديث، مع غياب بعض الفترات . ونجد بأن المكاشف الصخرية في حوض صنعاء تتراوح أعمارها بين الجوراسي إلى الرباعي، في حين أن البيانات تحت السطح يكشف عن وجود صخور هي من عصر ما قبل الكمبري.

هذا البحث يناقش التطور الترسيبي والركيبي في حوض صنعاء والذي يشير إلى أن المراحل التكتونية المهمة وقعت خلال العصر الجوارسي ، الطباشيري ، الثلاثي وكذا العصر الرباعي، حيث الآثار التركيبية لهذه المراحل التكتونية تتضمن مراحل حركة الرفع والإنخفاض مرات عديدة، ومع ذلك فقد تكون حوض صنعاء خلال العصر الجوراسي تحت سيطرة البنيات الموروثة من العصور القديمة ومن ثم أعيد نشاط التحكم البنائي من الاتجاه الشمالي – الجنوبي القديم.

لقد أكدت الدراسات الميدانية بأن حوض صنعاء قد تعرض لمرحلة ضغط خلال عصر الباليوسين والتي أسفرت عن ظهور طية محدبة محورها يأخذ إتجاه شمال – جنوب. وفي نهاية عصر الباليوسين تأثرت المنطقة بالصدوع والشروخ الإمتدادية ليظهر إنخساف نصفي مثل الإنخساف النصفي لوادي ظهر ، والإنخساف النصفي لمنطقة حده، أما خلال العصر الثلاثي فقد تأثرت منطقة صنعاء بنشاطات بركانية ضخمة لا سيما في الجزء الجنوبي من حوض صنعاء لتشكل هضبة اليمن ، ومن ثم تعرضت المنطقة مرة أخرى لنشا ط تكتوني متأثرا بالمرحلة الإمتدادية التي تزامنت مع الإتجاه السائد شمال جنوب – شمال غرب وكذا مع الإتجاه شرق شمال شرق—غرب جنوب غرب. لذلك فإن معظم هذه الصدوع والشروخ قد إمتلاءت بالسدود البركانية بمختلف التركيب المعدني. وفي فترة العصر الرباعي حدث نشاط بركاني آخر نتج عنه تشكيل الكثير من الرقاب البركانية والمخاريط التي اقتحمت وحدات الصخور القديمة.

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Characterization and Solution Properties of Poly(Methyl Metha-Acrylate) – Poly(Ethylene Glycol) Blends

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ABSTRACT

Measurements of viscosity of poly methyl methacrylate (PMMA)/poly ethylene glycol (PEG) blends in tetra hydro furan (THF) as a common solvent, were carried out for different blend compositions at 30, 40 and 50°C. Using the viscosity data, interaction parameters μ were computed to determine miscibility. These values revealed that the blend was miscible when the PMMA content was more than 30% of the blend. Further, the results revealed that the change in temperature has significant effect on the miscibility of PMMA/PEG polymer blends. The simple of (PMMA/PEG) blends were characterized by using (FTIR).

1. INTRODUCTION

During the last two decades, the phenomenon of inter-diffusion in miscible polymer blends has been the subject of many investigations and is of interest for several applications such as welding and blending of polymers [1]. When two miscible polymers come into contact with each other, mutual diffusion across the interface between the two polymers may occur.

In general, polymer-polymer interactions are small and the polymer coil volume is determined by polymer-solvent thermodynamic interactions [2]. viscosity probes the interaction of molecular structure with the solution. Several theories in polymer physics literature[4] The viscometric method used successfully in compatibility characterization of poly blends. It is the low cost, and rapid techniques to study the miscibility of polymer blends. [6,7] by this techniques was studied thermodynamics and interaction to alt of mixed of polymer blends [3,8,9] in order to make two mixed polymers. we make them have less energy when mixed than they would be separated.

In this study, we measured the viscosity of poly methyl methacrylate (PMMA)/poly ethylene glycol (PEG) blends in tetra hydro furan (THF) as a common solvent, for different blend compositions at 30, 40 and 50°C. with

the help of viscosity data available to us, interaction parameters μ were computed to determine miscibility. The simple of (PMMA/PEG) blend and unblends were characterized by using (FTIR).

2. Experimental section

2.1. Materials and solution preparation.

Poly(ethylene glycol) (PEG) with an average molecular weight of 3500-4500 and melting point (mp=58-64°C) was supplied by Scharlu, Poly (methyl methacrylate) (PMMA) of molecular weight 35×104 by Aldrich. Tetra hydro furan (THF) by Aldrich with purity 99.9% HPLC grade was used as reagent grades and used without further purification. The polymer solutions were prepared by dissolving 0.5g of each polymer separately in 100 ml THF from these solutions were prepared different concentration for each polymer in within the range from 0.2 to 0.5 (g/dl) of polymer. The polymer blends were prepared by solution casting using THF as solvent. (PMMA/PEG) were blended in several weight percent ratios and dissolved in THF. The solutions were stirred overnight and then poured into glass dishes and allowed to evaporate slowly at room temperature.

2.2. Viscosity measurements [4,8,12].

The viscosity measurements were carried out using a conventional Ubbelohde viscometer that was placed in a thermostatically controlled bath with a precision of 0.01°C. Measurements were initiated after approximately 5–10 minute equilibrium time. The flow times were determined from an average of several readings (more than 3 readings). All the viscosity measurements were performed according to the following specially designed experimental procedures.

The efflux time t0 minute of pure solvent THF recording at different temperatures 30, 40 and 50°C,with repeated the t0 minute(3 times).

Then 15 ml from 0.5 (g/dl) of the polymer solution (PEG in THF) was transferred into viscometer and the flow time(t) minute for solution recorder in temperature water-bath (30,40 and 50°C). The experiments were repeated by 15 mll with PEG(0.4, 0.3and0.2) (g/dl) separately as the same 0.5 (g/dl) solution. The flow time (t) of PMMA solutions were measured as the same way.

15 ml of this solution [70/30]concentration 0.5 (g/dl) was transferred into viscometer in constant temperature water-bath(30°C). The flow time minute blend recorder with repeated this process (3 times). The experiments were repeated(4 times) by diluting blend solutions by adding (5 ml of solvent THF each time to obtained the flow time of dilute blend solutions (0.4,0.3 and 0.2) (g/dl) for [70/30] at the same temperature degree. The experiments were repeated at (40 and 50°C)by the same way. Then the other ratios with different concentration and different temperatures(30 , 40 and 50°C) carried out such as first ratio.

2.3. FTIR Analysis.

Fourier Transform Infrared Spectroscopy (FTIR) method applies to characterize vibrations in molecules by measuring the absorption of light of certain energies that correspond to the vibration of the molecules from low to high frequency. FTIR spectra of polymer blends carried out by (Varian 800 FT-IR Spectrometer, Scimitar) with KBr pellets at room temperature .

3. RESULTS AD DISSECTIONS

Solution Properties.

Thermodynamic quantity of polymer concentration be obtained by intrinsic viscosities, [η] by plotting the reduced viscosity (dl/g) of polymer solutions against concentration (g/dl) .The measured values of reduced viscosity data for PMMA, PEG in THF and their blend ratios (70/30, 60/40, 50/50,40/60 and 30/70) at 30, 40 and 50°C , are given in tables1,2 and 3 respectively.

The plots of reduced viscosity versus concentration (g/dl) for the pure components and their blends solutions at 30, 40 and 50°C , refer to figures 1 ,2 ,3.

Intrinsic viscosity [η]and Huggins Coefficient KH are determined from taking intercept and slop these values show in table 4. The values of KH take rang 0.024-0.37 their according to literature [5].

Table (1): Reduced viscosity data for PMMA, PEG and their blends in solution at 30ºC.

Conc. g/dL	(PMMA/PEG) composition ratios in solutions at 30ºC.						
	PMMA	PEG	70/30	60/40	50/50	40/60	30/70
0.5	0.926	0.122	0.68	0.62	0.54	0.46	0.35
0.4	0.919	0.121	0.65	0.59	0.52	0.44	0.33
0.3	0.909	0.118	0.62	0.55	0.49	0.41	0.31
0.2	0.899	0.115	0.58	0.52	0.47	0.39	0.29

Table (2): Reduced viscosity data for PMMA, PEG and their blends in solution at 40°C.

Conc. g/dL	(PMMA/PEG) composition ratios in solutions at 40ºC.						
	PMMA	PEG	70/30	60/40	50/50	40/60	30/70
0.5	0.910	0.108	0.64	0.58	0.52	0.44	0.32
0.4	0.897	0.107	0.61	0.55	0.49	0.42	0.31
0.3	0.879	0.102	0.58	0.52	0.48	0.40	0.30
0.2	0.838	0.099	0.53	0.48	0.46	0.37	0.28

Table (3): Reduced viscosity data for PMMA, PEG and their blends in solution at 50°C.

Conc. g/dL	(PMMA/PEG) composition ratios in solutions at 50ºC.						
	PMMA	PEG	70/30	60/40	50/50	40/60	30/70
0.5	0.894	0.098	0.60	0.54	0.46	0.40	0.30
0.4	0.879	0.092	0.57	0.50	0.44	0.38	0.29
0.3	0.849	0.084	0.54	0.47	0.41	0.35	0.28
0.2	0.804	0.079	0.49	0.43	0.39	0.32	0.26

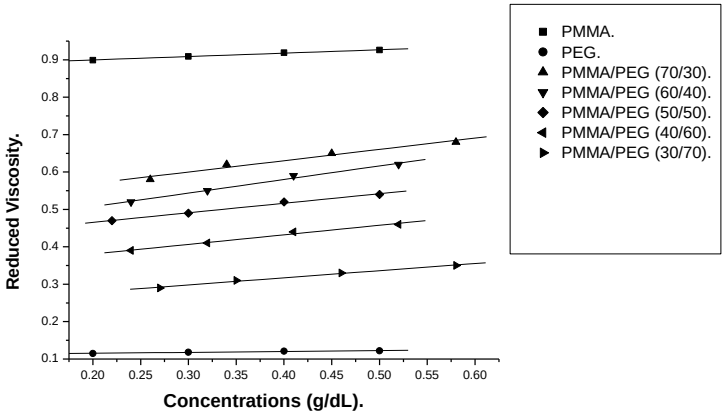

Figure (1): Reduced viscosity versus concentration (g/dL) for PMMA/PEG blend solutions at 30ºC.

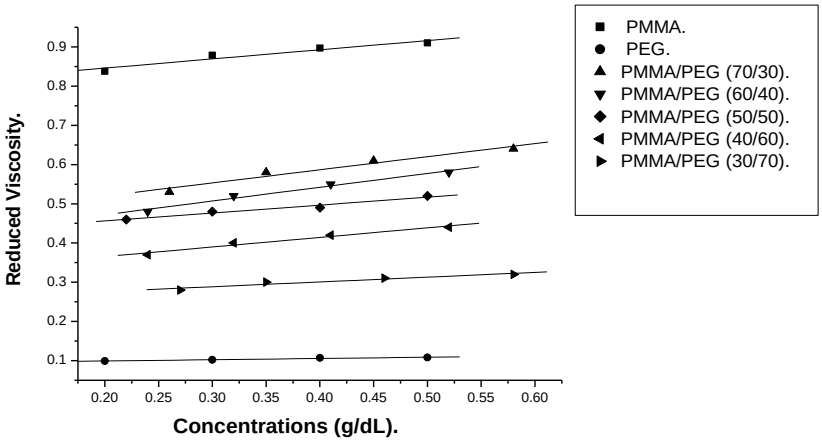

Figure (2): Reduced viscosity versus concentration.(g/dL) for(PMMA/PEG) blend solutions at 40ºC.

Table (4): The Huggins constant KH and Intrinsic viscosity[η] at different temperatures.

Conc. g/dL	(PMMA/PEG) composition ratios in solutions at 50ºC.					
	K_H	[η]	K_H	[η]	K_H	[η]
100/0	0.091	0.8814	0.234	0.7991	0.3000	0.7515
70/30	0.308	0.5123	0.329	0.4595	0.3044	0.4319
60/40	0.355	0.4449	0.338	0.4106	0.3763	0.3528
50/50	0.227	0.4275	0.173	0.4303	0.2441	0.3420
40/60	0.245	0.3349	0.240	0.3215	0.2849	0.2581
30/70	0.180	0.2469	0.126	0.2536	0.1310	0.2351
0/100	0.024	0.1106	0.032	0.0928	0.0650	0.0655

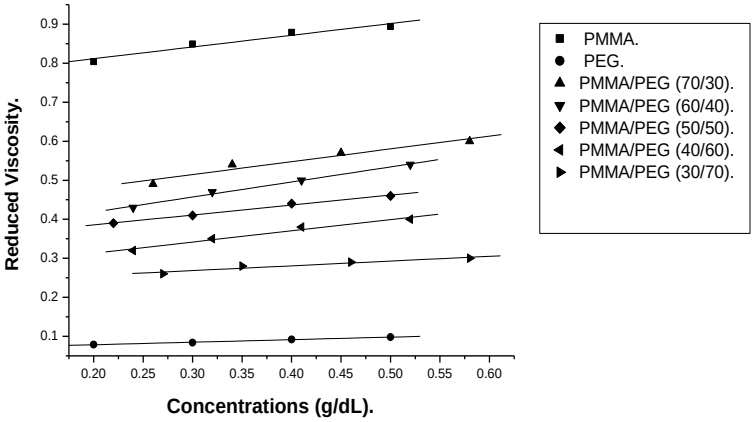

Figure (3): Reduced viscosity versus concentration (g/dL) for (PMMA/PEG) blend solutions at 50ºC.

values of intrinsic viscosity and Huggins constant were obtained in this way illustrated in table 4. From this data, it can be observed the intrinsic viscosity for PMMA,PEG,PMMA/PEG decreases for all the three systems with temperatures and that the intrinsic viscosity remains less than PMMA and higher than PEG throughout the investigated temperature.

A general decrease in intrinsic viscosity with temperature observed in both,(table and figure 2), is due to decrease in interactions of polymer with solvent as the quality of solvent deteriorates at this temperature.

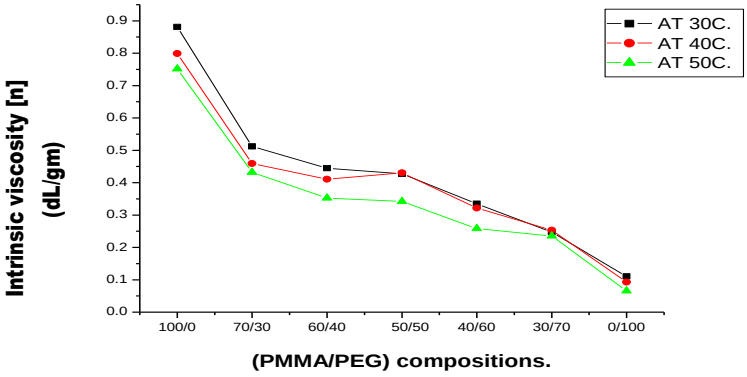

Figure (4): Intrinsic viscosity versus composition ratios at different temperatures.

Using these values, Chee[6] defined a more effective interaction parameter, as follows:

$$\mu = \frac{\Delta B}{\{[\eta]_2 - [\eta]_1\}^2} \quad \text{.....(1)}$$

where [η]1 and [η]2 are the intrinsic viscosities for the pure component solutions.

The blend is miscible when (μ >= 0) and immiscible [12] when(μ < 0). The values of μ calculated with the preceding expression at 30, 40 and 50 ºC are represented in table4.

Table (5): Interaction parameters μ of PMMA/PEG blends at 30, 40 and 50°C.

Compositions PMMA/PEG	Interaction parameter (μ) .		
	At 30 ℃	At 40 ℃	At 50 ℃
70/30	0.422329	0.394599	0.259139
60/40	0.502328	0.394599	0.259139
50/50	0.285626	0.081806	0.130961
40/60	0.316882	0.214769	0.217660
30/70	0.207731	-0.0135509	-0.1094144

The relation between the interaction parameters (μ) and intrinsic viscosity[η] are inverses according to equation(1), which explained why the value of(μ)to ratios (50/50) and(30/70) decreases with small arise for intrinsic viscosity[η] at (40ºC) which can also be observed in table 4.

In general, the results of interaction parameters (μ) in table5 enhancing and confirm that (PMMA/PEG)blend in solutions may be miscible for all ratios which were investigated.

Fourier Transform Infrared Spectroscopy (FT-IR).

Comparing figure 5 , and with figure(6 a,b,c) we are observed in region (C=O) of blend splits into two separate modes at (1734-1730)cm-1 and (1637)cm-1. As the similar in the region of O-H where small peak arise in the wide bands at (3517)cm-1 and (3440)cm-1. As its clear that the two regions in C=O stretch may be assigned to the native and loosely associated states. The carbonyl group, which is absolutely free from association, can have an absorption peak at 1730cm-1 [10]. The shoulder at 1637cm-1 corresponds, most likely to the hydrogen bond between oxygen atoms in PMMA units and PEG hydroxyl groups. The oxygen atoms in ester groups can also associate with PEG terminal -OH groups [10]. The most energetically favorable of hydrogen bonding through the oxygen atoms and C=O with OH groups of PEG in the blend PEG / PMAA-co-EA and PEG/PVP system has been explained with more details in previous literature[10]. In the spectrum of PMMA/PEG blend (1:3) the bands at the same region 1637 cm-1 possess low intensities compared with that (1:1 and 3:1).

That was maybe attributed to increased intra H-bonding between PEG chains with increased the amount of PEG in blend.

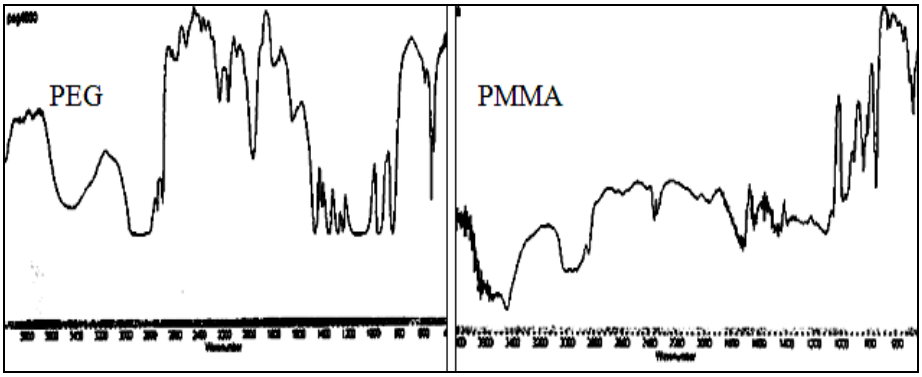

Figure5 FTIR spectrum for both the pure PEG,PMMA.

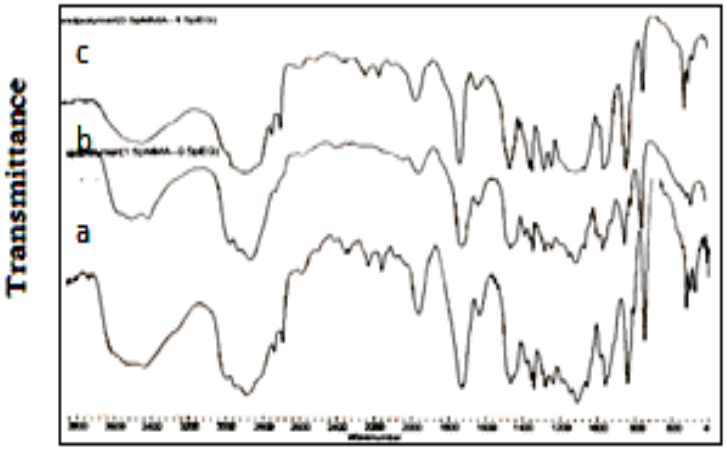

Figure 6 FTIR spectrum of (a, b, c)(1:1, 3:1 and 1:3)ratios of (PMMA/PEG)blends.

CONCLUSION

From the experimental data by Using viscosity, it has been shown that the thermodynamic affinity(similarity - suitable)of the solvent for the polymer affect the flexibility of the polymer chains, degree of aggregation of chains and the structure of the solutions effect the viscosity of solutions. The shape of the reduced viscosity versus concentrations curves is similar to those for the homo polymers and it is possible to predict the intrinsic viscosity of blends from those of the constituent polymers. In the case of blending, it is concluded that various ratios and concentrations of polymer blend systems has been found ,in generally, miscible or compatible mixtures as judged from the linear behavior of the reduced viscosity versus concentrations plots and from the absence of crossover over the whole range of ratios and concentrations at temperature has been confirmed. Observed Interaction parameters(μ) confirmed the polymer blend compatibility. It is also concluded

that the viscometry is simple technique determine the miscibility or compatibility of the polymer blend.

The different size of spheres indicating to still interaction effect with PMMA. That's confirmed by appeared newly peak and shifted the wave numbers for other peaks in FT-IR spectrum

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تشخيص ودراسة خصائص المحاليل لخليط من بولي اثلين جليكول وبولي ميثيل ميثاكريلات

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ملخص

تم في هذا البحث قياس اللزوجة لمخلوط بوليمري لكل من بولي اثلين جليكول (PEG) وبولي مثيل ميثا اكريلات/(PMMA) في مذيب رابع فيوران الهيدروجين (THF) وبنسب مختلفة وعند درجة حرارة 30 و 40 و 50درجة مئوية ومن خلال بينات اللزوجة المختلفة , ومقياس التداخل μ بين البوليمرين ثم حساب مدى قابليتهما للامتزاج, وقد وجد ان قابلية الامتزاج للبوليمرين تزداد بارتفاع نسبة بولي مثيل ميثا اكريات عن 30% وان التغيرات في درجة الحرارة توثر تاثيرا واضحا على قابلية امتزاج البوليمرين , ايضا تم تميز هذه المحاليل ومدى تداخلها بالستخدام جهاز(FTIR).

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TUJNAS

The Antimicrobial Effect of Aqueous and Ethanol Extracts of Steams, Roots and Leaves of *Salvadora Persica* on Oral Microbes

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ABSTRACT

Fresh samples of *Salvadora persica* were collected from Hudiadah province at 23/2/2011 . They include steams ,roots, and leaves . The ethanolic and aqueous extracts were prepared as w/v . (2.5, 5, 10)% for three plants parts .
The microbial samples were collected from privet dentists clinics in Thamar province by mouth swab and mouth washing methods . *S. aureu s S. mutans*, , and *C. albicans* were isolated and a pure cultures were prepared to each microbes for farther studies .The effect of different parts of plant showed high antimicrobial activity of root extract followed by stem and leaves extracts and the antimicrobial effecacy concern positively with concentration. The ethanol extract showed more antimicrobial activity than hot water extract.

INTRODUCTION

The current alternative medicine give a good evedinces about the trust of using plants as antimicrobial agents and drugs. The WHO reported that 80% of world major part of the therapies involve the use of plant extract or their constituents(1).

Salvadora persica L. (Salvadoraceae) is one of these plants, which was used by Bablonians some 7000 years ago(2). According to World Agro Forestry Center(www.Agroforetrycenter.org.), *S. persica* is an evergreen shrub or small tree known as siwak or arak. Arak trees are widely spread in African, Asian & Medill east countries such as Algeria, Egypt, Ethiopia, Libya, Nigeria, India, Jordan, Oman, KSA, Syria and Yemen.

In general the plant prefers areas where ground water is readily available(3). In republic of Yemen, the plant grow natively especially in Al-Hodeida governorate.

Oral hygiene by using siwak stick is a part of Islam regime[3]. Sticks of siwak were prepared from roots or shoots and used as toothbrush[4]. Siwak sticks are useful physically due to their fibers and chemically because of their antimicrobial efficacy[5].

Water, ethanol, methanol, ethyl acetate and acetic acid were used as solvent to extract the effective chemical compounds from siwak sticks[6],[7]. The chemical compounds isolated from root sticks are 3benzel-isothiocyanate, saponins, tanins, silica, small amount of resin, trimethylamine and fairly large amount of alkoloidal constituents[8]. Lewis and Elvin-Lewis (1977)[9] reported a high content of minerals in the roots.

In vitro studies showed the antibacterial effects of many extractions from siwak sticks[5]. Aqueous extract has a fungistatic effect on *C. albicans*[10]. Al-Ali and Al-Lafi (2003)[11] reported that the leaves have benzyl nitrate and the stem has cineol as a main components. Anti-plasmodia effect of *S. persica* was reported by Ali *et al* (2002)[12].

Clinical studies in children have evaluated the efficiency of siwak as an oral hygiene tool among various population and find to be effective in removing oral deposits[13].

Although Arak is a well-known shrub in Yemen but the plant has not received much attention. The aim of this study is to detect the antimicrobial activity of aqueous and ethanol extracts of leaves, shoots and roots of native *S. persica* against oral microbes.

MATERIALS AND METHODS

1. Microbial samples

Fifty oral swabs were collected from patients of privet dental clinics in Thamar city in addition to ten normal samples. Mouth washing samples were collected to test the effect of plant extracts against oral microbes.

The swabs were cultured directly by streaking method on nutrient agar plates (90mm), then were incubated at 37 °C. The growing microbes were isolated, purified and identified following standard methods[14]. The yeast pure cultures were prepared on NA with chloramphenicol (250 mg/l) to avoid bacterial growth. Germ tube test was followed to identify *Candida albicans*[15].

Sterile distal water (10 ml) was used to prepare mouthwash samples which collected in sterile vials with wide mouth. Mouthwashing samples were used to explain the inhibitory growth effects of water extracts of root, shoot, and leaves on total microbes by colonies count method.

2. Plant extracts

Arak samples were collected from Al-Hodeida province, they include stems and roots sticks besides the leaves. Samples were washed intensively by tap water and were dried at room temperature for two days[16].

The samples were grounded by household grinding machine. The powder of each plant parts were used to prepare 2.5%, 5% and 10% (w/v) of boiling distal water and ethanol as a solvents. The plant extracts were purified by fine mish then sterilized by millipore filter papers 0.45μm.

The sterile extracts were used to prepare nutrient broth media in sterile test tubes. The media were inoculated by full loop of pure culture of *S. aureus*, *S. mutants* and *C. albicans*. After incubation at 37 °C microbial growth were tested in the test tubes indirectly as turbidity by spectrophotometer. Test tube with nutrient broth only was used as a control.

Hole plate diffusion method was followed to show the inhibition zones of each solvent extract against microbes. Ethanol extracts was prepared as in aqueous extracts.

THE RESULT AND DISCUSSION

All collected samples showed microbial growth on nutrient agar plates. Patient's swabs and mouth washing samples showed more intensive microbial growth than normal swabs.

Two species of bacteria and one yeast were isolated and identified. They were *Staphylococcus aureus* , *S. mutans* and *Candida albicans*. The three microbes are common in the samples.(Table-1)

Table (1): Occurrence % of the common microbes in (50)samples.

The microorganism	Occurrence%*
Staphylococcus aureus	82
S. mutans	60
Candida albicans	94

***Occurrence%= (no. of samples with microorganism/50)x100

According to the colonies count test(Fig-1), the recent study showed that roots extract give the highest inhibition zone for total microorganisms followed by shoot and leaves extractions. This results were confirmed by test of the microbial growth in broth medium, the highest turbidity (lowest absorption)-measured by spectrophotometer- was recorded when leaves extract was used to prepare the growth medium followed by shoots and roots extracts.

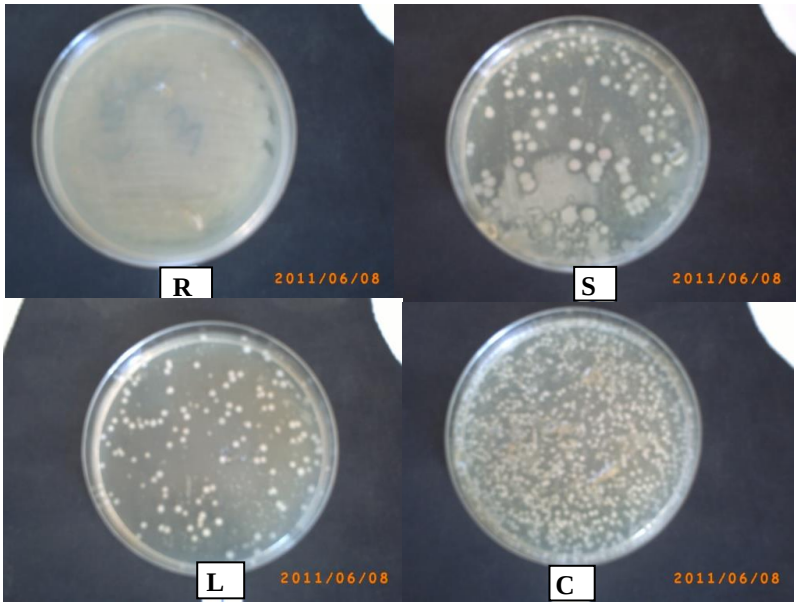

Figure (1): Effect of different plant parts on total microbial growth(R/root), S(stem), L(leaves), C(control).

Different compounds and their concentrations in roots, shoots and leaves may cause different inhibition levels. The extract of root showed the highest antimicrobial effect(fig.1-R) .It contain benzylisothiocyanate which is reported to have a broad spectrum bactericidal activity[20] and is the most potent[6] while stem extract gave a moderate effect(fig.1-S)

Leaves extracts inhibit microbial growth mildly in compare with roots and shoots extracts(fig,1-L), they have benzylnitrate as the main oil compounds which exhibit antibacterial activity[11]. The World Agroforestery Center (WAC) reported that decoction of leaves are used as mouthwash, and masticated leaves for tooth and gum problems[21].

To compare between ethanol and hot water extract on growth of isolated microbes, plant extracts were used to prepare the culture media . The results showed that the ethanol extract has highest antimicrobial activity than aqueous extracts against bacterial and yeast isolates (fig.2) Such effects may be related to several chemical compounds found in siwak sticks include trimethylamine, salvadorine (alkaloids), chlorides, fluorides, sulfur, V.C., tannins, flavenoids and sterols[1].

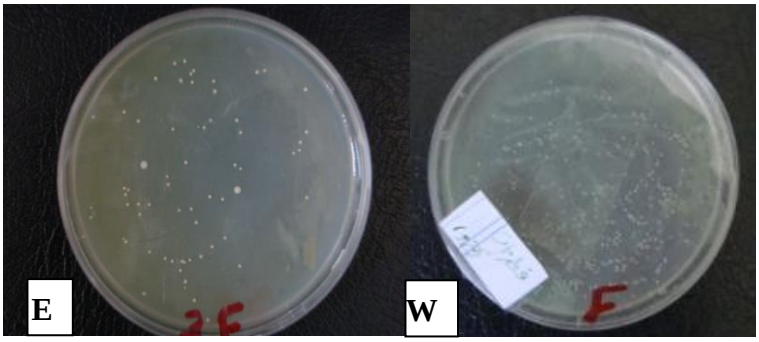

Fig.2- Effect of ethanol extract (E) and water extract (W) on growth of candida.

Alma (1993)[17] suggested that alkaloids present in *S. persica* is salvadorine which yield trimethylamine on hydrolytical cleavage, these compounds beside sulfur which present in siwak also have bactericidal effects [9,18].

The effect of aqueous extract of siwak against *C.albicans* which proved in current study agree with Al-Bayati and Suliman (2007)[2]. Tannic acid may caused such effect on *C. albicans*[3,19]. Ethanol extracts showed more effective zones than water extracts of *S. aureus*, *S. mutans* and *C.albicans* (Table-2) .

Table (2): The inhibition zone(mm.) of root(R),stem(S),leaves(L) extracts according to solvent and concentration.

Plant extract	Conc.%	*S.areus*			*S.mutans*			*C.albicans*		
		R	S	L	R	S	L	R	S	L
Ethanol ext.	2.5	4	3	1>	6	4	1>	4	2	1>
	5	10	6	3	11	5	3	7	3	1>
	10	13	8	3	18	7	3	11	7	4
Aqueous ext.	2.5	2	1>	1>	3	1>	1>	1	1>	1>
	5	5	2	2>	7	3	1>	5	2	1>
	10	8	5	3	12	7	2	6	3	2

Al-Lafi and Ababneh (1995)[5] ,by using water extract reported(20mm and 24mm) as an inhibition zones for *S. aureus* and *S. mutans* ,respectively the differences from the present study may due to the degree of siwak extract concentration or/and related to different bacterial isolates.

The solvents may give different results also do the age of plant parts used in preparing the extracts. In this study fresh parts (un stored) were used. Alcoholic extracts showed considerable effects, which increase with extract concentration for roots, shoots and leaves, these results agree with[5], [6], [22].

In all tests followed here, the inhibition effects of extracts against microbial growth are increase from 2.5%, 5% and 10% respectively (Table-2). Turbidimetry method and inhibition zones give the same results which agree with previous studies[5].

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التأثير الضد ميكروبي للمستخلصين المائي والايثانولي لساق وجذر وأوراق نبات الأراك Salvadora persica على ميكروبات الفم

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ملخص

جمعت عينات نبات الأراك الطازجة من مناطق نموها الطبيعية في محافظة الحديدة – اليمن بتاريخ 23-2 – 2011 م واشتملت العينات على قطع من الساق والجذر وكذلك جمعت الأوراق الخضراء وحُضر منها المستخلص المائي الساخن والايثانولي بتراكيز (2,5 % , 5 % و10 %) وزن / حجم ولجميع العينات التي تم جمعها .

أخذت العينات الميكروبية من أشخاص يراجعون العيادات الخاصة بأمراض الأسنان في محافظة ذمار وكان الجمع بطريقتي المسحة وبجمع ماء المضمضة . عزلت ونقيت مزارع *S. aureus* و *S. mutans* و *C. albicans* لأجراء الاختبارات عليها والتي شملت اختبار تباين التأثير المضاد للميكروبات بحسب الجزء النباتي المستعمل لتحضير المستخلص واختبار تأثير اختلاف التركيز على الفعالية المضادة للنمو الميكروبي ، وكذلك المقارنة بين المستخلصين الكحولي والمائي الساخن .

بينت النتائج بان مستخلص جذور الأراك فاق في تأثيره المثبط للنمو الميكروبي مستخلصي الساق والأوراق على التوالي كذلك أظهرت النتائج ان زيادة التأثير المثبط للنمو للمستخلصات المائية للجذور والساق والأوراق تزداد مع زيادة تركيزها، وكان المستخلص الكحولي ذو فعالية أعلى من المستخلص المائي الساخن.

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Analysis of Torsional Vibrations of Rotary Winding Machines

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ABSTRACT

This work is chosen to analyze the rotary winding machines because these machines are existed in our country and this analysis is practical from the side of input values and getting the results. Good rotary winding machine design practice demands the analysis of the system to insure that the reaction due to operation of the machine will not cause damaging vibrations. The widest phenomenon in vibration forms in mechanical transmission is the torsional vibration. The aim of this work is the analysis of the torsional vibrations of these rotary winding machines and to minimize that vibrations and to alleviate recurring costly maintenance problems.

To minimize system dynamic torques it is necessary to spread the torsional natural frequencies. This is best achieved by lowering the fundamental torsional natural frequency. In main rotary winding machine drives this is most readily accomplished by lowering the torsional stiffness at the lead spindle location or, by making the lead spindle torsional flexibility greater by increasing the shaft separation or, if necessary, by using a torsionally flexible spacer. Torsional stiffness is inversely proportional to shaft length. For the solution of the problem one must first of all estimate the physical system parameters taking into consideration the real set of components of a rotary winding machine and then to transform them into a mathematical model. In this work there was also the method of calculation model presented.

The equations of motion of the whole vibrating system are defined and the study include solution of torsional vibration of this machine by using Jacobi method as method of solution because it is easy to program and accurate. A computer program (Math Lab) has been used in order to Facilitate the solution because it is contain already comments specialized to solve the vibration problems. Finally, finding the final results gave a good vision to forecast the failure of the machine that could caused either by errors in design or operating conditions.

Key words : Torsional vibration, Torsional frequency, Torsional torque, Rotary machines, Torsional drives, Torque amplification factors, Dynamics of winding drives, Jacobi method.

1. INTRODUCTION

Vibration of a physical structure often is thought of in terms of model consisting of a mass and a spring [1]. The vibration of such a model, or system, may be free or forced. In free vibration, there is no energy added to the system but rather the vibration is the continuing result of an initial disturbance. In a real system, energy dissipation causes the amplitude of free vibration to decay continuously to a negligible value. Such free vibration sometimes is referred to as transient vibration [2]. Forced vibration continues under steady-state conditions because energy is supplied to the system continuously to compensate for that dissipated in the system. The forcing frequency at which energy is supplied appears in the vibration of the system. The vibration of the system depends upon the relation of the forcing frequency to the natural frequency. This relationship is a Prominent features of the analytical aspects of vibration [2].

The technology of vibration embodies both theoretical and experimental facets prominently. Thus, methods of analysis and instruments for the measurement of vibration are of primary significance. The results of analysis and measurement are used to evaluate vibration environments, to devise testing procedures, and testing machines, and to design and operate equipment and machinery [3]. In this work the objective is to eliminate vibrations or reduce their severity or, alternatively, to design equipment to withstand their influence. The wide phenomenon in vibration arms in mechanical transmission is the torsional vibration. Therefore the theory torsional vibration and its applications have reached large expansion of this branch was due to practice needs [4].

Torsional vibration involves angular oscillations of the rotors of a machine. Dynamics problems associated with rotary machines drive system generally result from the torsional vibrations. The torsional vibration problem arises when the natural frequencies of a system and/ or its components are within the operating range of the system, critical speeds may exist in which dynamic effects are predominant and give rise to large amplitude vibration. These vibrations can have a detrimental effect on fatigue life, regulating system performance, product quality and noise levels. For large rotating machinery the mechanical system consists of several rotors that are connected by relatively shafts and couplings. For example, Figure (1) is the photograph of the drum of winding machine.

It has the large diameter rotor bodies section and relatively flexible shafts extensions. Each rotor in the system has oscillated following a torsional disturbance to the machine about its rotational axis, resulting in twisting in the shafts and to a lesser extent in the large diameter rotor bodies themselves. For some machines involving geared rotor connections, for example, there are many several rotor axes of rotation. The twisting oscillations following several torsional disturbances to the machine may be sufficient to cause fatigue damage to the shafts of the machine and the other components [2] .

In the design of rotating machinery, torsional vibration analysis is vital for ensuring reliable machine operation. If shaft and rotating component failures occur on these large machine as a result of shaft torsional oscillations, the consequences can be catastrophic. In the worst case, the entire machine can be wrecked as a result of the large unbalancing forces that can arise following shaft separation and turbine blade failures, and this has actually occurred. There is also potential for loss of human life, for these reasons great attention is generally taken at the design stage to ensure that high-speed rotating machines have the required torsional capability.

Figure (1): Photograph of Drum of Winding Machine [5].

2. EXPLANATION OF THE SYSTEM

2.1 Defining the problem

The equipment arrangement of a modern winding machine is shown in Figure (1) consisting of several stage of gear boxes in order to control speed either reduction or magnification, because level of speed is controlling the wind quality of the cable. Also, there are large pulleys in order to organize the tension and reduce the diameter of the cable as final process. From a mechanical point of view, the determination and correction of responses of the system began with an evaluation of each individual stand considered as a separate entity. As the operation proceeds through each of these stands, at different speeds, each stand in turn is subjected to the initial different speed operation. At the instant of operation, each of these stands can be considered an integral system, consisting of all rotating components-rolls, pulleys, gears, motor rotors and their interconnecting shafts, couplings and spindles. With due regard for the composition, size, shape, dimension, and strength of all parts, the task at hand is to determine the response of each of these mechanical systems to the load imposed at the instant of operation.

2.2 Physical analysis of the system

To reduce the problem to a manageable form, many of these contributing factors must be assumed to have minor influence on the character of the behavior of the drive train. Fortunately, there is an abundance of technical literature dealing with the construction of a suitable physical model [6, 7, 8].

Most of this development is devoted to the consideration of steady- state vibration, the usual concern in reciprocating engine and compressor drives, but is equally applicable to the investigation of transient torsional vibration. This phase of the analysis is, consequently, clear-cut and can be relied upon to yield precise information about the natural frequencies of the system, the stresses which will occur as a result of torsional deflection at various stations and to suggest possible changes which can be made to reduce the torque

amplification factors which exceed specified values. The resolution values of all actual components of the drive into their physical is shown in Figure (2).

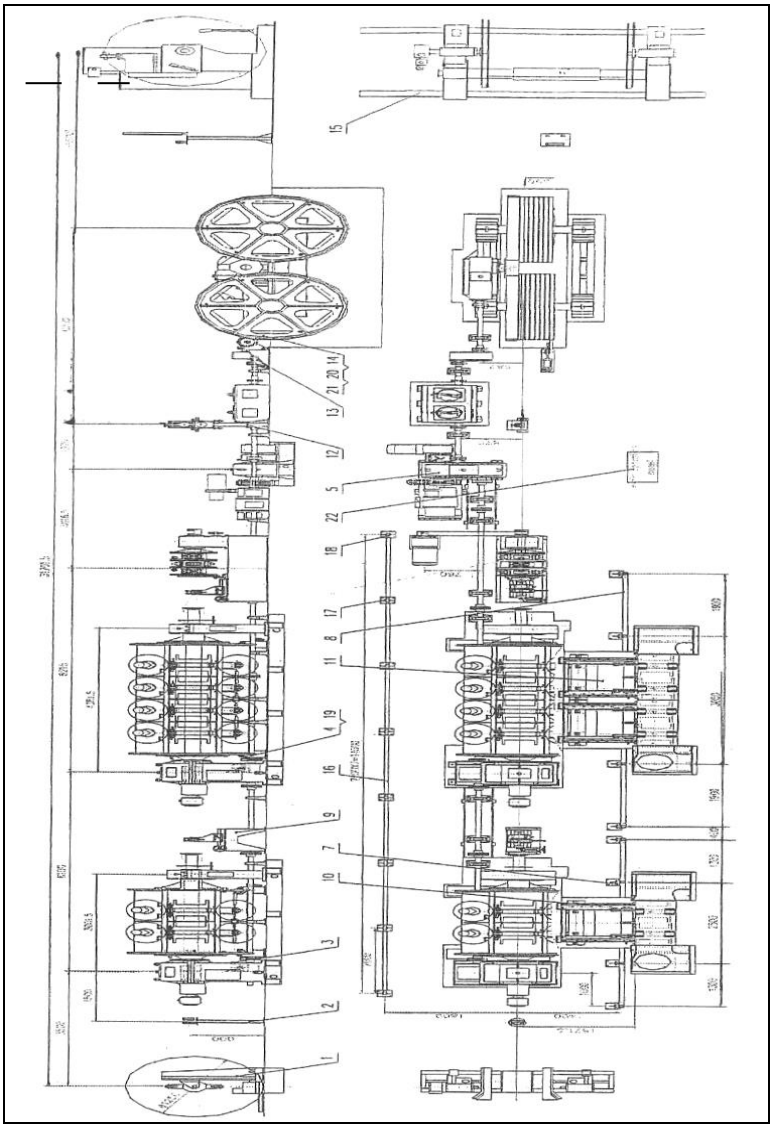

Figure 2 : Layout of a Rotary Winding Machine [9].

This is a sample layout of a production line of rotary winding machine. There is one motor that has operated the production line and are has rated power up to 90 KW and also there are gear boxes control the speeds. Each gear box has played an important role to make speed at each portion in the line of production as independent. The shafts of the system are made of steel structure A-36 and employed for motion transmission between different

stages and connected by means of pin bushes (flexible couplings) which are used elastic sleeve pin couplings instead of attachment bolts. Through the sleeve pin is usually oil resistant rubber. Also this winding machine has braking system, the system has contained two wheel drums, each one has capacity to be loaded with eight cable pulleys [5].

2.3 Mechanical analysis of the system :

To adapt the physical drive system shown in Figure (2) to a system may be validly modeled as a series of concentrated inertias connected by massless torsional springs and dampers. A typical block diagram model of a rotary winding machine is illustrated in Figure (3 a). In order to make an analysis the complete rotary winding machine drive shown in Figure (2) is reduced to an equivalent spring mass system as shown in Figure (3 b).

The drive system is transformed into a single line spring mass system by the application of fundamental equations of mechanics, Some of which are given as :

a) for ease of analyzing the motor parts, choose the motor shaft speed as the base speed and designate the other shaft speeds as ((n)) where ((n)) equals the speed ratio of the other shafts with respect to the base .

b) multiply all springs and inertias by n^2 . The effective stiffnesses of the shafts or couplings on the high speed side of a gear box, referred to the low speed is the actual stiffness multiplied by the gear ratio squared.

1. $K = \dfrac{G\, J_p}{L}$, K is the torsional stiffness of the shaft in N.m / rad

- G is the modulus of rigidity of the shaft in N / m^2
  ($G = 75 \times 10^9$ N / m^2 , for steel structure A - 36) [5].
- L is the length of the shaft in m.
- $J_p = \dfrac{\pi\, D_s^4}{32}$

  J_p is the polar area moment of inertia of the shaft in m^4 .
  D_s is the diameter of the shaft in m ($D_s = 0.075$ m, for all shafts)[5].

2. $y = \dfrac{P}{K_t} = \dfrac{P\, \ell^3}{3\, E\, J}$

- y is the bending deflection of the gear teeth measured on the pitch circle in m. (no slippage, i.e., no shear deflection).
- P is the circumferential force on the gear teeth in N.
- $K_t = \dfrac{3\, E\, J}{\ell^3}$
- K_t is the Stiffness of gear tooth in N / m.
- E is the modulus of elasticity of the deflected tooth in N / m^2.
  ($E = 210 \times 10^9$ N / m^2 , for steel)[5].
- ℓ is length of the deflected tooth in m.

- $J = \frac{\pi D_g^4}{64}$
- J is the diametral area moment of inertia of gear in m^4.
- D_g is the pitch circle diameter of the gear in m.

3. $K_{eq} = \frac{G J_p}{L_{eq}} = \frac{r_1^2}{\frac{1}{K_{t1}} + \frac{1}{K_{t2}}}$

- K_{eq} is the equivalent rigidity of the transmission teeth of gears in (N.m) / (rad) . ($G = 80 \times 10^9$ N / m^2 , for steel of gears)[5].
- r_1 is the pitch circle radius of the first driver gear in m.
- K_{t1} is the stiffness of first meshed driver gear in N / m.
- K_{t2} is the stiffness of Second meshed driven gear in N / m.
- $L_{eq} = \frac{G J_p}{K_{eq}} = \frac{G J_p \left(\frac{1}{K_{t1}} + \frac{1}{K_{t2}} \right)}{r_1^2}$
- L_{eq} is the reduced length of an equivalent shaft in m.

4. $I = m K_o^2 = m \frac{R^2}{2}$

- I is the polar mass moment of inertia in $kg.m^2$.
- m is the mass of the rotating part in kg.
- $K_o^2 = \frac{R^2}{2}$
- K_o is the radius of gyration of the rotating part in m.
- R is the radius of the rotating part in m.

5. $C = 2 \xi \sqrt{K I} = 2 \xi \omega_n I$

- C is the viscous damping coefficient in (N.m) / (rad/s).
- $\xi = \frac{C}{C_c}$
- ξ is the damping ratio factor in dimensionless.
  (ξ = 0.8 for the designed winding machine)
- $\omega_n^2 = \frac{K}{I}$
- ω_n is the natural frequency of the rotating part in rad / s.
- $C_c = 2 \sqrt{K I} = 2 \omega_n I$

- C_c is the critical viscous damping coefficient in (N.m) / (rad/s).

6. Two springs in series K_1 and K_2 can be represented by an equivalent spring.

$$K = \frac{1}{\frac{1}{K_1} + \frac{1}{K_2}}$$

7. Two springs in parallel K_1 and K_2 can be represented by an equivalent spring K .

$$K = K_1 + K_2$$

8. Rotational spring constant K of a hollow circular shaft of outside diameter D_o , inside diameter D_i and length L.

$$K = \frac{G\, J_{op}}{L} - \frac{G\, J_{ip}}{L} = \frac{G\, \pi\, (D_o^4 - D_i^4)}{32\, L}$$

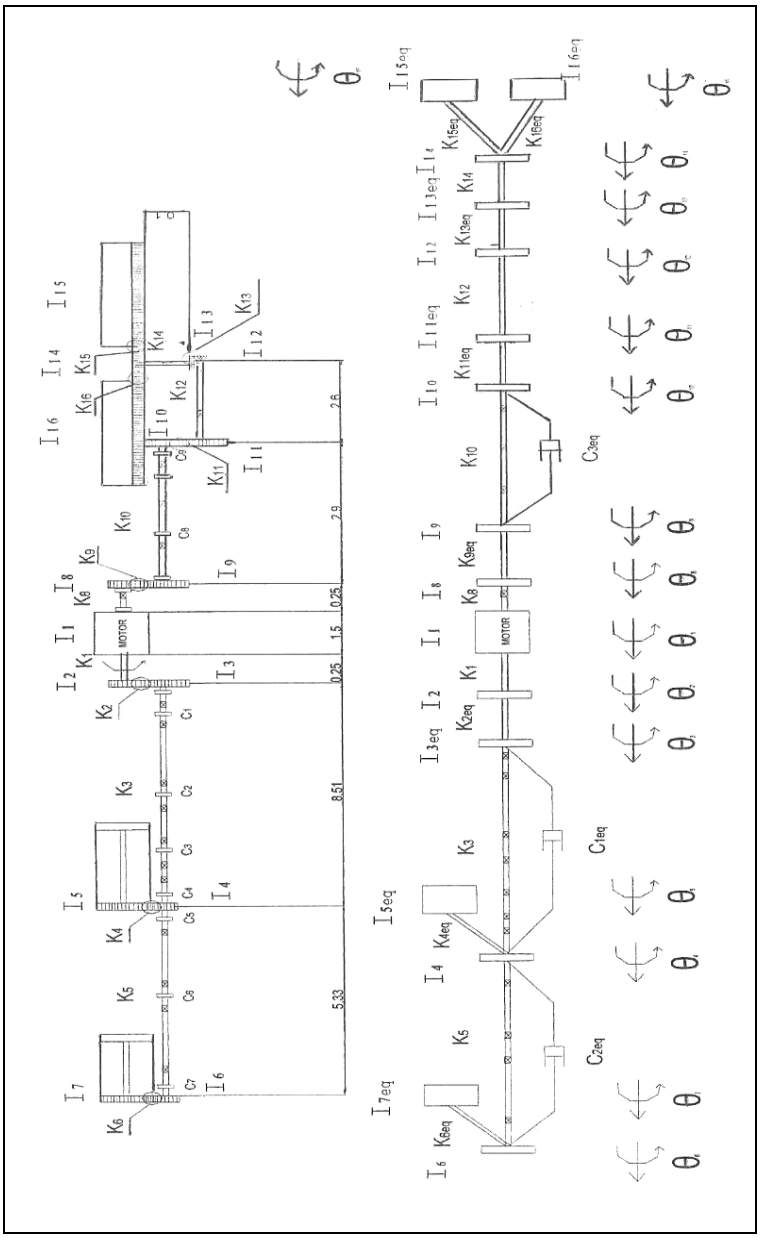

Figure (3): An Adapted Block Diagram Model of a Rotary Winding Machine.

2.4 Mathematical Analysis of The System

From point of view of mathematic analysis of general torsion system of the rotary winding machine system there is but no difference between subsidiary flexible bindings and the

terms that describe so called branching of the system, example due to influence of gear-insertion.

The derivation of equations of motion of the mathematical idealized model of rotary winding machine system shown in Figure (3 b) can be obtained by applying Lagrange's equations or by applying Newton's second Law. Thus the equations of motion of the winding machines system shown in Figure (3 b) are :

$$I_1 \ddot{\theta}_1 + K_1 (\theta_1 - \theta_2) + K_8 (\theta_1 - \theta_8) = + T_M$$

$$I_2 \ddot{\theta}_2 + K_1 (\theta_2 - \theta_1) + K_{2eq} (\theta_2 - \theta_3) = 0$$

$$I_3 \ddot{\theta}_3 + C_{1eq} (\dot{\theta}_3 - \dot{\theta}_4) + K_{2eq} (\theta_3 - \theta_2) + K_3 (\theta_3 - \theta_4) = 0$$

$$I_4 \ddot{\theta}_4 + C_{1eq}(\dot{\theta}_4 - \dot{\theta}_3)+C_{2eq}(\dot{\theta}_4 - \dot{\theta}_6)+K_3(\theta_4 - \theta_3)+K_{4eq}(\theta_4 - \theta_5)+K_5(\theta_4 - \theta_6) = 0$$

$$I_5 \ddot{\theta}_5 + K_{4eq} (\theta_5 - \theta_4) = 0$$

$$I_6 \ddot{\theta}_6 + C_{2eq} (\dot{\theta}_6 - \dot{\theta}_4) + K_5 (\theta_6 - \theta_4) + K_{6eq} (\theta_6 - \theta_7) = 0$$

$$I_7 \ddot{\theta}_7 + K_{6eq} (\theta_7 - \theta_6) = 0$$

$$I_8 \ddot{\theta}_8 + K_8 (\theta_8 - \theta_1) + K_{9eq} (\theta_8 - \theta_9) = 0$$

$$I_9 \ddot{\theta}_9 + C_{3eq} (\dot{\theta}_9 - \dot{\theta}_{10}) + K_{9eq} (\theta_9 - \theta_8) + K_{10} (\theta_9 - \theta_{10}) = 0$$

$$I_{10} \ddot{\theta}_{10} + C_{3eq} (\dot{\theta}_{10} - \dot{\theta}_9) + K_{10} (\theta_{10} - \theta_9) + K_{11eq} (\theta_{10} - \theta_{11}) = 0$$

$$I_{11} \ddot{\theta}_{11} + K_{11eq} (\theta_{11} - \theta_{10}) + K_{12} (\theta_{11} - \theta_{12}) = 0$$

$$I_{12} \ddot{\theta}_{12} + K_{12} (\theta_{12} - \theta_{11}) + K_{13eq} (\theta_{12} - \theta_{13}) = 0$$

$$I_{13} \ddot{\theta}_{13} + K_{13eq} (\theta_{13} - \theta_{12}) + K_{14} (\theta_{13} - \theta_{14}) = 0$$

$$I_{14} \ddot{\theta}_{14} + K_{14} (\theta_{14} - \theta_{13}) + K_{15eq} (\theta_{14} - \theta_{15}) + K_{16eq} (\theta_{14} - \theta_{16}) = 0$$

$$I_{15} \ddot{\theta}_{15} + K_{15eq} (\theta_{15} - \theta_{14}) = -T_{01}$$

$$I_{16} \ddot{\theta}_{16} + K_{16eq} (\theta_{16} - \theta_{14}) = -T_{02} \quad \ldots\ldots\ldots \quad (1)$$

The above differential equations second orders with constants coefficients can be written in matrix form as follows :-

$$M\ddot{\theta} + C\dot{\theta} + K\theta = F(t) \quad \ldots\ldots (2)$$

Where,
M is a diagonal matrix mass moments of inertia.
C is a symmetric damping matrix.
K is a symmetric stiffness matrix.

θ is a vector angular displacements of the masses.

$\dot{\theta}$ is a vector angular velocities of the masses.

$\ddot{\theta}$ is a vector angular accelerations of the masses.

F(t) is a vector excited torques.

3. SOLUTION OF THE PROBLEM

For low speed motors the problem of torsional vibration of a shafting system is usually ignored, because the torsional natural frequencies of a shafting system are much higher than its operating speed so that their effects can be ignored. However, for high speed motors, their effects cannot be ignored and have to be completely studied; and our problem on the rotating winding machine one of this type. Such problems supply calculation mathematical models with many degrees of freedom as shown in Equation (1) that can be solved using numerical techniques and computers and there are many suitable methods to solve the problem such as Holzer method and Jacobi method [10], whereas Holzer method is in fact a systematic tabulation of the frequency equation of the vibratory system, method of determining the shapes and frequencies of torsional modes of vibration of a system and in this work used Jacobi method because this method is an algorithm for determining the solution of the system of linear equation with largest absolute value in each row column dominated by the diagonal element. Otherwise it is method of solving matrix equation on a matrix that zeros along its main diagonal. Advantages of the Jacobi method are easy to program and accurate; so that this method is explained in the following article.

Jacobi Method: The free vibration equation for an undamped system is obtained from the general Equation (2), when F(t) and C are absent.
Therefore :

$$M\ddot{\theta} + K\theta = 0 \quad \ldots\ldots (3)$$

Consider the real eigen value problem with given symmetric matrices K and M with M positive definite, hence the problem is to determine the eigen vectors v_r and the eigen values ω_r^2 (r = 1,…,n) which satisfy

$$K v = \omega^2 M v \quad \ldots\ldots\ldots (4)$$

Where (n) are the real roots for ω^2. If K is singular, at least one root is zero. If K is positive definite all roots are positive. The (n) roots determine the (n) natural frequencies of the system. When a natural frequency ω_r is known, it is possible to return to equation (4) and solve for the corresponding vector v_r to within a multiplicative constant.

There are (n) independent vectors v_r (r = 1, … ,n) corresponding to the (n) natural frequencies ω_r (r = 1, … , n) which are known as eigen values. The complete solution to the eigen value problem of Equation (4) consists of (n) eigen values and (n) corresponding eigen vectors. These can be assembled compactly into matrices. Let the eigen vectors v_r

corresponding to the eigen value ω_r^2 have elements υ_{jr} (the first subscript indicates which row, the second subscript indicates which eigen vector). The (n) eigenvectors then can be displayed in single square matrix V, each column of which is an eigenvector.

$$V = [\upsilon_{jr}] \quad \ldots\ldots (5)$$

Where $j = 1, \ldots, n$ and $r = 1, \ldots, n$

The matrix V is called the modal matrix for the eigen value problem, equation (4). The (n) eigen values ω_r^2 can be assembled into a diagonal matrix Ω^2 which is known as the spectral matrix of the eigen value problem, Equation (4).

$$\Omega^2 = [\omega_r^2] \quad \ldots\ldots (6)$$

By using the modal and spectral matrices it is possible to assemble all of these relations into a single matrix equation :

$$K V = M V \Omega^2 \quad \ldots\ldots (7)$$

Equation (7) provides a compact display of the complete solution of the eigen value problem, Equation (4). By premultiplication the both sides of Equation (7) by V^T and after arrangement, it has reduced to :

$$\frac{V^T K V}{V^T M V} = \Omega^2 \quad \ldots\ldots (8)$$

The problem of Equation (7) is reduced to an eigen value problem for a simple symmetric matrix $A = M^{-1/2} K M^{-1/2}$ with modal matrix $U = M^{1/2} V$ as follows :-

$$K V = M V \Omega^2$$
$$K M^{-1/2} M^{1/2} V = M^{1/2} M^{1/2} V \Omega^2$$
$$(M^{-1/2} K M^{-1/2}) (M^{1/2} V) = (M^{1/2} V) \Omega^2$$
$$A U = U \Omega^2 \quad \ldots\ldots (9)$$

The solution of this eigen value problem, Equation (9) provides the spectral matrix Ω^2 of the original problem. The modal matrix U has the property that its columns are normalized so that :

$$U_r^T U_r = 1, \text{ i.e. , } U^T = U^{-1} \text{ and } U^{-T} = U$$

By post multiplication the both sides of the Equation (9) by U^T, it has reduced to :

$$A U U^T = U \Omega^2 U^T$$

$$A\ U\ U^{-1} = U\ \Omega^2\ U^T$$

$$A = A\ I = U\ \Omega^2\ U^T \quad \ldots\ldots (10)$$

Where, I is identity matrix or a diagonal unit matrix.

The basic computational operation in this method is the resolution of a single symmetric matrix A into its modal matrix U and its spectral matrix Ω^2 according to the relations shown in Equation (10). Where Ω^2 is a diagonal matrix of the eigen values ω_r^2, and the columns U are the eigen vectors U_r for the eigen value problem shown in Equation (9) .

Also, we can say that by premultiplication the both sides of Equation (9) by U^T, it has reduced to :

$$U^T\ A\ U = U^T\ U\ \Omega^2$$

$$U^T\ A\ U = U^{-1}\ U\ \Omega^2$$

$$U^T\ A\ U = I\ \Omega^2 = \Omega^2 \quad \ldots\ldots (11)$$

In comparison Equation (11) to Equation (8) we have deduced that :

$$V^T\ M\ V = I \quad \text{and} \quad V^T\ K\ V = \Omega^2$$

To obtain the modal matrix V of the original problem in Equation (7), it is necessary to perform the matrix multiplication :

$$V = M^{-1/2}\ U \quad \ldots\ldots (12)$$

which follows from inverting the definition of U. It remains to indicate how the resolution of Equation (10) is obtained by successive rotations.

4. RESULTS OF THE SOLUTION

By substitution all the values of the parts of the system and by solved it numerically by Jacobi method which is programmed by Math-Lab program we get the results for determining the frequencies, eigenvectors, and plotting the eigenvectors against the distances of the system [9].

A) The input data :

a) The constants data of the system, the mass moments of inertia matrix, the damping coefficients matrix and the stiffness coefficients matrix.

b) The size of square matrix $A = M^{-1/2} = I^{-1/2}$

Where M = I is the mass moments of inertia matrix.

c) The size of square matrix C = A * K .

Where K is the stiffness matrix .

d) The size of square matrix D = C * A .

e) The distances between the masses .

A =

Columns 1 through 15 | Column 16

0.2500	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	5.1920	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	1.2970	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	1.2970	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0.0210	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	1.2970	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0.0160	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	5.1920	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	1.2970	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	5.1920	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	1.2970	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	7.2550	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	7.2550	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0.3600	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0180	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0180

C =

1.0e+008 *

Columns 1 through 15 | Column 16

0.0047	-0.0023	0	0	0	0	0	-0.0023	0	0	0	0	0	0	0	0
-0.0484	0.6048	-0.5564	0	0	0	0	0	0	0	0	0	0	0	0	0
0	-0.1390	0.1393	-0.0004	0	0	0	0	0	0	0	0	0	0	0	0
0	0	-0.0004	2.2248	-2.2238	-0.0006	0	0	0	0	0	0	0	0	0	0
0	0	0	-0.0360	0.0360	0	0	0	0	0	0	0	0	0	0	0
0	0	0	-0.0006	0	6.4353	-6.4347	0	0	0	0	0	0	0	0	0
0	0	0	0	0	-0.0794	0.0794	0	0	0	0	0	0	0	0	0
-0.0484	0	0	0	0	0	0	0.9317	-0.8833	0	0	0	0	0	0	0
0	0	0	0	0	0	0	-0.2207	0.2217	0.0010	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0.0042	0.8875	-0.8833	0	0	0	0	0
0	0	0	0	0	0	0	0	0	-0.2207	0.2218	-0.0012	0	0	0	0
0	0	0	0	0	0	0	0	0	0	-0.0065	1.8419	-1.8354	0	0	0
0	0	0	0	0	0	0	0	0	0	0	-1.8354	2.0052	-0.1690	0	0
0	0	0	0	0	0	0	0	0	0	0	0	-0.0084	0.9536	-0.4726	-0.4726
0	0	0	0	0	0	0	0	0	0	0	0	0	-0.0236	0.0236	0
0	0	0	0	0	0	0	0	0	0	0	0	0	-0.0236	0	0.0236

D =

1.0e+009 *

Columns 1 through 15 | Column 16

0.0001	-0.0012	0	0	0	0	0	-0.0012	0	0	0	0	0	0	0	0
-0.0012	0.3140	-0.0722	0	0	0	0	0	0	0	0	0	0	0	0	0
0	-0.0722	0.0181	-0.0000	0	0	0	0	0	0	0	0	0	0	0	0
0	0	-0.0000	0.2886	-0.0047	-0.0001	0	0	0	0	0	0	0	0	0	0
0	0	0	-0.0047	0.0001	0	0	0	0	0	0	0	0	0	0	0
0	0	0	-0.0001	0	0.8347	-0.0103	0	0	0	0	0	0	0	0	0
0	0	0	0	0	-0.0103	0.0001	0	0	0	0	0	0	0	0	0
-0.0012	0	0	0	0	0	0	0.4837	-0.1146	0	0	0	0	0	0	0
0	0	0	0	0	0	0	-0.1146	0.0288	0.0005	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0.0005	0.4608	-0.1146	0	0	0	0	0
0	0	0	0	0	0	0	0	0	-0.1146	0.0288	-0.0008	0	0	0	0
0	0	0	0	0	0	0	0	0	0	-0.0008	1.3363	-1.3316	0	0	0
0	0	0	0	0	0	0	0	0	0	0	-1.3316	1.4548	-0.0061	0	0
0	0	0	0	0	0	0	0	0	0	0	0	-0.0061	0.0343	-0.0009	-0.0009
0	0	0	0	0	0	0	0	0	0	0	0	0	-0.0009	0.0000	0
0	0	0	0	0	0	0	0	0	0	0	0	0	-0.0009	0	0.0000

B) The output data :

1) The output data are :-

a) The eigen values squared (Lam) (natural frequency squared) in (rad/s)^2.

b) The eigen vectors (**V**), (mode shapes) modal matrix.

c) The eigen values (**E**) (natural frequencies in diagonal matrix) spectral matrix in (rad/s).

lam =

1.0e+009 *

2.7285
0.8348
0.5110
0.4893
0.3307
0.2886
0.0632
0.0338
0.0016
0.0014
0.0003
0.0000
0.0000
0.0000
0.0000
0.0000

V =

Columns 1 through 15

-0.0000	-0.0000	0.0023	-0.0000	-0.0036	0.0000	-0.0000	-0.0000	-0.2262	-0.1198	0.1022	-0.9602	-0.0254	0.0335	0.0172
0.0000	0.0000	-0.0000	0.0000	0.9744	-0.0003	-0.0000	-0.0000	0.0678	0.2096	0.0057	-0.0450	-0.0013	0.0016	0.0008
0.0000	-0.0000	0.0000	-0.0000	-0.2249	-0.0001	0.0000	0.0000	0.2974	0.9100	0.0233	-0.1798	-0.0052	0.0065	0.0031
0.0000	0.0001	-0.0000	0.0000	0.0002	0.9999	0.0000	0.0000	0.0000	0.0001	0.0000	0.0005	-0.0138	0.0077	-0.0035
-0.0000	-0.0000	0.0000	-0.0000	-0.0000	-0.0162	-0.0000	-0.0000	-0.0001	-0.0005	-0.0001	0.0353	-0.8511	0.4757	-0.2188
-0.0000	-0.9999	-0.0000	0.0000	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	-0.0000	0.0063	0.0082	-0.0067
-0.0000	0.0123	0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0001	0.5114	0.6640	-0.5455
0.0000	0.0000	-0.9729	0.0057	-0.0000	0.0000	0.0000	0.0000	0.2124	-0.0778	-0.0173	-0.0444	-0.0012	0.0016	0.0009
-0.0000	-0.0000	0.2312	-0.0003	0.0000	-0.0000	0.0000	0.0000	0.8962	-0.3261	-0.0740	-0.1773	-0.0046	0.0064	0.0035
-0.0000	0.0000	0.0054	0.9704	-0.0000	0.0000	0.0026	0.0007	0.0200	-0.0083	0.2394	0.0217	0.0004	-0.0015	-0.0014
0.0002	-0.0000	-0.0013	-0.2414	0.0000	-0.0000	0.0089	0.0024	0.0842	-0.0349	0.9622	0.0866	0.0016	-0.0060	-0.0058
-0.6912	0.0000	0.0000	0.0002	-0.0000	0.0000	-0.7152	-0.1030	0.0006	-0.0003	0.0070	0.0006	-0.0002	-0.0010	-0.0014
0.7226	0.0000	0.0000	0.0003	-0.0000	0.0000	-0.6838	-0.1007	0.0006	-0.0002	0.0064	0.0005	-0.0002	-0.0010	-0.0014
-0.0016	0.0000	-0.0000	-0.0000	0.0000	-0.0000	0.1441	-0.9889	0.0001	-0.0000	0.0010	-0.0010	-0.0041	-0.0203	-0.0286
0.0000	-0.0000	0.0000	0.0000	-0.0000	0.0000	-0.0019	0.0250	-0.0001	0.0000	-0.0038	-0.0227	-0.0814	-0.4069	-0.5716
0.0000	-0.0000	0.0000	0.0000	-0.0000	0.0000	-0.0019	0.0250	-0.0001	0.0000	-0.0038	-0.0227	-0.0814	-0.4069	-0.5716

Column 16

0.0000
0.0000
0.0000
-0.0000
-0.0000
-0.0000
-0.0000
-0.0000
-0.0000
-0.0000
-0.0000
-0.0000
-0.0000
-0.0000
-0.0000
-0.0000
-0.7071
0.7071

E =

1.0e+009 *

Columns 1 through 15															Column 16
2.7285	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0.8348	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0.5110	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0.4893	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0.3307	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0.2886	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0.0632	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0.0338	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0.0016	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0.0014	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0.0003	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0.0000	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0.0000	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0.0000	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0000	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0000

2) The plotting of mode shapes against the distances between the mass moments of inertia of the system .

a) Before any modification changed of the stiffness of the shafts between the mass moments of inertia .

Corresponding Mode Shapes Before Modification

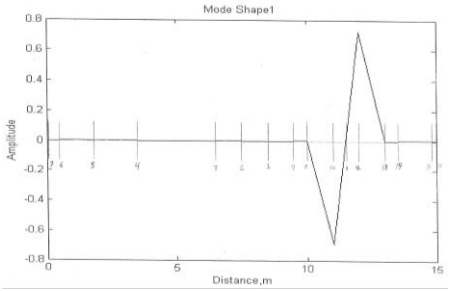

Figure 4: Mode Shape 1a

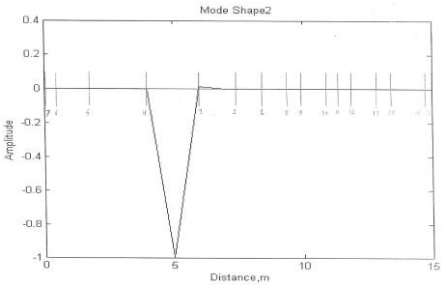

Figure 5: Mode Shape 2a

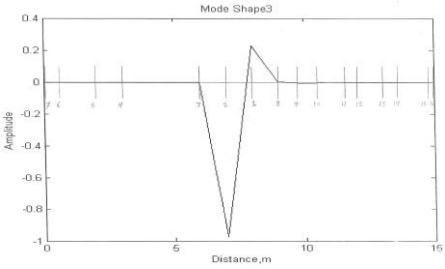

Figure 6: Mode Shape 3a

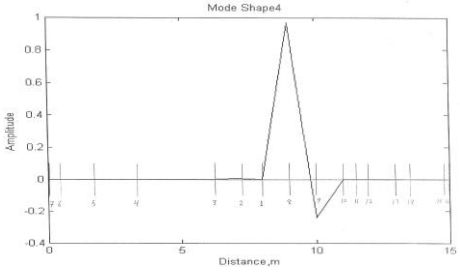

Figure 7: Mode Shape 4a

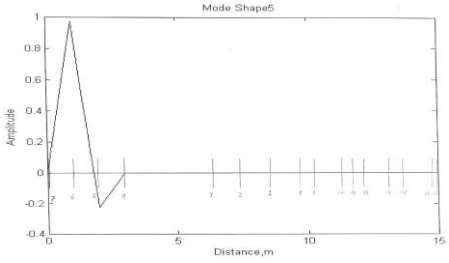

Figure 8: Mode Shape 5a

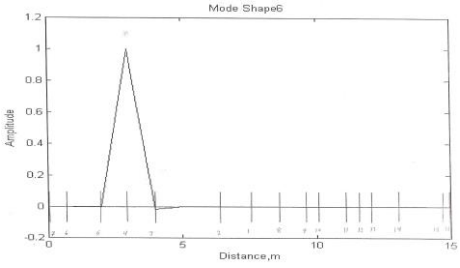

Figure 9: Mode Shape 6a

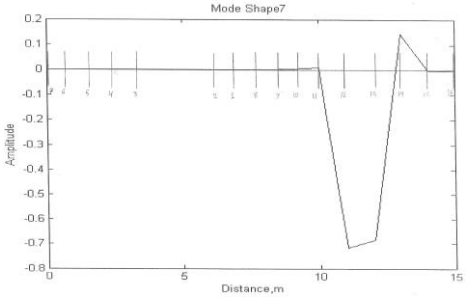

Figure 10: Mode Shape 7a

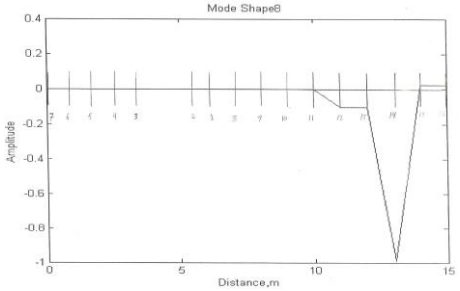

Figure 11: Mode Shape 8a

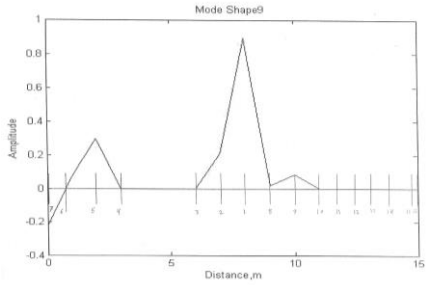

Figure 12: Mode Shape 9a

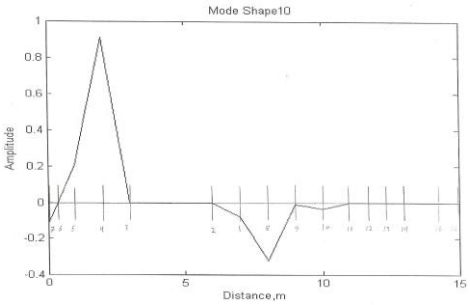

Figure 13: Mode Shape 10a

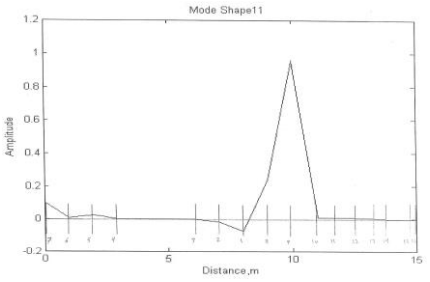

Figure 14: Mode Shape 11a

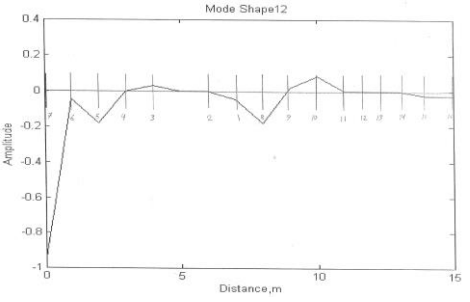

Figure 15: Mode Shape 12a

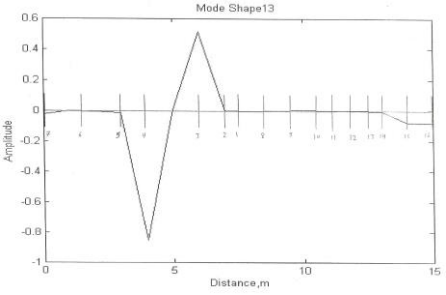

Figure 16: Mode Shape 13a

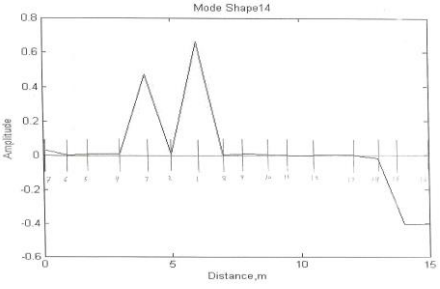

Figure 17: Mode Shape 14a

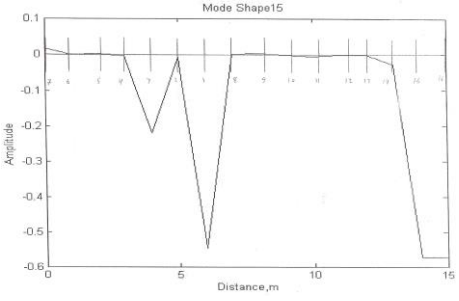

Figure 18: Mode Shape 15a

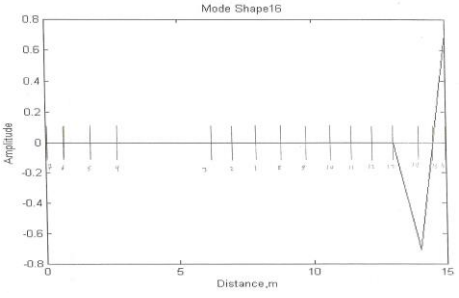

Figure 19: Mode Shape 16a

b) After modification changed of stiffnesses of the shafts between the mass moments of inertia.

MODIFICATION TO DETERMINE THE SUITABLE DESIGN :
When we changed all shafts of the system for propose of design modification in order to select optimum stiffness of shaft, it has been noted that no notable change in amplitude along the entire system i.e. shafts design is accurate, except change in stiffness of the shaft (K_3) which is located between masses number (3 & 4). The shaft (K_3) changed by addition ten percent and subtraction ten percent from value of its stiffness and can be seen that changed in the figures (graphs) below.

Corresponding Mode Shapes After Modification

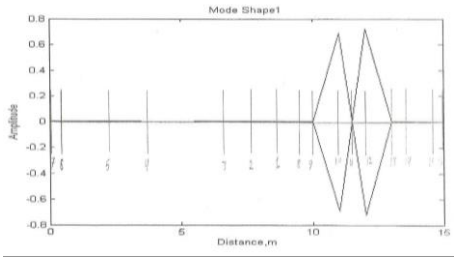

Figure 20: Mode Shape 1b

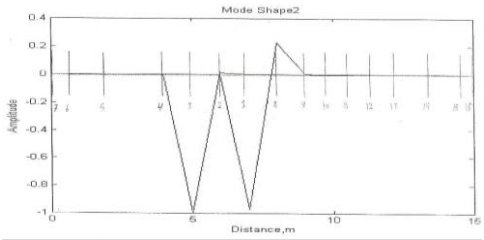

Figure 21: Mode Shape 2b

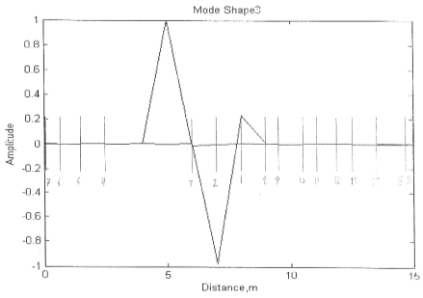

Figure 22: Mode Shape 3b

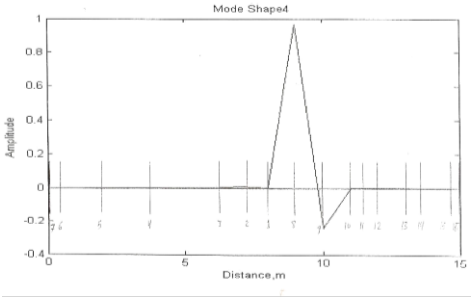

Figure 23: Mode Shape 4b

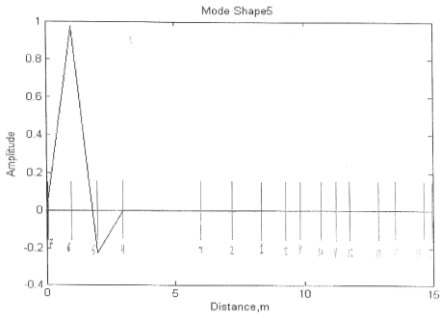

Figure 24: Mode Shape 5b

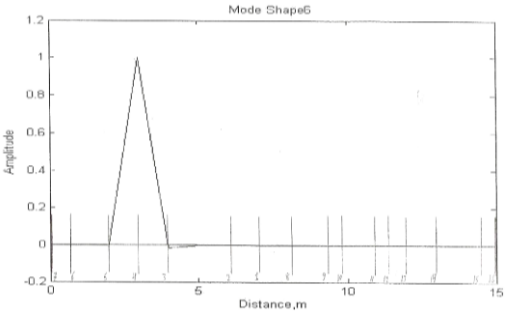

Figure 25: Mode Shape 6b

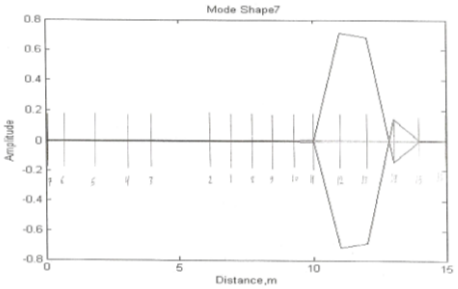

Figure 26: Mode Shape 7b

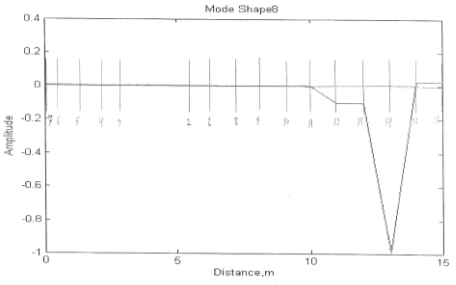

Figure 27: Mode Shape 8b

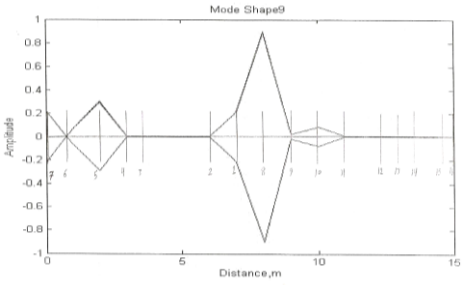

Figure 28: Mode Shape 9b

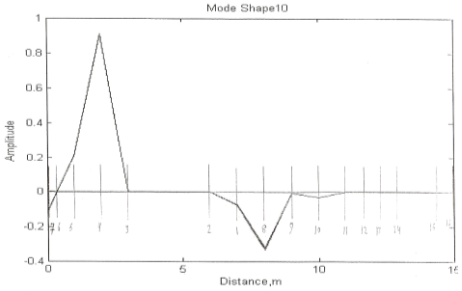

Figure 29: Mode Shape 10b

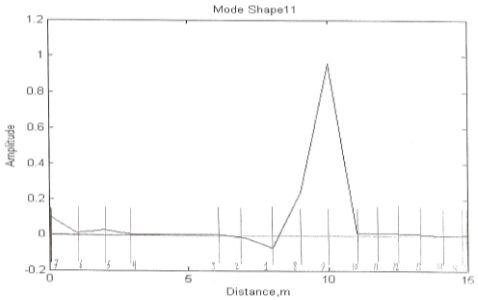

Figure 30: Mode Shape 11b

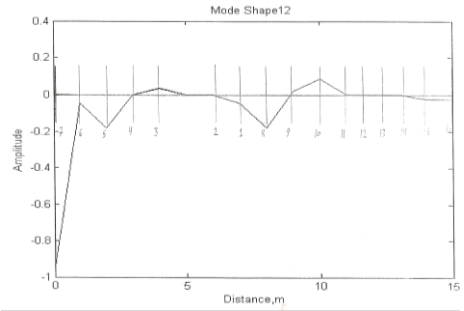

Figure 31: Mode Shape 12b

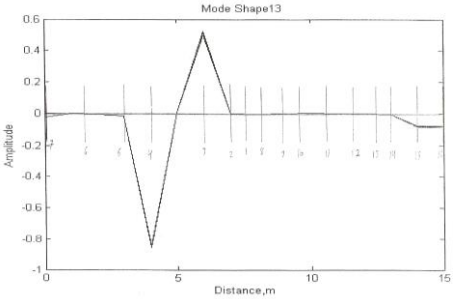

Figure 32: Mode Shape 13b

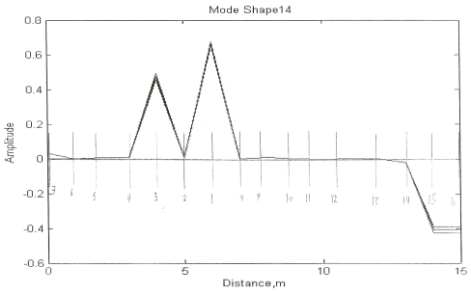

Figure 33: Mode Shape 14b

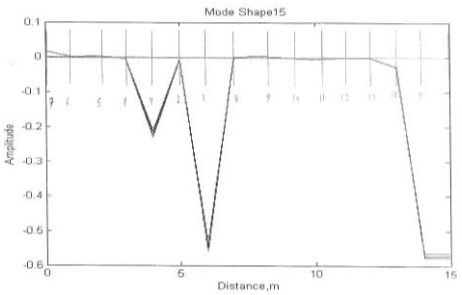

Figure 34: Mode Shape 15b

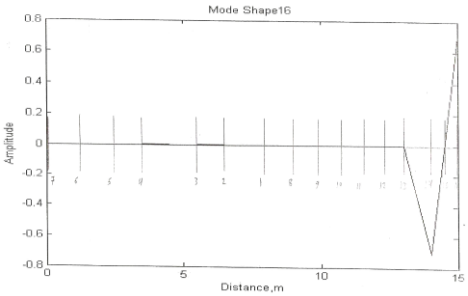

Figure 35: Mode Shape 16b

1. Desiccation

The mathematical model, Equation (1) of the mechanical model is shown in Figure (3b) are solved by Jacobi method using personal computer with Math-Lap program [10]. The solution of this model was done in two ways:

1. Considering the model without influence of modification of stiffnesses of shafts and plotting the results in the figures (4 to 19) where these figures are presented the relationship between the different distances of the shafts of the system and their responses amplitudes.
   These relationships are expressed the torsional torques in each shaft of the system, that is expressed the torque amplification factors in each shaft of the system, whereas this torque amplification factor is the main source to failure the system especially when it is bigger, that is out of the operation condition of the system.

2. Considering the model with influence of modification of stiffnesses of shafts by changing each shaft in turns by increasing and decreasing its stiffnesses by ten present of its original values and plotting the results in the figures (20 to 35).

By comparison the results from the figures before modification, figures (4 to 19), to the results from the figures after modification, figures (20 to 35), we have got that the results are same except in the shaft (K_3). Therefore this shaft must remove from the system by another suitable one to avoid the failure of the system completely.

2. Conclusion of the Results :

For the solution of the problem one first of all define the problem estimate the physical system and then the mechanical system to ease the system to analyze in form of mathematical model for aim of computations and results.

The mathematical model, a powerful tool, has proved valuable in predicting the overall dynamic behavior of drive systems of rotary winding machines. Figure (3-b) shows an arrangement of spring mass system of the drive system of the rotary winding machines.

Stated differential Equations (1) of a torsional drive system form the base of compilation of a program of numerical solution on computer. After allocation of individual constants one can numerically solve the transient states of regulating loop for the change of stiffnesses. By means of these calculations it is possible to optimize variable parameters of

regulating loop and to set in this manner the optimum regime of the whole torsional system of the rotary winding machine drive.

We have chosen Newton's second law method [2] for the theoretical analysis of vibration of the system for assemblies of equations of the torsional systems, and Jacobi method [10] for solution of these equations. The program of numerical mathematics was used here in Math-Lab programming language[9]. The calculation was done by means of a PC computer.

There were analyzed the responses of the drive of the system without and with change of characteristics of the shafts. At the same time all the results of the solution were compared. The useful result for the design procedure is obtained from the plotting of the relative amplitude values on the mass-elastic system diagram shown in the figures (20 to 35).

These plotted points join with a line (this line is called the normal elastic curve) Where this line crosses the line representing shaft torsional stiffness (really it represents torsional flexibility as it is drawn to a length between masses inversely proportional to torsional stiffness), this is a nodal point (point of zero torsional amplitude).

The shaft portion which has the nodal point is the shaft which have the largest vibratory vibration torque for that mode of vibration. For each natural frequency the number of nodes equal the mode number.

The location of the nodal points indicates which shaft sections have the major effect upon the frequency of that particular mode of vibration.

From stated calculations it is obvious that the importance of the influence of changing of shafts stiffnesses may lead to incorrect results. It is clearly seen that the non respectation of this changing may be substantially influence the course of investigated magnitudes so in quantitative manner as also the character of behaviour of the system .

Hence for unambiguous reply to question at what conditions and how significantly comes to force the influence of changing stiffnesses of shafts to the dynamics of the system, more through experimental investigations are needed.

Following the simple design procedures presented here will remove much of the mystery in finding a solution to torque amplification factor problems. Improved operating and maintenance procedures and increased use of automated rotary winding machine systems will afford additional major improvements in this area.

Now we conclude that the methods of vibration control may be grouped into :-

1. Reduction at the source by balancing of the moving masses, balancing of magnetic forces and control of clearances.
2. Isolation of source and isolation of sensitive equipment.
3. Reduction of the response by, alteration of natural frequency, energy dissipation and auxiliary mass.

The method and results of this work must be nevertheless considered only as a small step one of many leading to more detailed recognition of dynamic actions and events of changing of stiffnesses of shafts .

Also as to the problem solved in this work it is necessary to complete it by just a set of following tasks. So example, there will be necessary to solve:

1. The set of equations equation (1), with consideration of damped gears.
2. The system without reduction.
3. The system with consideration of effect of backlash in the gears on the system.
4. The system with consideration of the linear responses.

With the results in this work one can state that the used methods are generally suitable for investigation of the torsional vibrations of drives of other types of arrangements.

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تحليل الاهتزازات الإلتوائية لماكينات اللف الدوارة

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ملخص

اختيار هذا العمل الذي هو تحليل أنظمة ماكينات اللف الدوارة (Analysis of Rotary Winding Machines System) هو بسبب أن هذه الماكينات موجودة في البلد في مصنع الكيبلات الكهربائية في ضواحي مدينة عدن وهذا التحليل حقيقي وعملي من واقع المصنع وكل القيم والمقادير المستخدمة في هذا العمل أخذت كقيم فعلية لتلك الماكينات وبالتالي النتائج المتحصل عليها حقيقية ليست نتائج لمعطيات افتراضية.

إن التطبيق الجيد لنظام تصميم ماكينة اللف الدوارة يستدعي التحليل للنظام ليؤمن رد الفعل (Reaction) الناشئ عن تشغيل الماكينة بأن لا يتسبب عجز أو ضرر للماكينة وذلك من نشوء أو ظهور اهتزاز الماكينة، لأن اهتزاز الماكينة يؤدي إلى نتيجة تصنع أو تولد حمل ديناميكي كبير والذي غالباً يسبب العجز أو الضرر المفاجئ لأجزاء الماكينة أو تصنع نوعية إنتاج رديئة . يعتبر الاهتزاز ألالتوائي (Torsional Vibration) الأوسع ظاهرة في أنواع الاهتزاز في النقل الميكانيكي . التوسع الدائم والمكثف للماكينات يستدعي دائماً زيادة طلب العمل من المحللين والمصممين وفي استخدام هذه الماكينات يعتبر قضيب المحرك (Drive) الأوسع تأثيراً على خاصية مجموعة القوى الفاعلة على أجزاء النظام مجتمعة .

الهدف من هذا العمل هو التحليل للاهتزازات الالتوائية (Analysis of Torsional Vibrations) لماكينات اللف الدوارة وتخفيض تلك الاهتزازات إلى الحد الأدنى المسموح به والذي بالتالي يؤدي إلى تخفيف مشاكل تكاليف الصيانة المتكررة . لتخفيض عزوم ديناميكية النظام (System Dynamic Torques) أنه من الضروري نشر أي بسط الترددات الطبيعية الالتوائية (Spread Torsional Natural Frequencies) للنظام . هذا يكون الأفضل إنجازه بتخفيض التردد الطبيعي ألالتوائي الأساسي (Fundamental Torsional Natural Frequency) وذلك بتخفيض الصلابة الالتوائية (Torsional Stiffness) في موقع محور دوران (Lead Spindle Location) محركات ماكينة اللف الدوارة أو بصنع مرونة (Flexibility) أكبر لمحور الدوران ألالتوائي وذلك بزيادة فصل عمود الإدارة (Shaft Separation) أو إذا من الضروري باستخدام المباعدة المرنة (Flexible Spacer) الالتوائية ، لأن الصلابة (Stiffness) الالتوائية تتناسب عكسياً مع طول عمود الإدارة (Shaft Length) .

لتحليل وحل الاهتزاز ألالتوائي لنظام ماكينة اللف الدوارة يجب أولاً وقبل كل شيء تقدير معاملات (Parameters) النظام الفيزيائي مع الأخذ بعين الاعتبار المجموعة الحقيقية (The Real Set) لأجزاء(Components) ماكينة اللف الدوارة وبتحويل ذلك إلى مودل ميكانيكي (Mechanical Model) . المودل الميكانيكي إلى مدى أبعد يعرف بمجموعة معادلات تفاضلية (Differential Equations) والتي تشكل المودل الرياضي (Mathematical Model) لنظام ماكينات اللف الدوارة . مجموعة المعادلات التفاضلية (معادلة (1) في البحث) هي عبارة عن معادلات الحركة (Equations of Motion) لكامل النظام المهتز وقد تم إيجادها باستخدام قانون نيوتن الثاني، وحل هذه المعادلات تم باستخدام طريقة العالم يعقوبي (Jacobi Method) لأنها طريقة سهلة للبرمجة وتعطي نتائج مضبوطة . البرمجة التي استخدمت في هذا العمل برمجة مثلاب. (MathLab Program) بسبب خاصيتها لحل مسائل الاهتزاز.

أخيراً ومن واقع الحل والنتائج لهذا البحث فإنه يعطي رؤية جيدة لتنذر إخفاق الماكينة وذلك بسبب الأخطاء في التصميم أو في حالات التشغيل.

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Isolation and Identification of Bioactive Actinomycete Isolates from Yemen Soils

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ABSTRACT

A total of 50 actinomycete isolates were isolated from different locations in Yemen (Sana'a, Taiz, Ibb and Alhodida). Agar disc diffusion method that used for screening antibacterial and antifungal activities were more effective and give better results than agar well diffusion method. Antibacterial activity of isolates was more effective than antifungal activity. All five selected isolates for study were active against *Bacillus subtilis*, *Staphylococcus aureus*, *Escherichia coli*, *Candida albicans* and *Microsporium canis*. According to taxonomy of actinomycetes (Morphological, physiological, biochemical and chemotaxonomy characters**)**, all selected isolates were identified as members belonging to genus *Streptomyces* (*S. glaucescenes*, *S. luridus*, *S. antibioticus*, *S. exfoliatus* and *S. filipinensis*).

INTRODUCTION

Actinomycetes constitute a significant proportion of the microbial population in most soils and their viable count often exceeds 1 million per gram (McCarthy and Williams, 1990). Among soil inhabitants, actinomycetes and specifically, *Streptomycetes* are of practical importance because they produce most of the useful natural antibiotics for medical use (Taddei *et al*., 2005). Actinomycetes have the ability to synthesize many different biological active secondary metabolites such as antibiotics, herbicides, pesticides, antiparasitic, immunomodulators and enzymes (Moncheva *et al*., 2002; Oskay *et al*., 2004). More than 50% of the known natural antibiotics produced by actinomycetes. They are a proven source of structurally diverse secondary metabolites possessing broad ranges of biological activities. Example include antibiotic (erythromycin and tetracycline), anticancer (mitomycin and daunomycin), immunosuppressant (rapamycin and FK506) and veterinary agent (thiostrepton and monensin) (Miyadoh, 1993; Moore *et al*., 1999).

MATERIALS AND METHODS

1. Sampling procedure:

Soil samples were collected from different location in Yemen (Sana'a, Taiz, Ibb and Alhodida). The samples were taken from up to 20 cm depth, after removing approximately 10 cm of the soil surface. The samples were placed in sterile plastic container (Aghighi *et al*., 2004).

2. Isolation of actinomycetes:

Isolation of actinomycetes was performed by soil dilution plate technique using starch nitrate agar. Plates were incubated at 28°C for 14 days. The isolates were enumerated and selected for further study (Aghighi *et al*., 2004).

3. Screening of actinomycetes for antimicrobial activity:

-Test microorganisms as bacteria (*Bacillus subtilis* NCTC 10400, *Staphylococcus aureus* isolated from wound and *Escherichia coli* isolated from urine) and fungi (*Candida albicans* MTCC 227 and *Microsporium canis* isolated from hair).

- Antimicrobial activities of actinomycetes performed by agar disc and well diffusion methods. Antagonistic activity was measured by the size of the inhibition zone (Pisano *et al*., 1992; Tepe *et al*., 2004).

4. Identification of bioactive actinomycete isolates:

I. Actinomycete isolates characters:

Five actinomycete isolates were selected according to the maximum bioactive activity and characterized by the following characters:

a. Morphological characters:

- **Cultural characters:** morphology and color of the spores were observed by inoculating the isolates on starch nitrate agar and incubated at 28°C for 21 days (Shirling and Gottlieb, 1972).
- **Spore chain morphological characters:** were determined by cover slip technique according to the categories of Pridham *et al*., 1958 which modified by Shirling and Gottlieb, 1966.
- **Spore surface ornamentation:** was studied by scanning electron microscopic according to (Tresner *et al*., 1961; Dietz and Methews, 1971).
- **Melanin pigment production:** peptone-yeast extract-iron agar and tyrosine agar was used for the detection of deep brown to black melanin diffusible pigment (Shirling and Gottlieb, 1966).

b. Physiological and biochemical properties:

- **Growth at different temperatures:** temperature for the isolates growth was determined on starch nitrate agar media at 25, 30, 37 and 45°C (Kokare *et al*., 2004; Dastager *et al*., 2006).
- **NaCl tolerance of the isolates:** were determined on starch nitrate broth containing sodium chloride ranging from concentration 0-10% (Kokare *et al*., 2004; Oskay *et al*., 2004).
- **Antimicrobial activity:** was determined by agar well diffusion method using two Gram +ve bacteria (*Bacillus subtilis, Staphylococcus aureus*) and one Gram –ve

bacteria (*Escherichia coli*), fungi (*Microsporium canis*) and yeast (*Candida albicans*) as test microorganisms (Tepe *et al.,* 2004).

- **Degradation of different substrates:** hydrolysis of starch according to Collins *et al*., 1995, pectin hydrolysis according to Shejul, 1998, degradation of lecithin according to method used by Kanavade, 2003 and degradation of lipid according to method used by Deshmukh, 1997.
- **Sensitivity to different antibiotics:** actinomycete isolates were tested for antibiotic sensitivity in the presence of antibiotics as neomycin (30 µg), penicillin G (10 units), novobiocin (30 µg), ampicillin (10 µg) by method described by Kokare *et al*., 2004.
- **Nitrogen utilization of the isolated actinomycetes:** was determined by growth on basal medium supplemented with 0.1% nitrogen sources such as L-cystein, DL-phenylalanine, L-tyrosine, L-arginine, L-valine, L-histidine and sodium nitrate (Langham *et al*., 1989).
- **Carbohydrate utilization of the isolates:** was determined by growth on basal medium supplemented with 1% carbon sources such as D (+) sucrose, melibiose, xylose, lactose, D- fructose and rhammnose (Shirling and Gottlieb, 1966).

c. Chemotaxonomic characters: isomers of diaminopimelic acid in the whole cell hydrolysates were determined according to the method Lechevalier and Lechevalier, 1970. Whole cell sugars were analyzed according to the method of Becker *et al*., 1964; Becker, 1965.

II. Identification of actinomycetes: by using Probability Identification of Bacteria (PIB) computer software (Williams *et al*., 1989; Langham *et al.,* 1989).

RESULTS

1. Sampling procedure and isolation of actinomycetes: A total of 50 isolates of actinomycetes were isolated from 6 soil samples (Table 1).

Table (1): Count of actinomycete isolates from different location in Yemen.

Location	Isolate code	No of isolates
Aser-Sana'a, Yemen	A	4
Pit poss- Sana'a, Yemen	B	5
Hada- Sana'a, Yemen	H	8
Alhodida- Yemen	D	6
Taiz-Yemen	T	14
Ibb- Yemen	I	13
Total isolate	-	50

2. Screening of actinomycetes for antimicrobial activity:

Fifty of actinomycete isolates screening for antimicrobial activity by agar disc and well diffusion methods. The agar disc diffusion method was more effectiveness and gives better results than AWD. Out of 50 actinomycete isolates, there were 31 isolates (62%) shown activity against *B. subtilis* by ADD and 21 isolates (42%) by AWD. For *S. aureus* 29 isolates (58%) had activity by ADD and 19 isolates (38%) had activity by AWD. The activity was low against *E. coli*, only 19 isolates (38%) was shown activity by ADD and15

isolates (30%) showed activity by AWD. Only 11 isolates (22%) showed activity against *C. albicans* by ADD and 10 isolates (20%) showed activity by AWD. Against *M. canis*, the activity was very low, only 7 isolates (14%) showed activity by ADD and 4 isolates (8%) showed activity by AWD. The results of the antimicrobial activity of actinomycete isolates are given in table 2.

Table (2): Antimicrobial activity of actinomycete isolates.

Isolate code	Test microorganisms (inhibition zone in cm)									
	B. subtilis		*S. aureus*		*E. coli*		*C. albicans*		*M. canis*	
	ADD	**AWD**	**ADD**	**AWD**	**ADD**	**AWD**	**ADD**	**AWD**	**ADD**	**AWD**
A_1	-	-	-	-	-	-	-	-	-	-
A_2	1.8	-	-	1.7	-	-	-	-	-	-
A_3	-	-	1.9	1.8	-	-	1.7	1.6	-	-
A_4	-	-	1.7	1.6	-	-	-	-	-	-
B_1	-	-	1 .9	1.8	-	-	-	-	-	-
B_2	-	-	-	-	1.9	1.6	-	-	-	-
B_3	2	1 .8	-	-	-	-	-	-	-	-
B_4	1.5	-	1.8	1.6	-	-	-	-	-	-
B_5	-	-	-	-	-	-	-	-	2	-
D_1	1.6	-	-	-	-	-	-	-	-	-
D_2	2.6	-	2 .1	2	-	-	-	-	-	-
D_3	2.5	2.3	1.8	1.6	-	-	-	-	-	-
D_4	2. 4	-	1 .9	1 .7	-	-	-	-	-	-
D_5	2.8	2.5	3	2.5	2.8	2.5	1.9	1.6	1.7	-
D_6	3	2.5	3.3	2.7	1.8	1.6	2.7	2.6	1.9	1.5
H_1	3.4	3	3.5	3	3.5	3.4	2.5	2	2	1.6
H_2	2.1	1.9	1.9	1.6	2	-	-	-	-	-
H_3	-	1.6	1.7	1.6	2.3	1.6	2.1	1.6	-	-
H_4	3.5	2.5	-	-	3.4	2.5	2.1	-	-	-
H_5	-	-	-	-	-	-	1.9	1-.8	-	-
H_6	1.8	-	-	-	-	-	-	-	-	-
H_7	3	2 .5	2 .7	-	-	-	1.8	1.6	-	-
H_8	2.8	2.5	-	-	-	-	1.7	1.6	-	-
I_1	-	-	-	-	-	-	-	-	-	-
I_2	-	-	-	-	-	-	-	-	-	-
I_3	-	-	-	-	-	-	-	-	-	-
I_4	2. 6	1.8	1.6	-	-	-	-	-	-	-
I_5	2	-	2.2	-	-	-	-	-	-	-
I_6	2.6	2.3	2.5	2.4	2.2	2	2.1	1.8	1.8	1.6
I_7	2.8	-	2.2	-	3	-	-	-	-	-
I_8	2	1.6	-	-	-	-	-	-	-	-

I_9	2.4	2	2	-	2.3	-	2	1.6	-	-
I_{10}	2.3	2	1.7	-	-	-	-	-	-	-
I_{11}	3	2	2.4	2	1.9	1.6	1.6	-	-	-
I_{12}	2.1	1.9	2.6	-	2.2	1.8	-	-	-	-
I_{13}	2.2	1.8	2.3	-	2.2	1.7	-	-	-	-
T_1	2.2	1.6	2.5	-	2.5	1.9	-	-	-	-
T_2	1.7	-	-	-	2.8	2	-	-	-	-
T_3	2.2	1.9	3.2	-	2.5	2	-	-	-	-
T_4	-	-	-	-	-	-	-	-	-	-
T_5	-	-	2.6	-	-	-	-	-	-	-
T_6	2.1	1.9	2.2	1.9	2	1.7	1.9	1.6	1.8	1.7
T_7	-	-	-	-	-	-	-	-	-	-
T_8	2	1.5	2.5	1.6	1.5	-	-	-	-	-
T_9	-	-	-	-	-	-	-	-	-	-
T_{10}	-	-	-	-	-	-	-	-	-	-
T_{11}	1.9	-	2	2	-	-	-	-	-	-
T_{12}	-	-	-	-	-	-	-	-	-	-
T_{13}	-	-	1.8	1.6	2.3	2	-	-	1.6	-
T_{14}	-	-	-	-	-	-	-	-	-	-

ADD: Agar Disk Diffusion **AWD**: Agar Well Diffusion

3. Actinomycete isolates characters:

I. Cultural characteristics:

All five isolates grew on agar media showing morphology characters typical as *Streptomyces* genus. Cultural characteristics of isolates on starch nitrate agar are summarized in table (3).

Table (3): Cultural characteristics of five isolates on starch nitrate agar.

Characters / **Isolates**	**Growth**	**Aerial mycelium**	**Substrate mycelium**	**Diffusible pigment**
D_5	Good	White	Violet	Violet
D_6	Good	White to green	Grey	_
H_1	Good	Grey	Brown	_
I_6	Good	White	Brown	Dark brown
T_{10}	Good	White to pink	Orange	Orange

II. Morphological, physiological and biochemical characteristics:

The morphological, physiological and biochemical characters of five bioactive isolates are summarized in table (4).

III. Chemotaxonomic analysis:

Analysis of the whole-cell hydrolysate of five isolates showed the presence of a cell wall chemotype I by presenting of L-DAP and no diagnostic sugars were found.

Table (4): Morphological, physiological, biochemical and chemotaxonomy characters of five isolates.

Characteristics	Isolates				
	D_5	D_6	H_1	I_6	T_{10}
Aerial mycelium	+	+	+	+	+
Spore chain character:					
Spirals	+	+	-	-	+
Hook	-	-	-	+	-
Flexuous	-	-	+	-	-
Spore surface ornamentation:					
Wavy	+	-	+	ND	-
Hairy	-	+	-	ND	-
Spiny	-	-	-	ND	+
Spore mass color:					
White	+	-	-	+	+
Grey	-	+	+	-	-
Mycelium pigment red-orange	+	-	-	-	+
Diffusible pigment produced	+	-	+	+	+
Diffusible pigment yellow-brown	-	-	+	+	-
Melanin production on media:					
Peptone yeast extract iron agar	-	+	-	+	+
Tyrosine agar	-	-	-	-	-
Growth at:					
Temperature:					
25°C	+	+	+	+	+
30°C	+	+	+	+	+
37°C	+	+	+	+	+
45°C	+	+	+	-	-
NaCl:					
NaCl 6%	+	+	+	+	-
NaCl 8%	+	-	+	-	-
Antagonistic activity:					
B. subtilis	+	+	+	+	+
S. aureus	+	+	+	+	+
E. coli	+	+	+	+	+
C. albicans	+	+	+	+	+
M. canis	+	+	+	-	+
Degradation of:					
Lecithin	+	+	+	+	+
Lipid	+	+	+	+	+
Pectin	+	+	+	+	+

Xylan	+	-	+	+	+
Urea	+	+	-	-	-
Resistance to:					
Neomycin (30 µg)	-	-	-	-	+
Penicillin G (10 units)	+	+	+	+	+
Novobiocin (30 µg)	-	-	-	-	+
Ampicillin (10 µg)	+	-	+	+	+
Utilization of:					
L-cystein	+	+	-	-	+
DL-phenyl alanine	+	+	-	+	+
L-tyrosine	+	+	+	+	+
L-arginine	+	+	+	+	+
L-valine	+	+	+	+	+
L-histidine	+	+	+	+	+
Sodium nitrate	+	+	+	+	+
D(+)sucrose	+	+	+	+	+
Melibiose	+	+	+	+	+
Xylose	+	+	+	+	+
Lactose	+	+	+	+	+
D-fructose	+	+	+	+	+
Rhammnose	-	+	-	+	-
Chemotaxonomy:					
DAP	L-DAP	L-DAP	L-DAP	L-DAP	L-DAP
Diagnostic sugar	-	-	-	-	-

+, positive; -, negative; ND, not determined.

4: Identification of actinomycetes by PIB software: Table 5 show the identification of actinomycete isolates by PIB software.

Table (5): Identification of actinomycete isolates by PIB software.

Isolate code	Name
D_5	*Streptomyces glaucescenes*
D_6	*Streptomyces luridus*
H_1	*Streptomyces antibioticus*
I_6	*Streptomyces exfoliatus*
T_{10}	*Streptomyces filipinensis*

DISCUSSION

From 6 soil samples collected from different sites in Yemen, 50 isolates of actinomycetes were found. Actinomycete isolates were screened for antimicrobial activity by two methods, viz., ADD and AWD. All isolates showed antimicrobial activity on ADD but failed to do so in fermentation media. This was correlated with the morphology of the culture. It could maintain filamentous form on the agar medium, while in the liquid medium it fragmented into rods. This has suggested that the cell morphology plays an important role in the production of antibiotics which recorded by Shomura *et al.* 1979. According to antimicrobial activity and spectrum broadness, 5 isolates were selected and identified

depend upon maximum antimicrobial activities. Morphological examination of the 5 isolates clearly indicates that these isolates belong to the *Streptomyces* genus (Waksman, 1961; Cross, 1989; Goodfellow, 1989; Lechevalier, 1989; Locci, 1989; Williams *et al*., 1989). Further comparison of physiological and biochemical characteristics of the isolates after used software PIB for identification indicated that the D_5 is similar character to *Streptomyces glaucescenes* (98%). Isolate D_6 isolate as *Streptomyces luridus* (98%). In the same manner, H_1 isolate was identified as *Streptomyces antibioticus* (98%), I_6 isolate as *Streptomyces exfoliatus* (98%) and T_{10} isolate as *Streptomyces filipinensis* (98%).

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عزل وتعريف الأكتينوميسيتس ذات النشاط الضد ميكروبى من التربه اليمنية

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ملخص

تم فى هذه الدراسة جمع 50 عزله من الاكتينوميسيتس عزلت من مواقع مختلفة من اليمن (صنعاء, تعز, اب و الحديدة). وقد أظهرت طريقة انتشار أقراص الأجار التي استخدمت لدراسة النشاط الضد البكتيري و الضد الفطري أكثر تأثيرا و تعطي نتائج أفضل من طريقة انتشار حفر الأجار. كما أن نشاط العزلات ضد البكتيريا أكثر فاعلية من نشاط العزلات ضد الفطريات. كل العزلات المختارة للدراسة لها نشاط ضد *Bacillus subtilis*, *Staphylococcus aureus* , *Escherichia coli* , *Candida albicans* و *Microsporium canis* .

تبعا لتصنيف الاكتينوميسيتس (الصفات المورفولوجية, الفسيولوجية, الكيمائية الحيوية و التصنيف الكيميائي), كل العزلات عرفت كأعضاء تابعة لجنس *Streptomyces* (*S. glaucescenes* , *S. antibioticus*, *S. luridus* , *S. exfoliatus* و *S. filipinensis*).

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Numerical Solutions of Stiff and Nonstiff Ordinary Differential Equations Using Quadratic Spline Method

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ABSTRACT

This paper deals with the numerical solution of initial value problems(IVPs), for stiff and nonstiff ordinary differential equations by Quadratic Spline(QS) method. We convert a stiff and nonstiff equations to volterra integral equations and reduce a second order IVPs to a system of Volterra integral equations of the second kind . The numerical results shown to verify the conclusions .A comparison of the results generated from the QS formula was carried out with some existing Runge-Kutta methods of variety of means including the Geometric Mean method, the Contraharmonic Mean method, the Centroidal Mean method, the Harmonic Mean method, the Heronian Mean method, the Root Mean Square method, and the Arithmetic Mean formula and were found to compare favourably well. Good numerical results were obtained from the test examples and we conclude with numerical examples to justify the effectiveness of the QS method.
Key Words: stiff and nonstiff ordinary differential equation; quadratic spline method; volterra integral equations of the second kind..

1. INTRODUCTION

The quadratic spline Q(x) has continuous first derivatives at the knots $t_1 < t_2 < \ldots < t_n$.

The objective in quadratic spline is to derive a second order polynomial for each interval between data points(Chapra and Canale,1988, DeBoor,20011)

$$Q(x) = \begin{cases} Q_0(x) & t_0 \le x \le t_1 \\ Q_1(x) & t_1 \le x \le t_2 \\ . & \\ . & \\ . & \\ Q_{n-1}(x) & t_{n-1} \le x \le t_n \end{cases}$$

Where $Q_i(x) = \dfrac{Q'_{i+1} - Q'_i}{2(t_{i+1} - t_i)}(x - t_i)^2 + Q_i'(x - t_i) + y_i.$ …(1.1)

Which is continuously differentiable on the entire interval $[t_1, t_n]$.

There are three conditions which define the function Q(x) uniquely on $[t_i, t_{i+1}]$ as given in equation(1.1), they are:

1- $Q_i(t_i) = y_i$

2- $Q'_i(t_i) = Q'_i$

3- $Q'_i(t_{i+1}) = Q'_{i+1}$

Now, in order for the quadratic spline function Q(x) to be continuous and to interpolate the table of data, it is necessary and sufficient that $Q_i(t_{i+1}) = y_{i+1}$ for i=1,2,…,n-1 in equation(1.1) with Q_1' arbitrary.

The result is:

$$Q_i(t_{i+1}) = \frac{Q'_{i+1} - Q'_i}{2(t_{i+1} - t_i)}(t_{i+1} - t_i)^2 + Q_i'(t_{i+1} - t_i) + y_i.$$

So, we get:

$$Q'_{i+1} = -Q'_i + 2\left(\frac{y_{i+1} - y_i}{t_{i+1} - t_i}\right), \quad 1 \le i \le n-1 \qquad \text{… (1.2)}$$

This equation can be used to obtain the vector $[Q'_1, Q'_2, ..., Q'_n]^T$ starting with an arbitrary value for Q_1' (Fogiel,1983).

This quadratic spline will be used to find the solutions of volterra integral equation of the second kind as follows:

$$Q(x) = A_i(x)\, Q_i + B_i(x)\, Q_{i+1} + C_i(x)\, Q_i'. \qquad \text{… (1.3)}$$

Where

$$A_i(x) = 1-\left(\frac{x-t_i}{h}\right)^2 \quad ,$$

$$B_i(x) = 1 - A_i(x) \quad ,$$

$$C_i(x) = \frac{1}{h}(x-t_i)\ (x-t_{i+1}) \quad , \quad h = t_{i+1} - t_i$$

For the continuity of $Q^{'}$ we require that:

$$Q^{'}_{i+1} = -Q^{'}_{i} + \frac{2}{h}\left(y_{i+1} - y_i\right) \quad , \quad i = 1,2,....$$

Suppose now that $Q_0, Q_1, ..., Q_{r-1}$, $Q^{'}_0, Q^{'}_1, ..., Q^{'}_{r-1}$ are known, then we put (1.3) in (1.1) we get:

$$Q_r = g_r + [\sum_{j=0}^{r-2}\int_{x_i}^{x_{i+1}} K(x_r, y, A_j(y)\ Q_j + B_j(y)\ Q_{j+1} + C_j(y)\ Q_j^{'}.]dy] + \int_{x_{r-1}}^{x_r} K(x_r, y, A_{r-1}(y)\ Q_{r-1} + B_{r-1}(y)\ Q_r + C_r(y)\ Q_{r-1}^{'}.]dy \qquad (1.4)$$

This equation will be solved by iterations, and the integrals in (1.4) are replaced by Simpson's 1/3 rule (Delves and Walsh,1988).

2. CONVERTING INITIAL VALUE PROBLEMS TO VOLTERRA INTEGRAL EQUATIONS

***Example 1*)** To convert the following IVP to volterra integral equation:

$$\frac{dy}{dx} = f(x,y) \quad , \quad y(x_0) = y_0 \qquad (2.1)$$

We integrate (2.1) w.r.t. x from x_0 to x , we write:

$$y(x) - y(x_0) = \int_{x_0}^{x} f(t, y(t))dt$$

$$\therefore\ y(x) = y_0 + \int_{x_0}^{x} f(t, y(t))dt$$

which is a volterra integral equation of the second kind.

Example 2) To reduce the initial value problem:

$$\frac{d^2y}{dx^2} + y = \cos\ x \qquad (2.2)$$

$$,\ \ y(0) = 0\ , \qquad (2.3)$$

$$y'(0) = 0 \qquad (2.4)$$

to volterra equation , we let $u(x) = \frac{d^2y}{dx^2}$ then integrate one to have:

$$\frac{dy}{dx} = \int_0^x u(t)dt + c_1$$

With c_1 =0 after using the initial condition (2.3). We integrate this result again, using integration by parts :

$$y(x) = \int_0^x \int_0^s u(t)dtds$$

Let $u(s) = \int_0^s u(t)dt$ and $dv = ds$

So, $du = u(t)$ and $v = s$

$$y(x) = \int_0^x \int_0^s u(t)dtds$$

$$= \left[s\int_0^s u(t)dt \right]_0^x - \int_0^x s\ u(s)ds$$

$$= x\int_0^x u(t)dt - 0 - \int_0^x s\ u(s)ds$$

$$= \int_0^x (x-s)\ u(s)ds = \int_0^x (x-t)\ u(t)dt$$

we get:

$$y(x) = \int_0^x (x-t)\ u(t)dt + c_2$$

where we also have c_2 =0 from using the initial condition (2.4),

$$y(x) = \int_0^x (x-t)\ u(t)dt \qquad (2.5)$$

For the final result (2.5) to be an integral equation, we use (2.2) to have

$$y(x) = \cos\ x - \frac{d^2y}{dx^2} = \cos\ x - u(x)$$

to substitute for the y(x) term outside the integral for (2.5) to become a volterra integral equation of the second kind in $u(x) = \frac{d^2y}{dx^2}$

$$\cos\ x - u(x) = \int_0^x (x-t)\ u(t)dt$$

$$u(x) = \cos\ x - \int_0^x (x-t)\ u(t)dt$$

Example 3) To reduce the initial value problem :

$$\frac{d^2}{dt^2}y(t) + P_1(t)\frac{d}{dt}y(t) + P_2(t)y(t) = g(t)\ ,$$

$$y(a) = y_0 \qquad y'(a) = y_1$$

Let $y_1(t) = y(t)$, $y_2(t) = y'(t)$, we get:

$$y'_1(t) = y_2(t)\ ,$$

$$y'_2(t) = g(t) - P_1(t)y_2(t) - P_2(t)y_1(t)$$

Integrate both sides over [a,x] we get:

$$y_1(x) = y_0 + \int_a^x y_2(t)dt\ ,$$

$$y_2(x) = y_1 + \int_a^x g(t)dt - \int_a^x P_1(t)y_2(t)dt - \int_a^x P_2(t)y_1(t)dt\ .$$

For more details about the relationship between ordinary differential equations and integral equations and reduction of initial value problems to volterra integral equations see for example(Jerri,1985 ,and Wazwaz,1997) .

3. NUMERICAL RESULTS

In this section, we present numerical results when the problems(3.1-3.10):

(i) First order IVPs:

Problem 1 :

$$\frac{dy}{dx} = xy \quad , \quad y(0)=0 \quad , \quad 0\le x\le 1 \quad , \tag{3.1}$$

Where the exact solution is $y(x)= e^{\frac{x^2}{2}}$,

Problem 2 :

$$y' = -xy \quad , \quad y(0)=1 \quad , \quad 0\le x\le 1 \quad , \tag{3.2}$$

Where the exact solution is $y(x)= e^{-\frac{x^2}{2}}$,

Problem 3 :

$$y' = -y \quad , \quad y(0)=1 \quad , \quad 0\le x\le 1 \quad , \tag{3.3}$$

Where the exact solution is $y(x)= e^{-x}$,

Problem 4 :

$$\frac{dy}{dx} = x(y - x^2 + 2) \quad , \quad y(0)=1 \quad , \quad 0\le x\le 1 \quad , \tag{3.4}$$

Where the exact solution is $y(x)= x^2 + e^{\frac{x^2}{2}}$,

(ii) Second order IVPs:

Problem 5 :

$$y'' - 2(\cos(x-y))y = \frac{2}{x^2}\sin x \quad , \quad y(0)=0 \quad , \quad y'(0)= 0, \quad 0\le x\le 1 \quad , \tag{3.5}$$

Where the exact solution is $y(x)= x\, e^{x}$,

Problem 6 :

$$y'' - y = -\frac{1333}{2400}\, x \quad , \quad y(0)=0 \quad , \quad y'(0)=1 \quad , \quad 0\le x\le 1 \quad , \tag{3.6}$$

Where the exact solution is $y(x)= x$,

Problem 7 :

$$y'' + e^{-x+y} = -\frac{1}{x}\, e^{-x+2y} \quad , \quad y(0)=0 \quad , \quad y'(0)=-1 \quad , \quad 0\le x\le 1 \quad , \tag{3.7}$$

Where the exact solution is $y(x)= x$,

Problem 8 :

$$y'' + y = -\cos x \quad , \quad y(0)=0 \quad , y'(0)=-1 \quad , \quad 0\le x\le 1 \quad , \qquad (3.8)$$

Where the exact solution is $y(x)=(-1-\frac{1}{2}x)\sin x$,

Problem 9 :

$$y'' - (\frac{1}{x-y}\sin(x-y))y = \frac{2}{x^2}\cos x \quad , y(0)=0 \ , y'(0)=0 \ , \ 0\le x\le 1 \ , \qquad (3.9)$$

The exact solution is : $y(x)= 1$,

Problem 10 (Stiff system):

$$y_1' = y_2 \quad , \quad y_1(0)=1 \ , \ 0\le x\le 1$$

$$y_2' = -1000\, y_1 - 1001\, y_2 \quad , y_2(0)=-1 \qquad (3.10)$$

Where the exact solution is $y(x)= e^{-x}$

are solved using the Quadratic Spline (QS) method and comparing the obtained results with some methods including the Geometric Mean method, the Contraharmonic Mean method, the Centroidal Mean method, the Harmonic Mean method, the Heronian Mean method, the Root Mean Square method, and the Arithmetic Mean formula.

Tables (3.1-3.4) show the errors obtained by quadratic Spline method(QS), the fourth order Geometric Mean(GM) (Sanugi and Evans,1988), the Contraharmonic Mean(CoM), the Centroidal Mean(CeM), the Harmonic Mean(HM), the Heronian Mean(HeM) (Ponalagusamy and Senthilkumar,2008), the fourth order Root- Mean-Square(RMs4) (Yaakub and Evans,1993), and the third order Root- Mean-Square(RMs3) formula (Evans and Yaakub,1993).

The error in the numerical solution using Quadratic Spline formula(QS) compared with the exact solution are shown in Tables (3.5-3.6) .While the error in the numerical solution using Quadratic Spline formulae(QS) compared with Arithmetic Mean(AM) in (Sanugi and Evans,1988) and the exact solution are shown in Table (3.7).

Table (3.1) :Errors by using the various fourth order formulae for solving(3.1), h=0.1

X	*Error (QS)*	*Error (GM))*	*Error (CoM)*	*Error (CeM)*	*Error (HM)*	*Error (HeM)*	*Error (RMS3)*	*Error (RMS4)*
0.10	1.26048E-05	9.76569E-04	1.11026E-03	1.89784E-03	4.61308E-04	3.25467E-04	2.40415E-03	4.80117E-04
0.20	8.44982E-05	1.13862E-03	1.41870E-03	3.61521E-03	1.77921E-03	3.79466E-04	4.23212E-03	6.32071E-04
0.30	2.61854E-04	1.25842E-03	1.63542E-03	5.46699E-03	3.34006E-03	4.19369E-04	6.13173E-03	7.38278E-04
0.40	4.80859E-04	1.37320E-03	1.83262E-03	7.57058E-03	5.16784E-03	4.57590E-04	8.25632E-03	8.34024E-04
0.50	6.86416E-04	1.49668E-03	2.03652E-03	1.00472E-02	7.34790E-03	4.98704E-04	1.07363E-02	9.32225E-04
0.60	8.32555E-04	1.63723E-03	2.26240E-03	1.30419E-02	1.00018E-02	5.45497E-04	1.37181E-02	1.04037E-03
0.70	8.51714E-04	1.80192E-03	2.52252E-03	1.67370E-02	1.32907E-02	6.00329E-04	1.73823E-02	1.16442E-03
0.80	6.76874E-04	1.99809E-03	2.82906E-03	2.13690E-02	1.74269E-02	6.65642E-04	2.19601E-02	1.31026E-03
0.90	2.05026E-04	2.23419E-03	3.19578E-03	2.72486E-02	2.26918E-02	7.44258E-04	2.77540E-02	1.48449E-03
1.00	6.85999E-04	2.52055E-03	3.63925E-03	3.47902E-02	2.94617E-02	8.39629E-04	3.51664E-02	1.69504E-03

Table (3.2) : Errors by using the various fourth order formulae for solving(3.2) , h=0.1

X	*Error (QS)*	*Error (GM)*	*Error (CoM)*	*Error (CeM)*	*Error (HM)*	*Error (HeM)*	*Error (RMS3)*	*Error (RMS4)*
0.10	1.23964E-05	8.99897E-03	1.11200E-03	1.87438E-03	4.44409E-04	3.00030E-03	2.38611E-03	1.04558E-02
0.20	8.21925E-05	3.86186E-02	1.37540E-03	3.39442E-03	1.64616E-03	1.28158E-02	4.01468E-03	4.03794E-02
0.30	2.38577E-04	8.78933E-02	1.49803E-03	4.72227E-03	2.83845E-03	2.88204E-02	5.38497E-03	8.98601E-02
0.40	3.89868E-04	1.56623E-01	1.54870E-03	5.81988E-03	3.89355E-03	5.03963E-02	6.49785E-03	1.58769E-01
0.50	4.64298E-04	2.44713E-01	1.55071E-03	6.64831E-03	4.74106E-03	7.67280E-02	7.32710E-03	2.47035E-01
0.60	3.86826E-04	3.52232E-01	1.51619E-03	7.18156E-03	5.33761E-03	1.06839E-01	7.85259E-03	3.54739E-01
0.70	1.14633E-04	4.79507E-01	1.45342E-03	7.41018E-03	5.66133E-03	1.39639E-01	8.06810E-03	4.82219E-01
0.80	3.99640E-04	6.27249E-01	1.36905E-03	7.34191E-03	5.70989E-03	1.73978E-01	7.98322E-03	6.30190E-01
0.90	1.14688E-03	7.96696E-01	1.26891E-03	7.00048E-03	5.49841E-03	2.08701E-01	7.62275E-03	7.99897E-01
1.00	2.14169E-03	9.89786E-01	1.15820E-03	6.42308E-03	5.05679E-03	2.42694E-01	7.02448E-03	9.93287E-01
L.S.E.=	6.65604E-06	9.79676E-01	1.34144E-06	4.12559E-05	2.55711E-05	5.89003E-02	4.93433E-05	9.86619E-01

Where L.S.E. is the least square error.

Table (3.3) :Errors by using the various fourth order formulae for solving(3.3), h=0.1

x	*Error (QS)*	*Error (GM)*	*Error (HeM)*	*Error (RMS4)*
0.10	2.4564656542 E-03	1.9032496497 E-01	6.3432471495 E-02	1.9032519311 E-01
0.20	3.2354527611 E-03	3.8064989207 E-01	1.1881582590 E-01	3.8065039177 E-01
0.30	2.3240925411 E-03	5.7269834478 E-01	1.6697990177 E-01	5.7269916566 E-01
0.40	1.4670367364 E-03	7.6819388591 E-01	2.0867354171 E-01	7.6819508457 E-01
0.50	9.1548633227 E-03	9.6887568598 E-01	2.4457236439 E-01	9.6887732690 E-01
0.60	4.4472418149 E-03	1.1765141316 E-00	2.7528579503 E-01	1.1765162881 E-00
0.70	1.4984566722 E-02	1.3929265755 E-00	3.0136342481 E-01	1.3929293308 E-00
0.80	4.3886188919 E-03	1.6199933683 E-00	3.2330076317 E-01	1.6199968169 E-00
0.90	2.0869026894 E-02	1.8596743170 E-00	3.4154444095 E-01	1.8596785659 E-00
1.00	8.6447411923 E-04	2.1140257129 E-00	3.5649691646 E-01	2.1140308831 E-00
L.S.E.=	8.0770627787 E-04	4.4691047147 E-00	1.2709005145 E-01	4.4691265746 E-00

Table (3.4) : Errors by using the various fourth order formulae for solving(3.4), h=0.1

x	*Error (QS)*	*Error (CoM)*	*Error (CeM)*	*Error (HeM)*	*Error (RMS3)*	*Error (RMS4)*
0.10	3.77304E-05	3.32107E-03	5.66540E-03	9.74355E-04	7.19442E-03	1.43585E-03
0.20	2.52985E-04	4.21510E-03	1.06677E-02	1.13101E-03	1.25502E-02	1.87626E-03
0.30	7.74907E-04	4.81149E-03	1.58488E-02	1.24162E-03	1.79123E-02	2.16814E-03
0.40	1.39042E-03	5.32444E-03	2.14400E-02	1.34297E-03	2.36246E-02	2.41614E-03
0.50	1.90559E-03	5.82867E-03	2.76547E-02	1.44813E-03	2.99346E-02	2.65704E-03
0.60	2.15159E-03	6.36435E-03	3.47342E-02	1.56449E-03	3.70966E-02	2.91049E-03
0.70	1.89800E-03	6.96052E-03	4.29706E-02	1.69775E-03	4.54079E-02	3.19049E-03
0.80	9.24293E-03	7.64326E-03	5.27304E-02	1.85360E-03	5.52351E-02	3.50942E-03
0.90	1.08199E-03	8.43975E-03	6.44823E-02	2.03795E-03	6.70437E-02	3.88005E-03
1.00	4.46551E-03	9.38098E-03	7.88363E-02	2.25797E-03	8.14363E-02	4.31679E-03
L.S.E.=	3.64280E-05	8.80028E-05	6.21516E-03	5.09842E-06	6.63186E-03	1.86347E-05

Table (3.5) : Error in the Quadratic Spline formula for solving (3.5), (3.6) , (3.7), h=0.1

X	***Problem(3.5)***		***Problem(3.6)***		***Problem(3.7)***	
	Exact	*Error*	*Exact*	*Error*	*Exact*	*Error*
0.10	1.1051709181E-01	4.0892668892E-04	1.0000000000E-01	1.6835016834E-04	1.0000000000E-01	1.6277911971E-04
0.20	2.4428055163E-01	3.1745627412E-02	2.0000000000E-01	1.3649860064E-03	2.0000000000E-01	3.2509953573E-03
0.30	4.0495764227E-01	5.3708781052E-03	3.0000000000E-01	1.0187040093E-03	3.0000000000E-01	1.8803306125E-03
0.40	5.9672987906E-01	5.9974701153E-03	4.0000000000E-01	7.1177997461E-04	4.0000000000E-01	4.0332157964E-03
0.50	8.2436063535E-01	6.2002966060E-03	5.0000000000E-01	3.1897561616E-03	5.0000000000E-01	1.1632268023E-02
0.60	1.0932712802E+00	7.0774082760E-03	6.0000000000E-01	7.5510633051E-03	6.0000000000E-01	1.2162892241E-02
0.70	1.4096268952E+00	1.6882995802E-02	7.0000000000E-01	1.3382929083E-02	7.0000000000E-01	2.2228621474E-02
0.80	1.7804327428E+00	3.0888552837E-02	8.0000000000E-01	2.1837427546E-02	8.0000000000E-01	1.9495365182E-02
0.90	2.2136428000E+00	5.1725040514E-02	9.0000000000E-01	3.3411198240E-02	9.0000000000E-01	3.3952977842E-02
1.00	2.7182818285E+00	7.6922128144E-02	1.0000000000E+00	4.9464869352E-02	1.0000000000E+00	2.5322625841E-02
L.S.E.= 1.0992933304E-02			4.2896865191E-03		2.9818645078E-03	

Table (3.6) : Error in the Quadratic Spline formula for solving (3.8), (3.9) , h=0.1

x	***Problem(3.8)***		***Problem(3.9)***	
	Exact	*Error*	*Exact*	*Error*
0.10	-1.0049832501E-02	1.6708702333E-07	1.0000000000E+00	4.1638904804E-06
0.20	-2.0198653360E-02	5.0110315897E-09	1.0000000000E+00	8.2533006207E-08
0.30	-3.0445432706E-02	8.2843359905E-07	1.0000000000E+00	4.1871317080E-08
0.40	-4.0789120870E-02	2.0031598069E-06	1.0000000000E+00	2.1628329705E-07
0.50	-5.1228648502E-02	3.5229601849E-06	1.0000000000E+00	4.3075488065E-08
0.60	-6.1762926674E-02	5.3901333104E-06	1.0000000000E+00	2.8943668440E-07
0.70	-7.2390846994E-02	7.6084206739E-06	1.0000000000E+00	1.2660893844E-07
0.80	-8.3111281728E-02	1.0179976471E-05	1.0000000000E+00	3.6098208511E-07
0.90	-9.3923083912E-02	1.3108402754E-05	1.0000000000E+00	2.0794959710E-07
1.00	-1.0482608748E-01	1.6395700982E-05	1.0000000000E+00	4.3092950364E-07
L.S.E.= 6.4836089974E-10			1.7854237555E-11	

Table (3.7) : Error in the Quadratic Spline formula and the Arithmetic Mean formula for solving (3.10), h=0.1

x	*QS*		*AM*		*Exact Solution*	
	Error of y_1	*Error of* y_2	*Error of* y_1	*Error of* y_2	y_1	y_2
0.10	1.2672E-06	1.2672E-06	1.6258196410E-04	1.6258196138E-04	9.0483741804E-01	9.0483741804E-01
0.20	2.64E-07	2.64E-07	6.0258025769E-04	6.0258119356E-04	8.1873075308E-01	8.1873075308E-01
0.30	1.154E-06	1.154E-06	9.4427919339E-04	9.4415394506E-04	7.4081822068E-01	7.4081822068E-01
0.40	4.76E-07	4.76E-07	1.2162216217E-03	1.2338599645E-03	6.7032004603E-01	6.7032004603E-01
0.50	1.069E-06	1.069E-06	1.4254477474E-03	1.1173258627E-03	6.0653065971E-01	6.0653065971E-01
0.60	6.49E-07	6.49E-07	1.9536824184E-03	3.6665157673E-01	5.4881163609E-01	5.4881163609E-01
0.70	1.025E-06	1.025E-06	1.7907004613E+00	1.7891750594E+03	4.9658530379E-01	4.9658530379E-01
0.80	7.92E-07	7.92E-07	2.3614505812E+02	2.3614668880E+05	4.4932896412E-01	4.4932896412E-01
0.90	1.013E-06	1.013E-06	3.3784643524E+04	3.3784641829E+07	4.0656965974E-01	4.0656965974E-01
1.00	9.16E-07	9.16E-07	4.8220874845E+06	4.8220874862E+09	3.6787944117E-01	3.6787944117E-01
L.S.E . = 8.399503 E-12						

4. CONCLUSION

Several examples were applied for illustration and good results were achieved. Good results depend on the selecting of the initial value of Q and the initial value of the derivative.

From Table (3.1), it can be seen that the errors satisfying
QS < HeM < RMS4 < GM < CoM < HM < CeM < RMS3.
From Table (3.2), it can be seen that the errors satisfying
QS < HM < CoM < CeM < RMS3 < HeM < GM < RMS4.
From Table (3.3), it can be seen that the errors satisfying
QS < HeM < GM < RMS3.

From Table (3.4), it can be seen that the errors satisfying
QS < HeM < RMS4 < GM < CoM < CeM < RMS3.

Tables (3.5) and (3.6) show that the Quadratic Spline method performs better accuracy compared with the exact solution.

Table (3.7) noted that the Quadratic Spline method gives the smallest error compared to the Arithmetic Mean in (Sanugi and Evans,1988) formula. The results generated were of high accuracy and have minimal errors. From the above results, it will be observed that the QS method is appropriate for stiff and nonstiff problems.

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الحلول العددية للمعادلات التفاضلية الاعتيادية الصلبة وغير الصلبة بإستخدام طريقة الشرائح التربيعية

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ملخص

يتناول هذا البحث الحل العددي لمسائل القيم الابتدائية للمعادلات التفاضلية الاعتيادية الصلبة وغير الصلبة بإستخدام طريقة الشرائح التربيعية . حيث قمنا بتحويل المعادلات الصلبة وغير الصلبة إلى معادلات فولتيرا التكاملية، وكذلك اختزال مسائل القيم الابتدائية من الرتبة الثانية إلى نظام من إلى معادلات فولتيرا التكاملية من النوع الثاني. النتائج العددية التي تم الحصول عليها تؤكد الاستنتاجات. تم عمل مقارنة بين النتائج العددية التي تم الحصول عليها بطريقة الشرائح التربيعية مع نتائج بعض طرق رونج-كوتا الموجودة بمتوسطات متعددة متضمنة طريقة المتوسط الهندسي، وطريقة المتوسط التوافقي العكسي ، وطريقة متوسط مركز الشكل الهندسي ، وطريقة المتوسط التوافقي ، وطريقة المتوسط الهيروني ، وطريقة جذر متوسط المربعات ، وطريقة المتوسط الحسابي. ووجدنا أن المقارنة حسنة. وتم الحصول على نتائج عددية جيدة من الأمثلة المستخدمة وبذلك نستنتج ومن خلال الأمثلة العددية قوة تأثير طريقة الشرائح التربيعية.

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تشخيص إصابة محصول الذرة الصفراء طبيعيا بفيروس تقزم واصفرار الشعير-PAV في بعض المحافظات اليمنية

عادل العنسي

القسم الزراعي، كلية الزراعة والطب البيطري، جامعة ذمار، اليمن

ملخص

تم أجراء مسح حقلي للتحري عن فيروس تقزم واصفرار الشعير (Barley yellow dwarf virus -PAV) (BYDV-PAV، عائلة Luteoviridae) على محصول الذرة الصفراء في مناطق زراعتها في محافظات صنعاء وذمار وأب نفذ المسح الحقلي خلال سبتمبر / 2009، خلال هذا المسح تم زيارة عشرة حقول مزروعة بمحصول الذرة الصفراء اختيرت عشوائيا، شخّص فيروس تقزم واصفرار الشعير لكل حقل بالاعتماد على نتائج الأختبارات السيرلوجية/المصلية لـ 913 عينة (852عينة جمعت عشوائيا و 61 عينة كانت تبدي إعراض إصابة فيروسية)، طبعت جميع العينات على أغشية نتروسيلليلوز وفحصت باستخدام اختبار بصمة النسيج النباتي المناعي(TBIA) فأظهرت نتائج الأختبارات السيرلوجية/المصلية للعينات وجود فيروس تقزم واصفرار الشعير-PAV في حقول الذرة الصفراء المزروعة ضمن المحافظات الممسوحة ولم تتباين نسب الإصابة ما بين المحافظات، وكانت نسبة وجود فيروس تقزم واصفرار الشعير 4.5% في العينات المجموعة عشوائيا 18% في العينات التي تبدي إعراض فيروسي. و يعد هذا هو التسجيل الأول المصلي لتواجد فيروس تقزم واصفرار الشعير على محصول الذرة الصفراء في اليمن

كلمات مفتاحيه : فيروس تقزم واصفرار الشعير، الذرة الصفراء، مسح حقلي، اليمن

المقدمة

تأتي الذرة الصفراء.(*Zea mays* L.) في المرتبة الثالثة عالميا من حيث المساحة المزروعة وذلك بعد محصولي القمح والشعير إلا أن أهمية هذا المحصول في تزايد مستمر لكونه يستخدم في تغذية الإنسان والصناعات الغذائية والكحولية، كما يستخدم في تغذية الحيوان كعليقه مركزة أو خضراء أو جافة أو بشكل سيلاج (يوسف وآخرون، 1998).

تزرع الذرة الصفراء في اليمن على مساحة 142 ألف هكتار تنتج637 ألف طن وبمردود2410 كغ/هكتار وهو منخفض بالمقارنة مع المتوسط العالمي 3886 كغ/ هكتار(الإحصاء الزراعي السنوي، 2009) ويمكن أن يعزى سبب ذلك إلى تأثر إنتاجيتها سلباً بالإصابة بالآفات المختلفة، ومنها الفيروسات التي تعد أحد الأسباب الكامنة وراء تدني الإنتاج، حيث أشارت الدراسات السابقة إلى إصابة هذا المحصول في الظروف الطبيعية بعدد من الفيروسات في مختلف أنحاء العالم (Hull,2002 ،Zadoks،2001 ،Pearson & Robb,1984 ،Allen,1975) ،

يعد فيروس تقزم واصفرار الشعيرBarley yellow dwarf virus-PAV ، عائلة Luteoviridae من أهم الفيروسات التي تصيب الذرة الصفراء (Stoner,1977،Allen , 1975، Brown et al.,1984، Pearson & Robb, 1984 ، 2001، Zadoks، 2002, Hull)، حيث يسبب خسائر اقتصادية متفاوتة، ترتبط بمدى انتشار الفيروسBYDV-PAV وحساسية الأصناف المزروعة والظروف البيئية، فقد بلغت الخسارة في الغلة التي يحدثها الفيروس على المحصول في أوربا ومنطقة غرب آسيا وشمال افريقيا 25-57% (Panayotou, 1977، Makkouk & Ghulam, 2004) تؤدي الإصابة بالفيروس إلى خفض الوزن الجاف وطول النبات إلى 50%كما يتأثر الإنتاج كما ونوعا(Stoner,1977، Hull,2002) والأعراض المميزة لهذا الفيروس هي احمرار أوراق الذرة الصفراء أو تلونها بلون القرمزي مع تقزم للنباتات المصابة، (D'Arcy, 1995) على الرغم من تشخيص الفيروسBYDV-PAV مصلياً على محاصيل القمح والشعير في اليمن من قبل الباحثين (Kumari et al.,2006) إلا انه لا توجد معلومات عن تواجد فيروس تقزم واصفرار الشعير على محصول الذرة الصفراء في اليمن، لذلك هدف هذا البحث إلى دراسة مدى انتشار هذا الفيروس في مناطق زراعة الذرة الصفراء في بعض محافظات اليمن خلال سبتمبر/2009.

مواد وطرائق البحث

نفذ المسح الحقلي خلال سبتمبر /2009 في حقول الذرة الصفراء
شمل المسح الحقلي زيارة عشرة حقول اختيرت عشوائيا، موزعة كما يلي:
1-محافظة صنعاء (بني مطر، وعلان والعرة)
2-محافظة ذمار(قاع بلاسان، قاع جهران وقاع بكيل)
3-محافظة أب (ظفار، قاع الحقل، السدة)
خلال المسح الحقلي جمع نوعين من العينات (أوراق النبات) من كل حقل :(1) 5-10عينة تبدي أعراضا توحي بإصابة فيروسية، (2)50-100عينة جمعت بشكل عشوائي من مختلف مناطق الحقل، وذلك لتقدير نسبة الإصابة الفيروسية في الحقل بناء على نتائج الاختبارات السيرولوجية.جمعت خلال عملية المسح. 913 عينة (852عينة جمعت عشوائيا و 61 عينة كانت تبدي إعراض إصابة فيروسية)، فحصت كل عينة على حدة بعد ربط ورقة النبات(العينة) بغشاء من البارافليم ثم طبعت على أغشية نتروسيلليلوز وفحصت باستخدام اختبار بصمة النسيج النباتي المناعي(TBIA) الموصوف من Makkouk & Comeau (1994) في مختبر الفيروسات بالمركز الدولي للبحوث الزراعية للمناطق الجافة(ICARDA) حلب-سوريا وذلك بفحص جميع العينات مصلياً باستخدام مصل متعدد الكلون مضاد للفيروس Barley yellow dwarf virus-PAV تم الحصول عليه من المجموعة النمطية الأمريكية (American Type Culture Collection).

النتائج والمناقشة

أظهرت نتائج المسح الحقلي إلى وجود فيروس تقزم واصفرار الشعير في حقول الذرة الصفراء في اليمن مؤكدة بذلك نتائج الأعمال السابقة لتواجد الفيروس على هذا المحصول عالميا (Allen, 1975، Stoner,1977، Eweida et al.,1983، Brown et al.,1984 ، Pearson &

D'Arcy, 1995 ، Makkouk & Comeau,1994 ، Loi et al.,1985،Robb, 1984 ،Itnyre et al.,1999، 2001، Zadoks، 2002, Hull)، وهذه هي أول أشارة لتواجد فيروس تقزم واصفرار الشعير على محصول الذرة الصفراء محليا. لم تتباين نسب المئوية للإصابة ما بين المحافظات الممسوحة (جدول 1) وقد يعود هذا إلى تشابه الظروف الجوية السائدة التي تؤثر على انتشار و تكاثر المن الناقل وبالتالي تشابه نسبة انتشار الفيروس، علما بان المحصول يتعرض لهجرة المن من محاصيل الحبوب (القمح والشعير) (Hull ,2002،D'Arcy, 1995) وقد شمل المسح المناطق الرئيسية لزراعة الذرة الصفراء واختير حقول ممثلة لكل منها (جدول 2) وقد تباينت القيعان والمناطق المزروعة بمحصول الذرة الصفراء في نسب الإصابة للعينات المجموعة عشوائياً إذ كانت اقلها إصابة منطقة ظفار في محافظة اب وأعلاها إصابة منطقة العرة في محافظة صنعاء (جدول 2) ولوحظ خلال المسح تواجد الكثيف لمن الذرة (Fitch) *Rhopalosiphum maidis* على المحصول وهي كناقل رئيسي للفيروس تسهم في زيادة عدد النباتات المصابة خلال الموسم مع أكثر من عشرين نوعا من حشرات المن قادرة على نقلهاِ (D'Arcy, 1995، Zadoks ،2001 ،Hull ,2002) وهذا يفسر نتائج اختبار بصمة النسيج النباتي المناعي(TBIA) الدالة على إن الفيروسPAV _ BYDV منتشر في المناطق محل المسح الحقلي وذلك يعود إلى أن هذا الفيروس ينتقل لا تخصصيا بالمن (D'Arcy, 1995، Hull ,2002). كانت الأعراض المميزة للإصابة بفيروس تقزم واصفرار الشعير هي الاحمرار حول عروق الورقة يبداء من قمة الورقة ويغطي مساحة كبيرة من سطح الورقة، في حين أظهرت نتائج الفحص السيريولوجي للعينات المصابة (TBIA) تلون الأوعية الناقلة باللون الأزرق الغامق (صورة رقم1) دلالة على التفاعل الإيجابي والمتخصص بين المصل المضاد وبروتين الفيروس وظهور هذا اللون على أوراق النتروسيللوز دلالة قاطعة على وجود الفيروس في العينات المصابة وغياب هذا اللون في العينات السليمة دلالة قاطعة على خلوها من الفيروس حسبما ذكره الباحثان Makkouk & Comeau (1994). دلت النتائج في جدول(1) لاختبار بصمة النسيج النباتي المناعي(TBIA) لـ 61عينة من اوراق الذرة الصفراء كانت تبدي إعراض الإصابة بفيروس تقزم واصفرار الشعير (تلون الأوراق باللون الأحمر أو القرمزي) وجد أن العينات التي تفاعلت ايجابيا مع المصل المضاد للفيروس لم يتجاوز 18% عينة من مجموع عينات الأعراض المفحوصة، يعزى سبب تفاعل بعض العينات التي كانت تبدي اعرضا المرض سلبا مع المصل المستخدم في هذه الدراسة إلى إصابة هذه العينات بالفيروسات التي لها نفس الأعراض وهي _ BYDV _ MAV, BYDV _ RMV , CYDV RPV والتي لا يمكن الكشف عنه بالمصل المستخدم في هذا الدراسة، أو إن النباتات كانت مصابة بعامل ممرض أخر تؤدي الإصابة به لظهور إعراض شبيهة بتلك المميزة لمرض التقزم والاصفرار الفيروسي أو نتيجة لتعرض النباتات لعوامل بيئية معينة (Itnyre et al.,1999، 2001، Zadoks) إن الكشف عن تواجد فيروس تقزم واصفرار الشعير في حقول الذرة الصفراء تحت ظروف المرتفعات الوسطى اليمنية يفسر احد عوامل نقص الغلة في الحقول المصابة ويشير إلى محصول الذرة الصفراء كمصدر للعدوى الأولية بالفيروس لمحاصيل القمح والشعير حيث أظهرت العديد من الدراسات إلى إن محصول الذرة الصفراء يشكل مصدر للعدوى الأولية بالفيروس لمحاصيل الحبوب (Allen,1975، Pearson & Robb,1984، 2001،Zadoks، Hull,2002).

صورة(1): الإصابة بفيروس تقزم واصفرار الشعير(BYDV-PAV، عائلة *Luteoviridae*) على الذرة صفراء مصابة(يسار) مقارنة بالسليمة (يمين) الأعراض للأعلى والفحص المصلي للأسفل

جدول(1): النسبة المئوية للإصابة بفيروس تقزم واصفرار الشعير، كما تظهرها نتائج الاختبارات السيرولوجية/المصلية (TBIA) لعينات الذرة الصفراء التي تم جمعها من محافظات (صنعاء، ذمار، اب) خلال سبتمبر /2009

المحافظة	النسبة المئوية للأصابة	
	العينات المأخوذة عشوائياً	العينات التي أبدت أعراض إصابة بالفيروس
صنعاء	5.5	23.5
ذمار	3.6	19.0
أب	4.3	13.0
المتوسط العام	4.5	18.0

جدول(2) نتائج الفحص المصلي لفيروس تقزم واصفرار الشعير للعينات المجموعة من حقول الذرةالصفراء (صنعاء، ذمار، اب) خلال سبتمبر /2009

المنطقة	طريقة جمع العينات	عدد الحقول الممسوحة	عدد العينات المفحوصة	عدد العينات المصابة بـ BYDV
محافظة صنعاء				
بني مطر	عشوائية	1	54	3
	إعراض		2	0
وعلان	عشوائية	1	93	3
	إعراض		3	1
العرة	عشوائية	1	125	9
	إعراض		12	3
المجموع (صنعاء)	عشوائية	3	272	15
	إعراض		17	4
محافظة ذمار				
قاع بلاسان	عشوائية	1	53	2
	إعراض		6	0
قاع جهران	عشوائية	1	97	5
	إعراض		5	2
قاع بكيل	عشوائية	2	202	6
	إعراض		01	2
المجموع (ذمار)	عشوائية	4	352	31
	إعراض		21	4
محافظة اب				
ظفار	عشوائية	1	51	1
	إعراض		9	0
قاع الحقل	عشوائية	1	100	7
	إعراض		6	2
السدة	عشوائية	1	77	2
	إعراض		8	1
المجموع(اب)	عشوائية	3	228	10
	إعراض		23	3
المجموع الكلي	عشوائية	10	852	38
	إعراض		61	11

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Diagnosis Barley Yellow Dwarf Virus-Pav Naturally Infects Maize In Some Yemeni Governorats

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Abstract

A survey to identify Barley yellow dwarf virus- PAV (BYDV- PAV, Luteoviridae) affecting maize crop at different locations in Yemen (Sana, Dhamar and Ibb) was conducted ,during September 2009. A total of 852 random samples and 61 samples with symptoms suggestive of virus infection were randomly collected from 10 fields. Virus diseases incidence was determined on the basis of laboratory testing of samples against antisera of BYDV_PAV virus by Tissue blot immunoassay (TBIA). Laboratory testing showed that BYDV-PAV was identified in all fields maize-growing regions of Sana, Dhamar and Ibb governorates with no different infection rates, and BYDV-PAV incidence was 18% and 4.5% both random samples and the samples show symptoms of infection, respectively. This is the first report of Barley yellow dwarf virus- PAV naturally infecting maize crop in Yemen

Key words : Barley yellow dwarf virus-PAV ، maize ،survey، Yemen.