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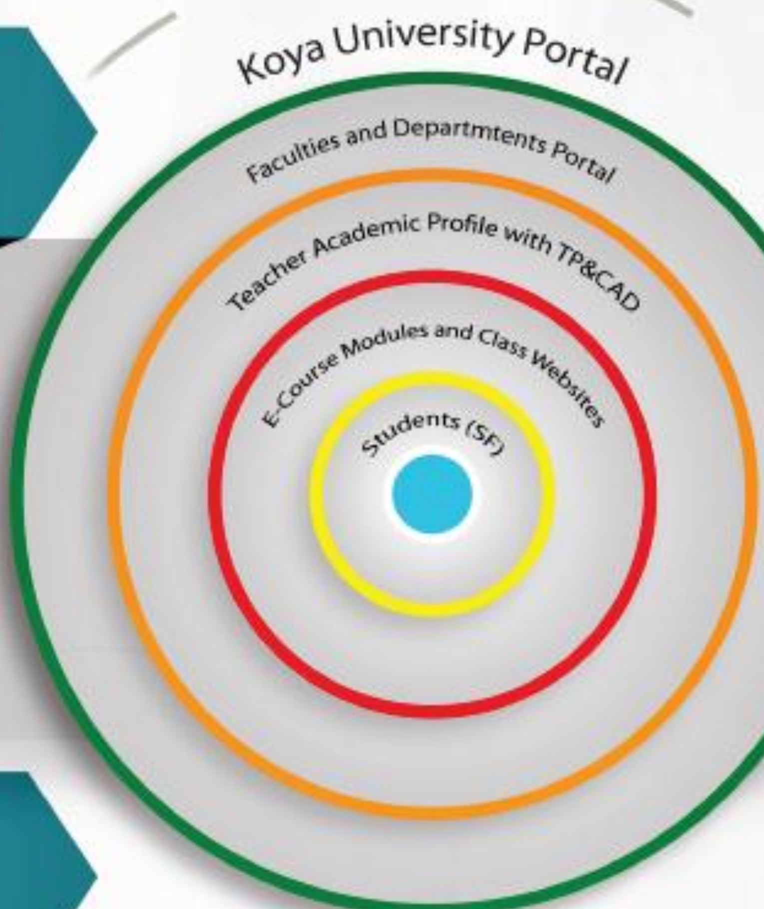

A Sustainable Paperless Online System (SPOS)
for Engineering Quality in Teaching:
Koya University as a Case Study

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Aro Editorial Words

You are now browsing the fourth issue (Vol III, No 1) of Aro the Scientific Journal of Koya University. Aro is now starting the third year of its journey and it continues to become a globally recognized scientific journal with wider local impact. The editorial team is determined to keep the path of such a mission and sustain Aro's future publications with quality and reliability in mind.

Aro was created with long-term visions of becoming accessible to all researchers in Kurdistan and beyond, and covering a wide range of scholarly disciplines in sciences. The focus of the journal is to reflect that of the Koya University, namely promoting scientific knowledge and research in Kurdistan and secure a brighter future in education. Aro aspires to become a channel for exchange of scholarly research by establishing academic connections between scholars.

Aro is a journal of original scientific research, global news, and commentary. The Aro Scientific Journal is a peer-reviewed, open access journal that publishes original research articles as well as review articles in areas of natural sciences and technology. In this issue you will have access to genuine research paper in variety of areas, such as biochemistry, engineering and material.

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The warm response from researchers, academics and professionals in the last two years has made us to create a wider Editorial Board which serves the wider submitted scientific manuscripts. However, it is clear that having a dedicated and well organized editorial board for the journal is only one side of the coin. The other is the ability to attract submissions of quality research and scholarly work. We are thankful to all of those who put their trust in Aro and presented their original research work for publication in Vol III, No 1 of the journal, as well as, our thanks are extended to the 12 peer-reviewers from the universities worldwide for their efforts in reviewing this issue of Aro publications.

Your support and feedback are invited and appreciated.

Sincerely

Wali M. Hamad
Executive Publisher

Dilan M. Rostam, Shwan K. Rachid, Salah I. Yahya and Sarkawt S. Abdulrahman
Executive Editorial Board

A Sustainable Paperless Online System (SPOS) for Engineering Quality in Teaching: Koya University as a Case Study

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***Abstract*—Rapidly advancing computer based technologies offer many possibilities for innovation in educational and administrative assessment tasks which allow for a reliable real time reporting and feedback process. This paper considers the requirements for teacher assessments to become an accurate and reliable process. As a case study, the challenges of implementing such a system at Koya University have been considered. This paper examines how a paperless online system can support faculties' efforts for improving sustainable quality in learning and up-to-date assessment techniques. The proposed sustainable paperless online system (SPOS) uses Google Applications for Education that have been adopted at Koya university as a communications and collaboration medium to enhance its teaching quality. Such a system may enhance security, transparency and ease of use while consuming less time and resources and promoting green practice. The work throughout this paper explains how the initiative is engineered for achieving and monitoring a better quality in teaching.**

***Index Terms*—Continuous academic development, Google Apps, online system, quality teaching, student feedback, sustainable system, teacher portfolio, teaching quality assurance.**

I. Introduction

The recognition of higher education as a major driver of economic competitiveness has made high-quality education more important than ever before in both industrialised and developing countries. Fabric (2010) considers the imperative for countries to improve employment skills calls for quality teaching within educational institutions.

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The past decade has witnessed an increased interest in assessment in a learning culture (Popham, 2008; Stobart, 2009; Darling-Hammond, 2010; Colbert, et al, 2012) with quality academic faculty member (teacher) assessment understood as central to local and systemic efforts to improve student learning and outcomes (Murphy, 2009; Wilson, 2010; Willis, 2010; Colbert, et al., 2012).

Although the quality and standards of the courses taught at the university are the responsibility of all academic staff, the quality of teaching and the teacher’s academic achievement are assured in part through the academic performance review process run by the Teaching Quality Assurance (TQA) directorate/office at each academic institute.

“Institutions may implement evaluation mechanisms in order to identify and promote good teaching practices. The environment of higher education institutions can enhance the quality of teaching through various means. For example, a national policy run by the public authorities or recommendations issued by quality assurance agencies are likely to help university leaders to phase in a culture of quality that encompasses teaching” (Fabric, 2010).

Deane and Krause (2012) argued that an institution may use multiple forms of peer review and calibration to provide evidence that it is monitoring and assuring learning standards. We believe that beside this multiple forms of peer review, other activities that involve both academics and students may play a role to assure a quality teaching and helping to assure the learning standards.

Assuring a quality teaching in the higher education, two activities need to be implemented continuously; student evaluation of teaching, student feedback (SF), and institute/university evaluation of teacher. Numerous of publications have been written on students’ feedback. It probably started with pioneers such as Max Freyd a psychologist in social behaviour in 1923 something which is still widely in use. He suggested that his graphic rating scale could be used to measure characteristics of the teacher that he accepted as “fundamental to the acquisition of a successful teaching technique” (1923, p. 434). A good survey on the student feedback were written by (Feldman, 1997; Marsh, 2007; Addison and Stowell, 2012). In spite of the major literature reviews during the last forty years (Marsh, 1987; Centra, 1993; Costin, Greenough, and Menges, 1971; McKeachie and Lin, 1979; Cashin, 1988, 1995) that support the reliability of student ratings when used for evaluating instruction, but their relationship to educational outcomes is questionable due to the reasons explained by Deane and Krause (2012).

In line with this argument the teacher evaluation by institute/university via teaching or teacher portfolio (TP) is providing a multilevel assuring of quality teaching in higher education.

TP describes and documents the different aspects of teaching ability and prepared either in a summative format created for the purpose of applying for an academic job or for promotion and tenure within a department as well as a formative format for the purpose personal and professional development (Edgerton, Hutchings and Quinlan, 1991; Lang and Bain, 1997, Kaplan, 1998; Wiedmer, 1998; Seldin, 2004).

In 2010 the Ministry of Higher Education and Scientific Research (MHE) in Kurdistan Region (KRG) of Iraq started to adopt the TQA in the higher education institutes (Dlawer, 2010). The quality assurance process at Koya University goes through three channels:

1) Student feedback (SF).
2) Teacher portfolio (TP).
3) Continuous Academic Development (CAD) scoring system.

The TQA process adopted by Koya University until May 2013 was a paper-based process. The data from the three TQA channels was collected manually then converted to electronic data sources for later report and analysis. This laborious work took place from mid-April to mid-June each year engaging 6 members of staff full-time and other 28 members of staff part-time. This manual mechanism faced many issues, among them:

1) Insecurity.
2) Inefficiency.
3) High cost.
4) Large use of resources.
5) Lack of transparency.

In the two recent decades the Internet has been having a great impact on education and in particular higher education quality in teaching. New challenges are emerging constantly, which require global solutions for geographically distributed common issues that our modern societies are facing. Due to the global nature of the current education concepts and the evolving impact of IT on educating the future professionals, the teaching methodology are continuously changing for better qualities. These challenges require support with communication, interaction, integration, knowledge transfers, and shared up-to-date best practices. IT facilities such as the Internet can potentially provide integrated environments satisfying these requirements. (Roshani, 2006)

Reference to outlined arguments the drawbacks of the manual mechanism adopted in assuring a quality teaching/learning, at Kurdistan Universities in general and at Koya University in particular, this paper presents a new engineered mechanism based on an online digital interactive system to assure a secure quality teaching/learning and promoting the university to become an electronic enabled university.

II. E-Management at Koya University

Koya University is one of 9 public universities in Kurdistan Region regulated by the ministry of higher education (MHE), with common legislation and regulations. Koya University consists of four faculties and 24 departments in different fields, with 3500+ students, 650 academic (including teaching staff, teaching assistants, tutors and engineers) and 750+ administrative staff all are recorded in the year 2014. The management of the university like other public universities in the region is heavily centralised, bureaucratic and manually managed as well as over populated by students and staff.

Since the establishing of the first university of the world the University of Bologna A.D. 1088 the fundamental concept of higher education institute has been the same, namely spreading of knowledge with organisational focus on discipline through student's education and training. Through time the combination of demands for improved efficiency and increased access to better quality have made the higher education to seek quality in their offered education. At the same time reduce expenditure whilst improving the operation of resources.

In line with these concepts Koya University aimed to process with new approach to update its strategies for a faster and effective response in managing its academic community. The university outlined a new progressive strategy in 2012 to be ranked globally based on its student welfare, organisational performance, teaching quality and inclusive policy. The university started its long term strategy by identifying the needs and the bottlenecks vs global standard, rearrange and mobiles the basics, facilitate the logistic for new approaches, put the students at the core of the new approaches (see Fig. 1) and choose technology with a minimum cost, then implement and training the trainers. This has created a chain of active line of knowledge transfer among our academic community.

The directorate of TQA gathered skills to facilitate the new Koya University strategy which appeared feasible and logically practical to enhance the QA procedure system. Therefore a new TQA policy focused to engineer a new Sustainable Paperless Online System (SPOS) to overcome the drawbacks of the current bureaucratic process to achieve a faster and effective response with workable data.

III. Quality Teaching

As the landscape of higher education has been undergoing continuous changes, quality teaching has become a demand and an issue of importance. Student numbers have considerably expanded and diversified, both socially and geographically.

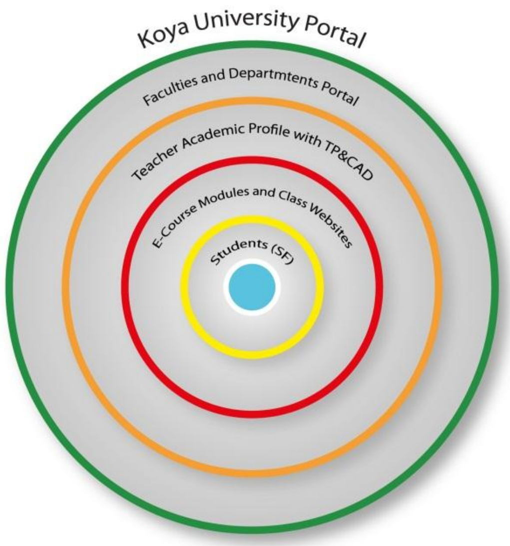

Fig: 1. Students at the core of an integrated inclusive e-Management.

Today's rapid developments increasingly demand dynamic teaching methods. Modern technologies have entered the classroom, thus modifying the nature of the interactions between students and teachers (Henard and Leprince-Ringuet, 2008). Henard and Leprince-Ringuet believe that "good teachers" have empathy for students, are generally experienced and most of all are organised and expressive. "Excellent teachers" are those who have passions: passions for learning, for their field, for teaching and for their students. But research also demonstrates that "good teaching" depends on what is being taught and on other situational factors. Quality teaching lacks clear definitions and to some extent can't be disconnected from debates on quality culture in higher education that remain controversial terms. Some scholars regard quality primarily as an outcome, others as a property. Some consider teaching as the never ending process of reduction of defects and so quality teaching can never be totally grasped and appraised. In fact, conceptions of quality teaching happen to be stakeholder relative: students, teachers or evaluation agencies do not share the definition of what "good" teaching or "good" teachers is (Henard and Leprince-Ringuet, 2008).

The quality of higher education in developing countries is influenced by complex factors that have their roots in commercialization, general funding, and population growth as well as demand for skilled manpower. Appropriate policies and home-bred professionals, both academic and administrative, are necessary for improving the quality of higher education in developing countries (Bunoti, 2010).

IV. TQA Mechanism at Koya University

In the academic year 2012-2013, 358 teaching staff, including the external lecturers, and around +3500 students were registered by the QA directorate in 24 departments and four faculties, namely;

1) Faculty of Engineering (FENG).
2) Faculty of Science and Health (FSCH).
3) Faculty of Humanities and Social Sciences (FHSS).
4) Faculty of Education (FEDU).

The TQA directorate at Koya University is taking responsibility for assuring quality teaching at the university through a mechanism that comprises several major and minor activities. All these activities are monitored by 4 TQA faculty officers and 24 TQA department coordinators. The TQA officers/coordinators are all working under the supervision of the Directorate of TQA.

A. Major TQA Activities

The major TQA activities at Koya University include:

1) SF; at the end of every academic year, usually in May, the students are asked to give their feedback on every course they study via a questionnaire which contains 12 questions. These questions are expected to be scored from 1 (Poor) to 5 (Excellent). There are 24 departments with an average of 7 modules per year/stage. There are some 672 different course modules taught at Koya University. There are about 3500-4000 students studying at the university every year and they submit a minimum of 21000 yearly response sheets.
2) TP; to achieve this activity, all teaching staff members are asked to prepare a box-file containing all documents, certificates and proofs about their academic and non-academic activities during the forthcoming academic year. The portfolio may comprise academic certificates, publications, seminars, academic committee engagements, workshop activities, etc. Usually, a single TP is about 100-500 sheets in size, depending on the level of teacher activities. For the 358 teachers at Koya University in the 2012-2013 academic year, as an example, a minimum of 35000 sheets of paper were submitted to the TQA directorate under the umbrella of the TP activity. It is the responsibility of the TQA directorate at the university to assign a TP assessment committee at each scientific department that head by the teachers' head of department. The TP activity is scored from 1 (Poor) to 5 (Excellent). For every single TP assessment, the committee needs to complete an evaluation sheet that consists of 16 questions based on portfolio content and the recommendation of the relevant head of department.
3) Teacher Continuous Academic Development (CAD): It is based on the teachers' academic achievements throughout the academic year and covers the details of all the teacher's scientific publications, scientific reviews, seminars, training courses, workshops, postgraduate student supervision, *etc*. This requires teachers to submit a box-file of about 100-500 sheets of paper, depending on the level of teacher academic activities. CAD produces a

minimum of 35000 sheets of paper at the university level. The CAD activities/actions are divided into passive actions e.g. attending seminars, workshop and conference, *etc.*, and active actions e.g. scientific publications, presenting seminars, *etc*.

It is worthy to mention that although both TP and CAD having the same sub-activities, e.g., scientific publishing, participating conferences, contributing to scientific committees, etc., their assessment are different. The TP assessment is a qualitative, whereas, the CAD assessment is a quantitative.

B. Minor Activities

The minor TQA activities at Koya University may include:

1) Teacher Seminars: Usually the teacher may present one seminar or more during the academic year and attend seminars presented by other teaching staff. Every presented seminar should be evaluated by the attendees via a special assessment form. Presenting a seminar is considered as an active action and evaluated at 3-4 points for CAD, whereas attending a seminar is considered as a passive action and evaluated at 1 point for CAD. Every academic year, the TQA directorate receives about 14000 seminar assessment sheets. The seminar scoring depends on the average assessment sheet value: a value of less than 2.5/5 scores the activity with zero point, a value of 2.5-4.5/5 enables the seminar presenter to score 3 points, whilst a value of more than 4.5/5 enables the seminar presenter to score 4 points.
2) Teacher Feedback on Performance of their Head of Department: At each of the 24 University departments, teachers are asked to evaluate the performance of their head of department. This takes place via an assessment sheet that contains 16 questions scored from 1 (Poor) to 5 (Excellent). There are about 334 assessment sheets to be submitted to the TQA directorate for processing. The 24 head of departments are not involved in the process of lecturers' feedback submissions.

At the end of every academic year, all the major and minor QA activities related documents, a minimum of about 105000 sheets of paper excluding the waste, are processed manually by the TQA directorate staff. Then, every teaching staff member receives a certificate which shows their scores on the main three QA activities namely; SF, TP and CAD.

V. Definition of the Problem

We believe that TQA activities are not the same as quality teaching: they are tools to be used to achieve a quality teaching that leads to better student learning. The tools adopted should guarantee efficiency, accuracy, transparency, cost effective, and environmentally friendly which are important for a productive sustainable quality teaching.

Based on experience and analysis of the TQA process outcomes of the Kurdistan Region’s higher education institutes in general, and Koya university in particular, since the year 2010, the following outlines have been observed:

1) The TQA process is currently not sustainable due to its convolution and lack of clear outcomes and its inefficient implementation.
2) The SF is not totally transparent. The students claim giving the feedback on (5-8) taught courses during a one hour class in the presence of the TQA coordinator and the class teacher makes them feel uncomfortable and under a sort of pressure and classmates interfere.
3) The SF is a paper-based process; the data is collected manually then goes through data entry to be analysed electronically. This is a time- and resource consuming process.
4) More than 21000 SF paper sheets were submitted yearly to the TQA office at Koya University before May 2013 where the SPOS is applied. This huge number of paper sheets is exhausting the TQA resources and devalues the whole purpose of the SF.
5) The TP appears impractical to the teachers as well as to various evaluation committees due to the number of paper sheets (100-500) submitted for evaluation. The evaluation committee needs a long time to review the TP contents with such a huge number of paper sheets. This causes serious problems in transparency and hinders true evaluation of the academic staff's scientific achievements during the academic year. The same is true for the CAD scoring system.

The list of drawbacks above made Koya University rethink its QA policy and proceeding system to include with its established long-term strategy to become an electronically manageable university and globally recognised higher education institute.

VI. Challenges in Applying a Computer-Based Online System

Adopting the SPOS using Koya University adopted Google Apps. for Education (GAE), (Google, 2013), which has enabled the university wide e-management strived strategy. As any new approach, this would present a big challenge to members of our academic community.

A. Challenges to the System Architecture

Computerizing the paper-based QA process requires a central database that all users (students and academics) can access to complete forms or upload their scientific activity proof files, and other information related to the QA evaluation. Such a traditional computer-based system, Fig. 2, has many drawbacks for implementing/assuring a quality teaching, among them;

1) The data has to be collected and stored in one central database.
2) There is no interaction between the database management system (DBMS) and the user. It is just a one direction data flow.

3) Maintaining the database is the responsibility of the DBMS administrator.
4) Since accessing the database (DB) is via a secure process, sharing the online academics' scientific activities and achievements among each other will be not an easy task and need authentication at each sharing-access time. Transparency is not easy to achieve completely.
5) Such a system is considered a passive system that has no added value to user.

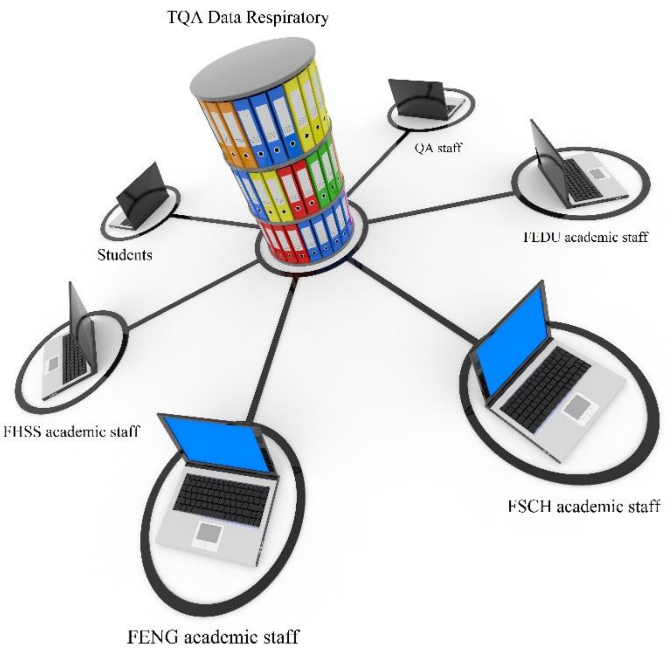

Fig. 2. A diagram showing a traditional computer-based network for collecting data into a central database.

B. Challenges for the Students

The current TQA system allows all students to give their feedbacks on the taught courses. Computerizing the SF process as a paperless e-system needs:

1. A standard Google email account for every student for academic activity purposes as well as access to the online feedback system. Such a process has been constructed by Koya University directorate of IT, Fig. 3.
2. Internet provision for students at the university campus and home.
3. Workshops on how use the online system and give feedback, and the benefits of such activity in order to create better understanding of the feasibility of the online system.

C. Challenges for the Academics (Teachers)

Although the current TQA system appears practical to individual teachers, it represents a huge resource cost to the university. Nevertheless computerising the process such as TP and CAD needs:

1) A basic IT literacy course to enable all academic staff to make use of TAQ e-processing. This will ensure senior academic staff become familiar with the online e-system.
2) Special workshops on Google Apps for Education in particular its feasibility for TP and CAD in the new TQA e-system.
3) A comparison of the usability of data between the current and proposed e-system.
4) Internet provision at the university campus/offices and at home.

Naturally adoption of a SPOS needs to address the above challenges to validate its feasibility and logical practicality.

Fig. 3. A poster shows the process of creating a standard Google email account for the students at Koya University

VII. The Proposed System at Koya University

In line with Koya University long term strategy to become an electronic enabled inclusive student centred university with successful presence locally and internationally, the directorate of TQA created an innovative engineered SPOS to assure quality teaching practices to support a rapid teaching quality assurance policy. This new system, SPOS, offers a platform where all academics can be credited for their scientific achievements during an academic year, easily and efficiently. The proposed SPOS is not just a simple online portal system for students and academics of Koya University accessing to record their activities, e.g., giving feedback and uploading certificates, documents and proofs for both TP and CAD activities, but an interactive and dynamic shared space. The suggested SPOS is a self-training interactive online system enables members of academic community to play an important role. SPOS consists of the digital interaction between the teachers and their university (T-U), between the teacher and teacher (T-T), between teachers and students (T-S) and between the students and their university (S-U).

With the GAE the teachers can easily create and deal with forms, spreadsheets, presentations, videos, sites, etc. Moreover, GAE offers a simple automatic data analysis and graphs. Fig. 4 shows the proposed network diagram of the SPOS.

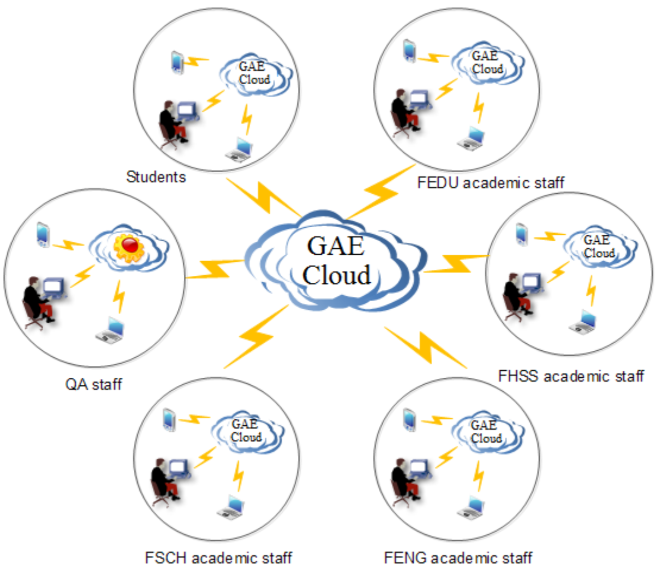

Fig. 4. The SPOS network diagram on GAE Cloud core.

Within the SPOS the TQA is functioning as Knowledge Transfer Hub (KTH) and staff being trained to give individual remote of face-to-face support. SPOS may guarantee:

1) Security.
2) Transparency.
3) Accuracy.
4) Less time consumption.
5) Ease of use by students and teachers.
6) Less use of resources.
7) A lighter environmental footprint: uses less paper during the process.
8) Accessibility of data for university strategy and policy making.

It is important to mention that using SPOS, sharing the online information and activities can be authenticated easily based on the users' University account, i.e., @koyauniversity.org. This will assure achieving a complete transparency.

The academic staff need an @koyauniversity.org account which is based on GAE, whereas the students need a normal free Google Gmail account i.e. firstname.IDNo@gmail.com, to be granted using the new SOPS system. SPOS includes:

1) Profile sites that created for teachers with their names that appear in the @koyauniversity.org account. Each faculty has its own profile, based on the logo and colour. The profile site is shared with publics and linked with teacher name at the university main website, i.e., www.koyauniversity.org. Fig. 5 shows the profile template for the academics of the FSCH.
2) A completely secure online TP and CAD website. Every teacher receives a dedicated PF&CAD site that should be completed yearly with documents and proofs about all activities to be considered for the TQA assessments. The site contain all help documents and guidelines that the teacher may need to complete their site information. The teacher just needs to state the number of activities under each different category and upload the certificates and proof documents. The TP and CAD website is owned (administered) by the teachers as well as by the TQA directorate account for remote help and upgrading. Creating an individual TP and CAD site is easy with GAE, where a template site for each faculty is created according to its logo, colour, language and specialization. This allows teachers who belong to one of these faculties to get access to an individual TP and CAD site. Each TP and CAD site has a portfolio evaluation page and a CAD assessment page to be accessed securely for scoring by the assigned committee, where the results are collected in a Google spreadsheet for each faculty. Fig. 6 shows the main page of the online TP and CAD (PF&CAD) site template which belongs to FENG.
3) A completely secure online Quality Assurance Achievements Scores (QAAS) site is created to enable teachers accessing their own secure homepage to get their certificate of achievement score and scoring details for the relevant academic year. The QAAS site is shared with the TQA office at the MHE. Fig. 7 shows a screenshot of the QAAS site. The QAAS site represents a portal from which the user can access all other sites working under the umbrella of the QA directorate.
4) A completely secure online teacher feedback website to assess the head of department performance is also created to enable teachers giving their feedback online. Fig. 8 shows the homepage of teacher feedback online.
5) A complete secure CMS-based website for online SF, where the student can access the site using their unique account and get all the information, guidelines, and help and then submit feedback. Tutorial videos are provided to provide an easy interactive approach to the system. Besides the security of the system, a duplicate feedback entry by the same account is prohibited by the system. Fig. 9 shows the main portal of the online SF.
6) A completely secure online teacher seminar submission/feedback and scoring pages that embedded inside the website of the QA directorate. Fig. 10 shows the homepage of the QA directorate site.

Fig. 5. Screenshot of the GAE-based online electronic academic profile of the FSCH.

Fig. 6. Screenshot of the GAE-based online electronic TP and CAD system of the FENG.

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Fig. 7. Screenshot of the GAE-based online QAAS system.

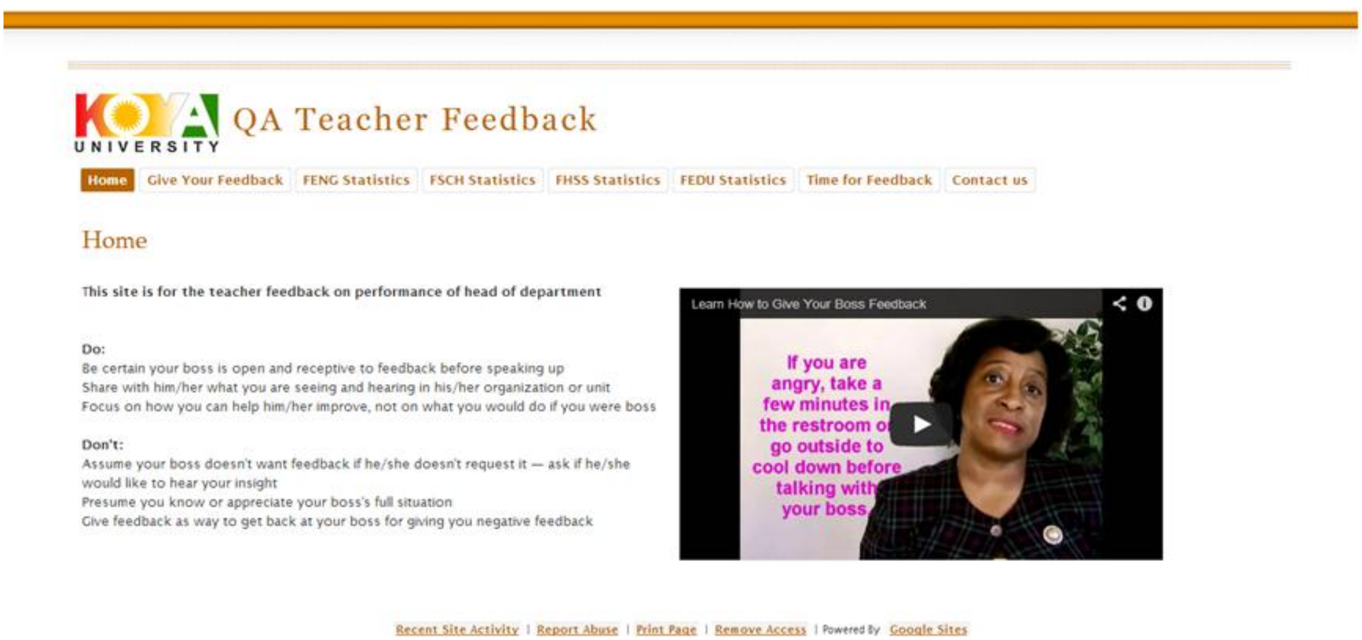

Fig. 8. Screenshot of the GAE-based online teacher feedback system.

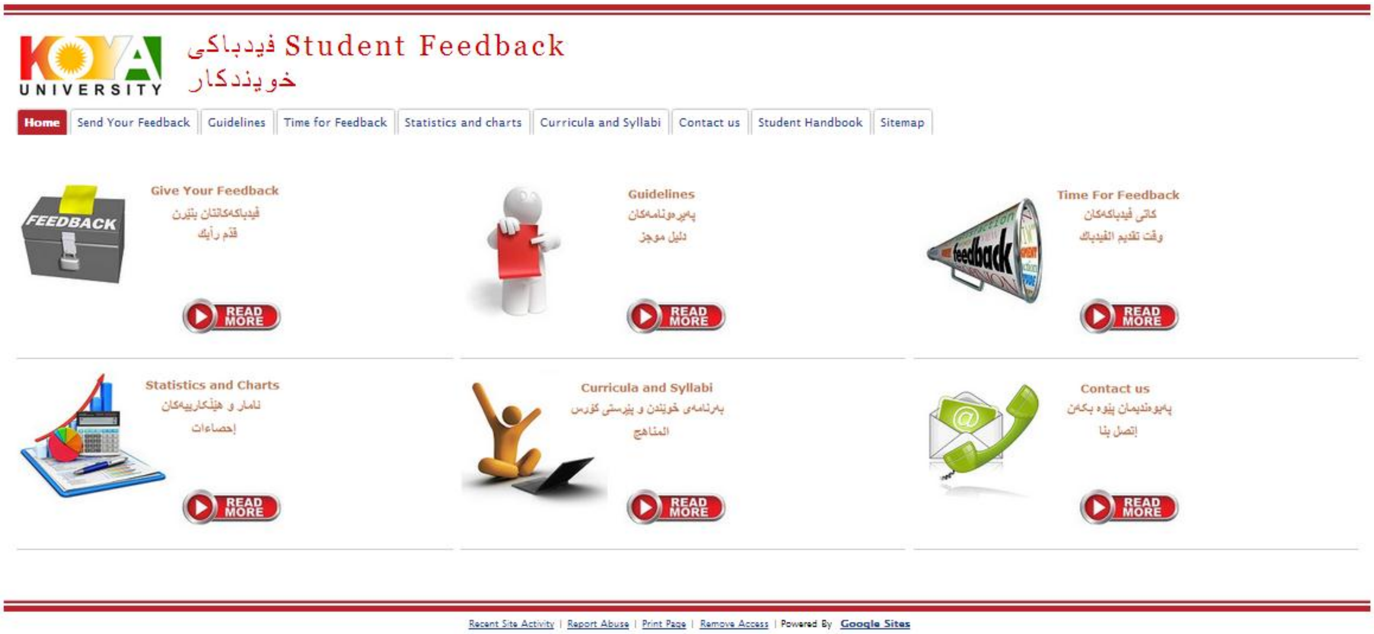

Fig. 9. Screenshot of the GAE-based Site for the online student feedback system.

Fig. 10. Screenshot of the GAE-based Site for QA directorate that enables teachers to register and give feedback on seminars.

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VIII. ADDITIONAL SUPPORTING TOOLS

Since the proposed SPOS may not guarantee the participation/involvement of all students/teachers e.g. giving feedback, due to the different reasons listed in section IV, the directorate of TQA has established a complete help site that gives information from A to Z in a simple way supported by tutorial videos. Fortunately, internet provision covers more than 80% of Koya university campus, besides the commercial internet provision in different forms in the city of Koya at reasonable a speed and price. A 24/7 help desk created to assist teachers and students, and weekly seminars have been provided by experts to enhance the users' IT skills.

IX. SYSTEM IMPLEMENTATION AND RESULTS

Koya University announced the launch of their SPOS on 14th May 2013 to assure a feasible quality TQA process. With the new system during the academic year (2013-2014):

1) Out of the 3505 university students, only 3150 were Eligible to give their feedback on taught courses and teacher performance. This is due to the regulation that stops students who have less than 90% class attendance to take part in the SF activity. With (4) faculties, 24 departments and an average of 7 taught courses/student, our system registered the following data; the percentage of the actual submitted SF hits was 76% of the eligible hits. Fig. 11 shows the eligible and actual number of hits per each faculty, and Fig. 12 shows the percentage of the actual feedback hits per faculty. Fig. 13, created by Google Spreadsheets, shows the average score versus number of teachers as an outcome of the online SF. Google spreadsheets collected data is able to present several different kinds of statistics and graphs, of which the graph in Fig. 13 is an example.

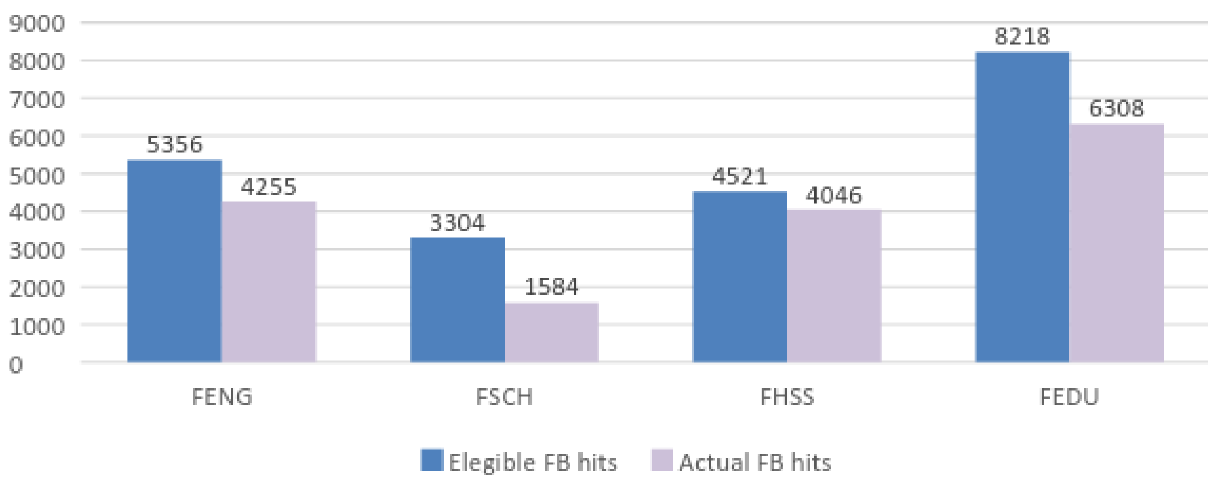

Fig. 11. The eligible and actual number of student feedback hits per each Faculty.

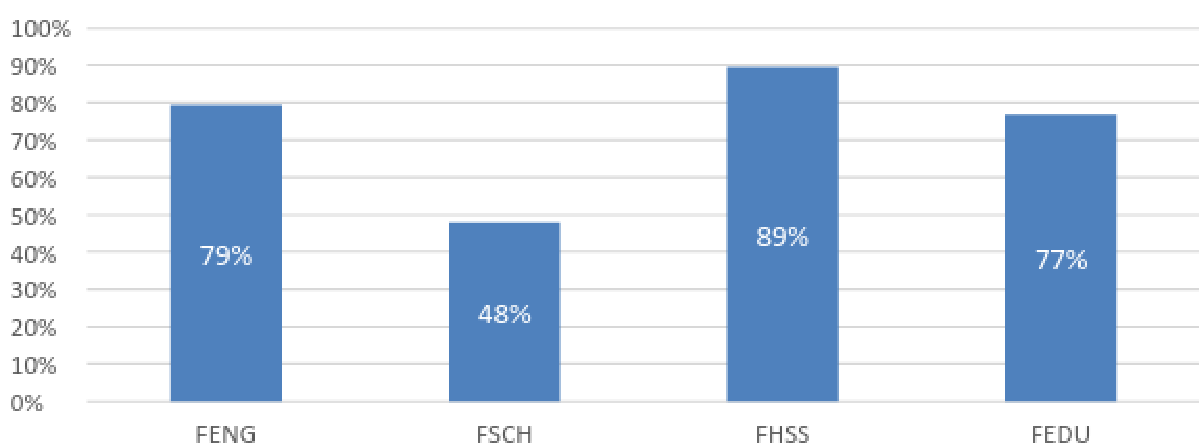

Fig. 12. The percentage of actual student feedback hits per Faculty.

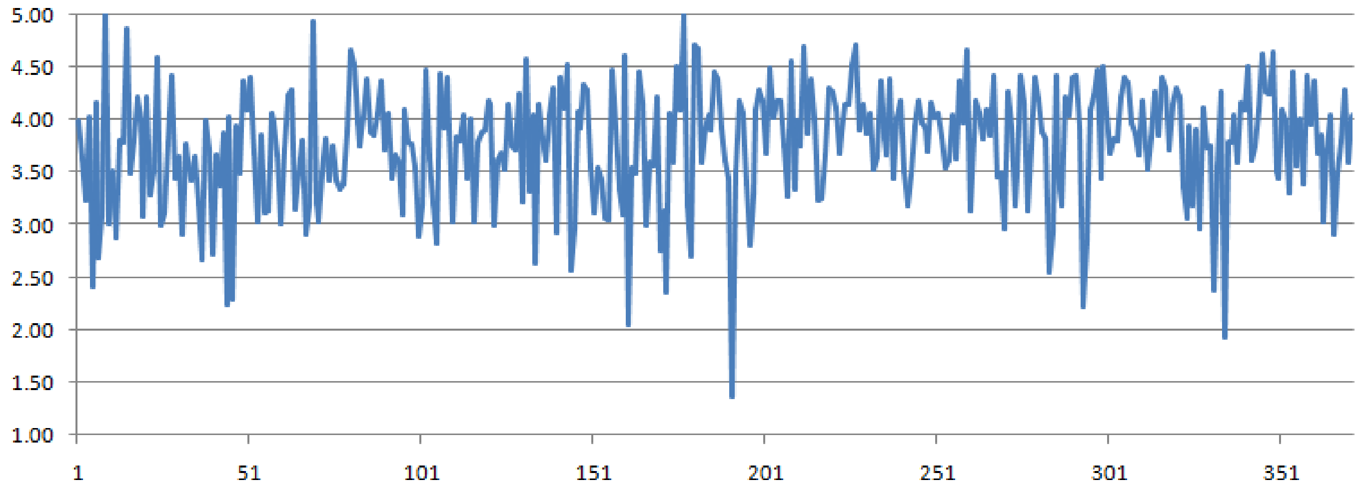

Fig. 13. Average SF score (on a scale of 5) versus number of teachers/courses.

2) For the 358 teachers, everyone has a complete dedicated personal electronic TP and CAD site, where they can record their number of activities and upload their certificates and proof documents. Moreover, the teachers are using a GAE-based QA directorate site to register their presented and attended seminars that are later scored by the same system and transferred automatically to their electronic TP and CAD personal site.
3) The teacher Portfolio and CAD are assessed online and scored using Google CMS-based form available at each teacher's TP and CAD site.
4) The SF and data collection process, and the process of the TP and CAD scoring both went smoothly and successfully.
5) The process is transparent, where the teacher's scientific achievement during an academic year is published on their electronic TP and CAD site and shared within the domain @koyauniversity.org only.
6) The process is secure and gives advisory accurate live results, statistics and graphs.

Furthermore the project implementation contributed to increase the overall computer literacy and Internet impact in education among academic community of Koya University. It is also contributed to Koya University global web presence. In the latest global university web raking by webometics.info Koya University has showed a significant increased presence. The "Webometrics Ranking of World Universities" is an initiative of the Cybermetrics Lab, a research group belonging to the Consejo Superior de Investigaciones Científicas (CSIC), the largest public research body in Spain. The Webometrics report shows that Koya University has secured a world rank of 12096 compared with zero presence in any previous global web raking before. The report reveals that Koya University is now ranked 20th university amongst 55 total university in Iraq and ranked 4th university amongst the KRG universities (webometics.info, 2014)

X. Anticipated Risk with SPOS and Tackling

The implementation of SPOS during the academic year (2013-2014) revealed that only 76% of the students were accept to be involved in the online SF of SPOS and around 90% of the academics were able to be engaged with SPOS online activities. These were due to:

1) Limitation of internet access.
2) Limitation of computer literacy that was generally obvious in both FEDU and FHSS more than FENG and FSCH, due to the later better IT background.
3) Lack of awareness on the benefits of using the online system, by both; academics and students.
4) The prevalence of a culture of rejection to the online systems implementation, particularly by senior academics.

The above risks can be tackled with the:

1) Provision of the high speed internet and increase the coverage over the Koya university faculties, library and campus, via wire and wireless access.
2) Provision of IT training courses for the University academics to enhance their IT skills.
3) Provision of frequent seminars to the university students to be more familiar with the online systems.
4) Increasing the academics/students awareness on the benefits of the online system implementation using posters and brochures.
5) Provision of online tutorial videos in the SPOS sites.

Considering the above tackling actions, were some of them are already followed, we believe that in the second and later years of implementing SPOS, more academics and the students, as well, will be fully engaged and take the benefits of this online system. Nevertheless, we also believe that there will always be a small percentage of the academics who will continue to reject the SPOS due to its, security, transparency and efficiency that create accountability to their scientific community in different forms.

XI. The Benefits of Implementing SPOS

Since May 2013, where SPOS has been implemented, and till September 2013 where all students and academics presented their different activities via the online system, the following benefits were achieved:

1) More than a quarter of million sheets of paper, plus printer toner and scans were saved.
2) The QA office staff needed for collecting sheets and forms, data entry, and data processing became useless after implementing SPOS.
3) Since the SF and other major activities are accommodated electronically, the physical direct monitoring by coordinators has been eliminated.
4) The academics and students showed more confidence about their activities assessment, due to the transparency and efficiency.
5) The SPOS revealed itself as a low cost online system, were all belonging sites are edited and updated by the academics themselves. Moreover, the manpower needed to run, administrate and maintain the system is limited to four persons with average IT skills working at the QA directorate office with the assistance of the four faculty officers that make a physical bridge between the QA directorate and the academics.
6) SPOS may show more adaptation, as compared with paper-based system, to any future updating/upgrading to the TQA process.
7) It is an easy interactive way to access statistics and analyse data faster to enhance and assure the quality of teaching at Koya University.
8) It creates a genuine link between members of our academic community for sharing experiences and personal views.
9) It puts the university in the unique position of advocating more futuristic and dynamic ways of assuring its TQA policies.
10) Lack of serious accountability measures against faculty's low rated TP and CAD by MHE has led to shortcoming in full hearted engagement by academics.

During the short period of implementing SPOS at Koya University from May 14th, 2013 till the date of collecting SFs and assessing the TP and CAD in June 20th, 2013, SPOS registered a high turnout by the students, namely about 76%. The teachers' turnout was 90%, who were engaged and prepared their online TP and CAD. The whole process also revealed that, in general, faculty members and students in the FENG performed better in using the new system. This indicated that users with an engineering background approached the new system more quickly and easily.

XII. Conclusion

This paper presented a newly-engineered paperless online system to assure quality teaching practices at Koya University. The proposed/implemented system uses GAE as the medium and:

1) It is a totally computerised and processed electronically and online. It is not a lost hybrid system (paper+paperless system).
2) It is a secure, convenient and easy to use for the SF as well as the TP and CAD.
3) Guarantees the transparency and accuracy in evaluating the TP and scoring the CAD.
4) It is less time-consuming, organized out of the package and easy to use by the teachers, and makes them more familiar with the benefits of computer-based technology and online applications.
5) It offers a good archiving system for the University/teacher, since the data is saved in the Google Drive of the teacher's Google-based account and shared with the University. This makes teachers personally responsible for their data and archive.
6) The process takes less effort since the physical link between teachers and the TQA directorate has been shortened via electronic link. They share their inputs directly with the directorate of TQA in an easy way.

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Effects of Some Dates, Pre-treatment Sowing, Soil Texture and Foliar Spraying of Zinc on Seedling of *Dalbergia sissoo* (Roxb.)

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***Abstract*—Three experiments were conducted from the beginning of March to the end of October, 2012, in a field condition in Koya city-Iraqi Kurdistan region on shisham *Dalbergia sissoo* (Roxb.) trees. First experiment was laid out to study the effects of three date of sowing (15 of March, April and May), and six pre- treatments on seed germination of *D. sissoo* (Roxb.). The Results show that the best time of sowing for good seed germination was 15 of April. Highest germination rate was found when both sides of the pod were cut with soaking in tap water for 24 h. Second experiment was conducted to study the effects of three transplanting soil textures (clay, sandy and sandy clay (1:1) on seedling survival and some growth characteristics. Results indicates that *D. sissoo* gave better seedling survive rate, seedling leaves and height in sandy clay and sandy soils compared to clay soil. Third experiment was laid out to study the effects of foliar application of zinc (0, 57 and 114 ppm) sprayed on *D. sissoo* plants growing in clay, sandy and sandy clay (1:1) soils. Zinc application caused a significant increase in most vegetative growth characteristics. Treatments significantly increased leaves phosphorus, sulphate and zinc content compared to control. Most promising results were obtained from seedlings sprayed with zinc and grown in sandy clay soil**.

***Index Terms*—Dalbergia sissoo, seeds germination, shisham, soil texture, Zn-spray.**

I. Introduction

Shisham *Dalbergia sissoo* (Roxb.) belongs to family Fabaceae, sub-family Faboideae (Saha, et al., 2013), it is deciduous tree with a light crown and is propagated by seeds and suckers, this tree can grow naturally up to 1500 m above sea level. The temperature in its native range averages 10 – 40°C, it can withstand average annual rainfall up to 2000 millimeters and 3–4 months of drought, it grows best in porous well-drained soils like sands, sandy loam, gravels, and alluvial soils, but grows poorly in heavy clay and waterlogged soils, shisham can grow in slightly saline soils. *D. sissoo* is one of the most common multipurpose species with value for its timber. Leaves, young shoots and green pods, are an important source of fodder. *D. sissoo* is widely used in urban and roadside plantings and erosion control; it's also one of the important sources of medicines. (Shaltout and Keshta, 2011; Lal and Singh, 2012; Bharath, et al., 2013).

Many studies were carried out for accelerating the germination and increase germination rate of *D. sissoo* hard seeds, such as, breaking the seed pod into several pieces, each containing 1-2 seeds, soak pods in tap water for at least 24 hours before sowing (Sheikh, Abdul Matin and Nasir Uddin, 2006; Singh and Kaushik, 2011). Extraction of seeds from the pods, sulphuric acid and dewinging were found to be the best treatments for dormancy breaking compared to soaking in hot or tap water or electric burner or extraction of seeds (Idrees and Mohammed, 2014). Sheikh and Abdul Matin (2007) showed that the required germination period for *D. sissoo* (Roxb.) was very short in seeds without coats (3-6 days) in relation to coated seeds (14-15 days).

D. sissoo seed germination and seedling growth affected by different soil media like clay, sandy, sandy clay and silty soils (Sah, et al., 2003; Singh and Kaushik, 2011). Webb and Hossain (2005) found that soil parameters had no correlation with *sissoo* mortality.

Without adequate levels of zinc, the plant is unable to synthesize the various enzymes and proteins. Zinc is a structural component of the ribosome (Dickinson, et al, 2003; Obaid and Al-Hadethi, 2013). Sulfur is another important element for healthy plant growth, it is an essential component

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in the synthesis of amino acids required to manufacture proteins (Salisbury and Ross, 1991).

This study was conducted because of the lack of information about *D.sissoo* trees in Iraq, limiting area cultivated with these trees, furthermore to increase this type of trees in different regions in new province of Kurdistan (Koya), the objectives of this study were to determine the most suitable time in field condition for seed sowing and best pre-treatment for best germination, the most suitable cultivating soil for best seedling growth, and finally to know the effects of foliar spraying of zinc on the growth, chemical constituents and some physiological characteristic of the seedling

II. MATERIAL AND METHODS

For conducting this study, the pods with one seed of *D. sissoo* trees cultivated in Mnara Park in Erbil governorate were collected on 6th March, 2012. Three experiments were conducted in a field condition in Koya city located at 44°38 E, 36°4 N and 517 m altitude above sea level, as follow:

A. *Effect of Time of Sowing and some Pre–treatments on D. sissoo Seed Germination*

A factorial experiment with randomized complete block design (R.C.B.D.) with three replicates was conducted to study the effect of three times of sowing, (15th March, April and May, 2012) and six pre- treatments on germination of *D. sissoo* seeds. Pre-treatments used includes: control or untreated pods, soaking pods in tap water at room temperature for 24 hours (Sheikh and Abdul Matin, 2007), cutting one side of the pods, cutting one side of the pods with soaking in tap water at room temperature for 24 h, cutting both sides of the pods, and cutting both sides of the pods with soaking in tap water at room temperature for 24 h.

Nursery box (50×30×30 cm) were used as seed beds by using sandy soil, each bed contain 50 seeds. The rate of seed germination was calculated by dividing the number of seedling by the total number of seeds multiplied by 100 (Ahmadloo, et al., 2012).

A. *Effect of Different Soil Textures on Seedling Survival Rate and some Vegetative Growth Characteristics of D. sissoo*

randomized complete block design experiment with three replicates was conducted to study the effect of three soil textures (clay, sandy and sandy clay 1:1) on seedling survival and some vegetative growth of *D. sissoo*, by transplanting 10 cm length seedling with 4-6 leaves in poly ethylene bags sized 10×10×30 cm on the first of June, 2012, the following characteristics were studies on the first of August, 2012:

- Rate of survival seedlings was measured by dividing the number of survival seedlings by the number of initial planted seedlings at transplanting time. (Kusmana, 2010).
- Number of seedling leaves.
- Seedling height (cm): It was measured from the point of stem attachment with soil to the apical point of the main shoot.

B. *Effect of Different Soil Textures and Foliar Spraying with Zinc on D. sissoo Vegetative Growth, Leaves Chemical Constituents and Some Stomata Characteristics*

A factorial experiment using randomized complete block design with three replicates was conducted on the first of August, 2012 to study the effects of three soil textures (clay, sandy and sandy clay 1:1) with three concentration of Zn (0, 57 and 114 ppm) and their combinations on vegetative growth, leaves chemical content and some stomata characteristics of *D. sissoo* seedlings. Spraying was carried out twice; first spray was done on 30th of August, while the second spray was 10 days after the first one. The spraying carried out early in the morning until all leaves on the target plants were wet.

C. *Studied Characteristics*

Vegetative Growth

This includes seedling height and leaves number, number of branches per seedling, leaf area which calculated by the method described by Watson and Watson (1953) and main root length.

Chemical Constituents of Leaves

This includes percent of shoot and root dry matter which were calculated as it described by Al-Sahaf (1989), total carbohydrates determined according to Joslyn (1970), chlorophyll content estimated according to Ranganna (1977), total nitrogen determined by kjeldahl method (Allen, et al., 1974), total phosphorus estimated by spectrophotometer at 410 nm as described by Ryan and Rashid (2001), total potassium determined by using flame photometer as it mentioned by Kalra (1998), total zinc determined by using atomic absorption spectrophotometer and using acetylene gas at 213.9 nm (A.O.A.C., 1970), and sulphate determined according to Gupta (2004).

Stomata Characteristics

Number, length and width of stomata in upper and lower surfaces of leaves measured by the method of lasting impressions as it described in Rai and Mishra (2013).

Meteorological Data and Soils Properties

Some meteorological data in the field condition during the growing season were measured in Agro-Meteorological Station in Koya city as it shown in Table I. Chemical and physical properties of the study soils are measured in the Agricultural Research Center-Ainkawa-Erbil, and University of Sulaimanya -Department of Soil and Water Science as it shown in Table II.

D. *Statistical Analysis*

The treatments of all experiments replicate three times, and the comparisons between means were made by using Duncan's Multiple Range test at 5% level (Reza, 2006). The statistical analysis was carried out by using SAS program.

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TABLE I
MAXIMUM AND MINIMUM TEMPERATURE, THE RELATIVE HUMIDITY AND THE AMOUNT OF RAIN FALL DURING THE GROWING SEASON (2012)

Month	Air Temp. C°		Relative Humidity%		Rain fall (mm)
	Max.	Min.	Max.	Min.	
March	14.2	6.2	75.2	65.7	122.2
April	25.7	15.5	72.6	67.4	32.0
May	32.3	21.3	54.8	47.5	8.0
June	38.3	27.8	47.1	40.3	0.0
July	40.5	30.9	47.6	41.9	0.0
August	40.7	29.6	51.7	45.7	0.0
September	37.2	27.7	53.7	48.9	0.0
October	29.8	21.2	67.1	57.8	18.0

TABLE II
SOME CHEMICAL AND PHYSICAL PROPERTIES OF THE STUDIED SOILS

Soil properties	Type of soil		
	Clay	Sandy	Sandy clay
EC (dS. m^{-1})	0.40	0.30	0.50
pH	8.07	8.17	8.22
Total N (%)	0.06	0.04	0.06
P^{3-} (ppm)	3.60	6.18	5.54
Zn^{2+} (mg/L)	0.19	0.18	0.20
CO_3^{2-} (mg/L)	0.00	0.00	0.00
HCO_3^- (mg/L)	2.80	2.90	2.00
Ca^{2+} (mg/L)	6.60	9.60	7.00
Mg^{2+} (meq/L)	3.20	1.80	1.40
Cl^{1-} (meq/L)	1.28	1.50	1.38
Na^+ (meq/L)	1.46	1.07	0.73
K^+ (meq/L)	0.24	0.16	0.19
SO_4^{2-} (meq/L)	7.42	8.23	5.94
Gypsum (%)	0.32	0.00	0.00
Organic Matter (%)	1.04	0.15	1.02
Clay ($g.kg^{-1}$)	638	222	322
Sand ($g.kg^{-1}$)	62	655	555
Silt ($g.kg^{-1}$)	300	123	123
Textural name	Clay soil	Sandy soil	Sandy clay soil

III. RESULTS AND DISCUSSION

A. *Effect of Time of Sowing and some Pre-treatments on D. sissoo Seeds Germination.*

Results in Table III show significant differences between different times of sowing on the rate of germination. The highest value recorded in April sowing time (19.11%), while the lowest value (0.00%) recorded in March. The highest seed germination (10.89%) recorded when both sides of the pod were cut with soaking in tap water for 24h, whereas, the lowest value (9.00%) recorded in control pods. Interaction between different times of sowing and pre- treatments had significant effect on the rate of seed germination, the highest value (32%) obtained from April sowing with cutting both sides of the pod and soaking in tap water for 24 h, while the lowest value (0.00%) obtained from seeds sowing in March with different pre-treatments sowing.

The failure of March sowing date, may due to snow falling that precipitated and accumulated in the beds followed by dissolving, that led to the decay of the seeds in their beds, also it may be due to decrease in temperature 6.2° C which caused decreasing enzymes activity (Salisbury and Ross, 1991). This study agrees with Khera and Singh (2005) that germination of seeds is strongly influenced by different environmental factors, like water stress, light requirements and temperature. Increasing temperature leads to changes in protein conformation occur which promote the germination process, and too high temperatures may weaken or decrease seed activity, also too much moisture may limit the supply of air, under normal conditions (Robbins, 2004), for the above reasons, may be the seeds sown in March died and not germinated.

TABLE III
EFFECT OF TIME OF SOWING, SOME PRE- TREATMENTS AND THEIR INTERACTIONS ON *D. sissoo* SEEDS GERMINATION RATE

Treatments	Germination rate (%)
Date of sowing	
15 March	0.00 c *
15 April	19.11 a
15 May	5.00 b
Pre-treatments	
Control or untreated pods	6.00 a
Soaking pods in tap water for 24 hours	6.44 a
Cutting one side of the pod	7.78 a
Cutting one side of the pod with soaking in tap water for 24 h	7.78 a
Cutting both sides of the pod	9.33 a
Cutting both sides of the pod with soaking in tap water for 24 h	10.89 a
Interaction	
15 March + Control or untreated pods	0.00 f
15 March + Soaking pods in tap water for 24 hours	0.00 f
15 March + Cutting one side of the pod	0.00 f
15 March + Cutting one side of the pod with soaking in tap water for 24 h	0.00 f
15 March + Cutting both sides of the pod	0.00 f
15 March + Cutting both sides of the pod with soaking in tap water for 24 h	0.00 f
15 April + Control or untreated pods	12.67 bcd
15 April + Soaking pods in tap water for 24 hours	18.00 bc
15 April + Cutting one side of the pod	13.33 bcd
15 April + Cutting one side of the pod with soaking in tap water for 24 h	21.33 b
15 April + Cutting both sides of the pod	17.33 bc
15 April + Cutting both sides of the pod with soaking in tap water for 24 h	32.00 a
15 May + Control or untreated pods	5.33 def
15 May + Soaking pods in tap water for 24 hours	1.33 ef
15 May + Cutting one side of the pod	10.00 cdef
15 May + Cutting one side of the pod with soaking in tap water for 24 h	2.00 ef
15 May + Cutting both sides of the pod	10.67 cde
15 May + Cutting both sides of the pod with soaking in tap water for 24 h	0.67 ef

* Means followed by the same letters within column are not significantly different at $p \leq 0.05$ according to the Duncan test.

Significant effect of cutting both sides of the pod with soaking in tap water for 24h on seeds germination, may due to provide the fastest movements of water into the seeds, because of those species of seeds have hard coats that are impermeable to water, however, after a sufficient time in the soil, with warmth, moisture, and action of soil organisms, the coat becomes permeable, water can enter the seed, and then germination will start (Robbins, 2004). The results agree with Sheikh and Abdul Matin (2007), Singh and Kaushik (2011), and Idrees and Mohammed (2014) were studied the soaking of *D. sissoo* seeds in water for 24 hours at room temperature or dewinging the seeds, which led to increasing seeds germination rate.

B. *Effect of Different Soil Textures on Seedling Survival, Number of Seedling Leaves and Seedling Height*

Table IV shows the significant increase in each of rate of survival seedling, leaves number and seedling height in sandy clay soil compared to clay soil.

TABLE IV
EFFECT OF DIFFERENT SOIL TEXTURES ON SURVIVAL AND SOME VEGETATIVE GROWTH CHARACTERISTICS OF *D. sissoo* SEEDLING.

Type of soil	Seedling survival rate (%)	Number of leaves. $seedling^{-1}$	Seedling height (cm)
Clay	45.33 b *	13.18 c	27.50 b
Sandy	82.67 a	16.75 b	32.97 ab
Sandy clay	82.00 a	19.70 a	41.03 a

* Means followed by the same letters within columns are not significantly different at $p \leq 0.05$ according to the Duncan test.

These effects may be attributed to the physical and chemical properties of different soils used in the study, Table II, sandy soil drain easily, so water logging is not a problem, the ions absorption is easier while some of ions adsorb on the clay soil particles, their open structure means that they quick to warm up in spring, allowing earlier sowing and planting. However sandy soils do dry out very quickly and nutrients are easily washed through the soil, while clay soils are heavy, they are slow to warm in the spring, sticky when wet and very hard when dry, clay soils hold moisture and nutrients well and remain warm (James and Michael, 2009; Mazhar, Abd El-Aziz and Habba, 2010). However, it has been observed that in well-drained soils, even a few days of water logging due to poor drainage outlet may result in shisham mortality (Webb and Hossain, 2005). The intermediate properties of sandy clay soil may due to adequate soil moisture and nutrient content and formation of more carbohydrate and also new leaves and growth in the seedling, Table IV. The results agree with Geply, et al. (2011) whom found that the best soil media for growing *Jatropha curcas* is sand compare to top soil and sawdust media. The results also agree with Vishnoi, Rajwar and Kuniyal (2010) whom observed that sandy loam to sandy soil was the most suitable soil condition for *D. sissoo* growth, while results did not agree with Mazhar, Abd El-Aziz and Habba (2010) in Egypt whom found that haat plant *Jatropha curcas* L. (Euphorbiaceae) height and number of plant leaves increased by using clay media followed by sandy clay soil as compared with sandy soil.

C. *Effect of Different Soil Textures and Foliar Spraying with Zinc on D. sissoo Vegetative Growth, Leaves Chemical Constituents, and some Stomata Characteristics*

Vegetative Growth

Results in Table V shows that sandy clay soil increased each of seedling height, number of seedling leaves, leaf area and main root length significantly to 66.82 cm, 25.52 $leaves.seedling^{-1}$, 325.82 cm^2 and 36.70 cm respectively compared to clay soil and non-significantly for seedling branch number, which increased with increasing the concentration of Zn, while each of seedling height, number of seedling leaves, leaf area and main root length had no significant response to Zn application.

The interaction between soil textures and foliar application of Zn had no significant effect on seedling height and number of leaves, while the interaction treatments affected significantly on other vegetative growth characters.

Sandy clay soil stimulating the growth of plants because of the reasons mentioned in the second experiment, the interaction between different soil textures and zinc spraying affected significantly on some vegetative growth parameters, like number of branches per seedling, leaf area, main root length, these results agree with Ayad, Reda and Abdulla (2010), whom confirm that spraying zinc increased vegetative growth of *Pelargonium graveolens* L. The results also agree with Al-Imam and Al-Jubury (2008) and Al-Aareji and Al-Hamadany (2009) and Khalifa, Shaaban and Rawia (2011). This increment of growth may due to formation of the amino acid tryptophan, which consists of hormone indole acetic acid that regulates cellular elongation, apical dominance and root initiation (Obaid and Al-Hadethi, 2013).

Chemical Constituents of Leaves

Results in Table VI shows that each of soil texture and concentration of Zn weren`t affect significantly on chemical constituents of leaves except total carbohydrate which was affected by Zn spraying, while the interaction between them affected significantly only on each of shoot dry matter and total carbohydrates, the highest values were recorded from sandy clay soil with spraying 57 ppm Zn with rate 46% and 0.15% respectively, while lowest value (38.87%) for shoot dry matter was obtained from clay soil with spraying 57 ppm Zn and 0.1% carbohydrate was obtained from clay soil with spraying 114 ppm.

These effects of Zn due to zinc are closely involved in the metabolism leads to stimulation of carbohydrates, protein and the DNA formation. Several enzymes are often activated by Zn, which therefore have a considerable effect on protein synthesis and nitrogen metabolism of plants (Dickinson, et al, 2003).

Results in Table VI shows that different soil texture, foliar spraying with zinc and their interactions had non-significant effects on leaf content of chlorophyll a, b and total chlorophyll.

Results in Table VII shows that soil texture had non-significant effects on leaf content of total nitrogen, phosphorus and sulphate. Clay soil increased total potassium to 1.04%, while it decreased total zinc in leaves to 73.84 ppm compared to sandy clay soil which increase it to 91.93 ppm. Foliar spraying of Zn increased significantly the leaves content of

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total phosphorus, zinc and sulphate, and decreased potassium content, while this effect was non-significant on nitrogen content, Table VII.

Zinc foliar application on the leaves had significant effect on increasing phosphorus, potassium, sulphar and zinc concentration in leaves, these results agree with those obtained by Al-Imam and Al-Jubury (2008) and Al-Aareji and Al-Hamadany (2009). These results also agree with Ayad, Reda and Abdulla, (2010), whom confirms that spraying zinc increased total carbohydrate, nitrogen, phosphorus, potassium, total sulphate and total zinc in sandy clay and sandy soils with increasing zinc concentration.

TABLE V

EFFECT OF DIFFERENT SOIL TEXTURES, FOLIAR SPRAYING WITH ZINC AND THEIR INTERACTIONS ON SOME VEGETATIVE GROWTH OF *D. sissoo* SEEDLINGS

Treatments	Seedling height (cm)	No. of leaves. $seedling^{-1}$	No. of branches. $seedling^{-1}$	Leaf area (cm^2). $seedling^{-1}$	Seedling main root length (cm)
Type of soil					
Clay	49.52 b*	19.16 b	4.67 a	203.38 b	26.33 b
Sandy	56.82 ab	22.51 ab	5.44 a	342.87 a	31.72 ab
Sandy clay	66.82 a	25.52 a	5.44 a	325.82 a	36.70 a
Zinc					
Control	55.59 a	22.00 a	4.00 b	269.77 a	31.83 a
57 ppm	57.77 a	21.87 a	4.56 b	280.23 a	30.35 a
114 ppm	59.81 a	23.32 a	7.00 a	322.06 a	32.57 a
Interaction					
Clay + control	47.83 a	18.33 a	3.00 b	186.68 bc	20.94 b
Clay + 57 ppm	47.50 a	18.50 a	3.33 b	160.18 c	27.44 ab
Clay + 114 ppm	53.23 a	20.65 a	7.67 a	263.27 abc	30.61 ab
Sandy + control	50.16 a	21.20 a	3.67 b	271.94 abc	31.67 ab
Sandy + 57 ppm	59.52 a	22.81 a	5.33 ab	394.36 a	28.72 ab
Sandy+ 114 ppm	60.79 a	23.52 a	7.33 a	362.30 ab	34.78 ab
Sandy clay + control	68.78 a	26.47 a	5.33 ab	350.69 abc	42.89 a
Sandy clay+ 57 ppm	66.28 a	24.29 a	5.00 ab	286.14 abc	34.89 ab
Sandy clay+ 114 ppm	65.40 a	25.80 a	6.00 ab	340.62 abc	32.33 ab

* Means followed by the same letters within columns are not significantly different at $p \leq 0.05$ according to the Duncan test.

TABLE VI

EFFECT OF DIFFERENT SOIL TEXTURES, FOLIAR SPRAYING WITH ZINC AND THEIR INTERACTIONS ON CHEMICAL CONSTITUENTS OF *D. sissoo* LEAVES

Treatments	Shoot dry Matter (%)	Root dry Matter (%)	Total Carbohydrate (%)	Chlorophyll a	Chlorophyll b	Total Chlorophyll
				mg /100g wet weight		
Type of soil						
Clay	41.82 a	46.85 a	0.12 a*	1.93 a	1.56 a	3.49 a
Sandy	39.77 a	45.07 a	0.12 a	1.99 a	1.51 a	3.49 a
Sandy clay	42.87 a	46.57 a	0.14 a	2.08 a	1.96 a	4.04 a
Zinc						
Control	40.90 a	45.40 a	0.13 ab	1.92 a	1.64 a	3.56 a
57 ppm	41.61 a	46.68 a	0.14 a	2.12 a	1.67 a	3.79 a
114 ppm	41.95 a	46.02 a	0.11 b	1.95 a	1.72 a	3.67 a
Interaction						
Clay + control	41.16 ab	45.76 a	0.12 ab	1.77 a	1.57 a	3.33 a
Clay + 57 ppm	38.87 b	45.90 a	0.14 ab	2.15 a	1.62 a	3.77 a
Clay + 114 ppm	45.44 ab	48.89 a	0.10 b	1.86 a	1.50 a	3.36 a
Sandy + control	39.99 ab	45.15 a	0.12 ab	1.83 a	1.52 a	3.36 a
Sandy + 57 ppm	39.97 ab	46.58 a	0.13 ab	2.26 a	1.26 a	3.51 a
Sandy+ 114 ppm	39.36 ab	43.48 a	0.10 b	1.87 a	1.74 a	3.61 a
Sandy clay + control	41.56 ab	48.34 a	0.14 ab	2.16 a	1.84 a	4.00 a
Sandy clay+ 57 ppm	46.00 a	47.57 a	0.15 a	1.96 a	2.12 a	4.08 a
Sandy clay+ 114 ppm	41.05 ab	48.35 a	0.12 ab	2.12 a	1.91 a	4.03 a

* Means followed by the same letters within columns are not significantly different at $p \leq 0.05$ according to the Duncan test.

TABLE VII
EFFECT OF DIFFERENT SOIL TEXTURES, FOLIAR SPRAYING WITH ZINC AND THEIR INTERACTIONS ON SOME CHEMICAL CHARACTERISTICS OF *D. sissoo* LEAVES

Treatments	Total Nitrogen%	Total Phosphorus%	Total Potassium%	Total Zinc (ppm)	Total Sulphate%
Type of soil					
Clay	2.04 a*	0.38 a	1.04 a	73.84 b	0.19 a
Sandy	2.56 a	0.40 a	0.87 b	78.03 ab	0.22 a
Sandy clay	2.52 a	0.36 a	0.90 b	91.93 a	0.24 a
Zinc					
Control	2.17 a	0.31 b	0.98 a	68.48 b	0.19 b
57 ppm	2.43 a	0.41 a	0.94 ab	75.63 b	0.23 ab
114 ppm	2.52 a	0.42 a	0.90 b	99.70 a	0.24 a
Interaction					
Clay + control	1.15 b	0.33 b	1.11 a	55.73 d	0.17 b
Clay + 57 ppm	2.75 a	0.42 ab	1.10 a	70.60 bc	0.16 b
Clay + 114 ppm	2.22 ab	0.38 ab	0.91 b	95.20 ab	0.26 a
Sandy + control	2.73 a	0.32 b	0.92 b	61.90 cd	0.18 ab
Sandy + 57 ppm	2.19 ab	0.40 ab	0.84 b	78.80 bc	0.26 a
Sandy+ 114 ppm	2.75 a	0.48 a	0.86 b	93.40 ab	0.22ab
Sandy clay + control	2.63 a	0.29 b	0.90 b	87.80 ab	0.21 ab
Sandy clay+ 57 ppm	2.33 a	0.40 ab	0.87 b	77.50 bc	0.27 a
Sandy clay+ 114 ppm	2.59 a	0.39 ab	0.93 b	110.50 a	0.23 ab

* Means followed by the same letters within columns are not significantly different at $p \leq 0.05$ according to the Duncan test.

Effect on Some Stomata Characteristics

Stomata structure in *D. sissoo* seedlings leaves is shown in Fig. 1 and Fig. 2, both adaxial and abaxial epidermis have stomata. The anatomical study indicated to non-significant differences between soil textures, zinc application and their interaction on adaxial and abaxial stomata number, width and adaxial stomata length, Table VIII, whereas, the interaction between soil texture and foliar spraying with zinc increased stomata length significantly in abaxial surface of seedlings that growing in clay soil and sprayed with 57 ppm zinc compared to seedlings growing in sandy soil and sprayed with 57 ppm zinc.

These results agree with Artik (2005) who refers that stomata number on lower surface is more than stomata number on upper surface in *Vicia faba* L. plants. These results also agree with other studies that mentioned that stomata characteristics like number, length and width is affected by genetic constituents, ecological condition, environmental factors, physiological process, season, leaf position and leaf surface (Caglar, Sutyemez and Sudhakar, 2004; Peksen, Peksin and Artik, 2006).

TABLE VIII
EFFECT OF DIFFERENT SOIL TEXTURES, FOLIAR SPRAYING WITH ZINC AND THEIR INTERACTIONS ON SOME STOMATA CHARACTERISTICS ON UPPER & LOWER LEAVE SURFACES OF *D. sissoo*

Treatments	Stomata Number /mm^2		Stomata length (µm)		Stomata width (µm)	
	Adaxial surface	Abaxial surface	Adaxial surface	Abaxial surface	Adaxial surface	Abaxial Surface
Type of soil						
Clay	77.56 a*	177.78 a	22.17 a	14.39 a	19.11 a	13.44 a
Sandy	81.56 a	202.22 a	22.33 a	13.83 a	19.06 a	13.28 a
Sandy clay	73.78 a	193.11 a	22.11 a	14.39 a	19.06 a	13.28 a
Zinc						
Control	83.78 a	190.22 a	22.39 a	14.06 a	18.44 a	12.83 a
57 ppm	75.33 a	185.56 a	22.67 a	14.44 a	19.94 a	13.50 a
114 ppm	73.78 a	197.33 a	21.56 a	14.11 a	18.83 a	13.67 a
Interaction						
Clay + control	78.67 a	174.00 a	22.33 a	13.83 ab	18.50 a	12.83 a
Clay + 57 ppm	76.00 a	168.00 a	23.67 a	15.50 a	20.50 a	13.67 a
Clay + 114 ppm	78.00 a	191.33 a	20.50 a	13.83 ab	18.33 a	13.83 a
Sandy + control	85.33 a	197.33 a	22.17 a	13.83 ab	18.00 a	13.00 a
Sandy + 57 ppm	80.00 a	206.00 a	22.33 a	13.67 b	19.33 a	13.00 a
Sandy+ 114 ppm	79.33 a	203.33 a	22.50 a	14.00 ab	19.83 a	13.83 a
Sandy clay + control	87.33 a	199.33 a	22.67 a	14.50 ab	18.83 a	12.67 a
Sandy clay+ 57 ppm	70.00 a	182.67 a	22.00 a	14.17 ab	20.00 a	13.83 a
Sandy clay+ 114 ppm	64.00 a	197.33 a	21.67 a	14.50 ab	18.33 a	13.33 a

* Means followed by the same letters within columns are not significantly different at $p \leq 0.05$ according to the Duncan test.

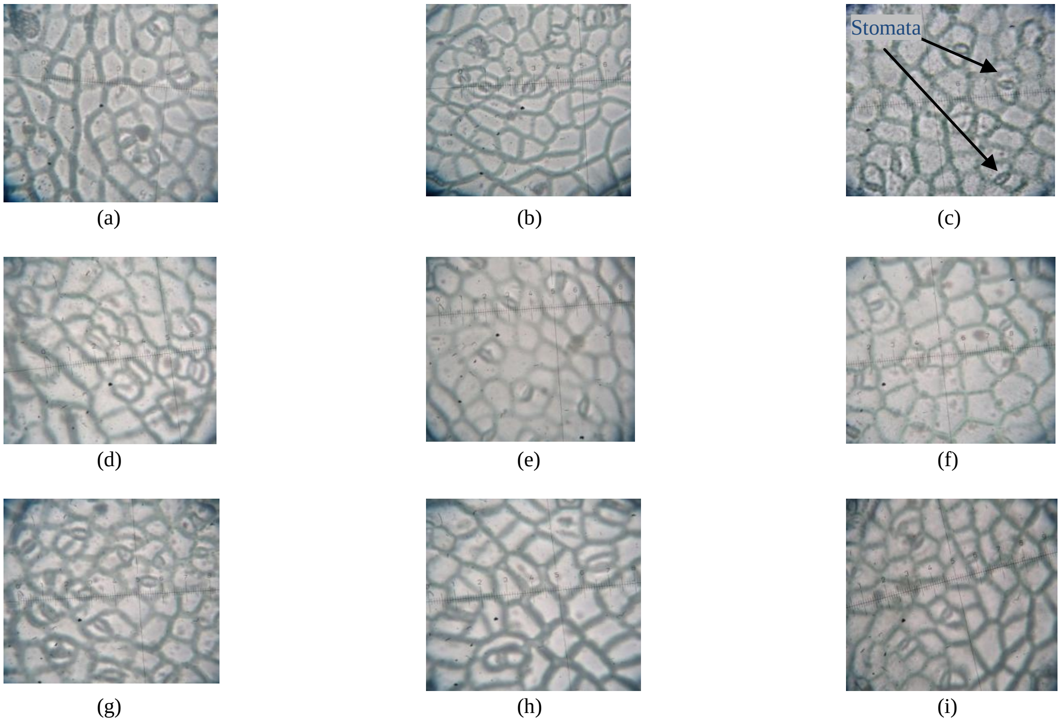

Fig. 1. Upper (adaxial) *D. sissoo* leaves surfaces stomata 400X for seedlings grown in; (a) Clay soil and no Zinc sprayed, (b) Clay soil and sprayed with 57 ppm Zinc, (c) Clay soil and sprayed with 114 ppm Zinc, (d) Sandy soil and no Zinc sprayed, (e) Sandy soil and sprayed with 57 ppm Zinc, (f) Sandy soil and sprayed with 114 ppm Zinc, (g) Sandy clay soil and no Zinc sprayed, (h) Sandy clay soil and sprayed with 57 ppm Zinc and (i) Sandy clay soil and sprayed with 114 ppm Zinc.

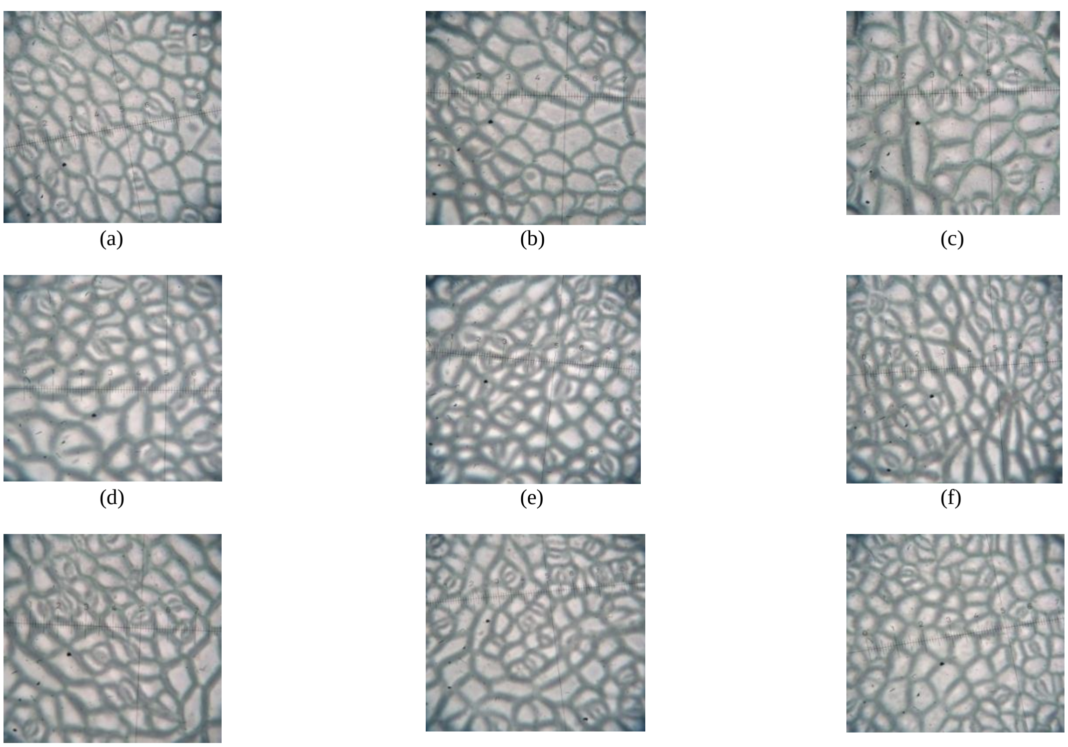

Fig. 2. Lower (abaxial) *D. sissoo* leaves surfaces stomata 400X for seedlings grown in; (a) Clay soil and no Zinc sprayed (b) Clay soil and sprayed with 57 ppm Zinc, (c) Clay soil and sprayed with 114 ppm Zinc, (d) Sandy soil and no Zinc sprayed, (e) Sandy soil and sprayed with 57 ppm Zinc (f) Sandy soil and sprayed with 114 ppm Zinc, (g) Sandy clay soil and no Zinc sprayed, (h) Sandy clay soil and sprayed with 57 ppm Zinc and (i) Sandy clay soil and sprayed with 114 ppm Zinc.

IV. Conclusions

From this research it was evident that different date of sowing and different seed pre-treatment have significant effects on germination rate of *Dalbergia sissoo* (Roxb.) in Koya city. Best time was 15th April, while best pre-treatment for seeds was cutting both sides of seeds. Data analysis also shows that growth of seedling is strongly depend on soil texture, sandy clay soil was the best media for growing the seedling. Foliar spraying of Zinc has a good role in improving most of the vegetative growth characteristics and chemical constituents of leaves except potassium.

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Calculated-Experimental Model for Multilayer Shield

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***Abstract*—The effective linear attenuation coefficients and build-up factors for single shield of *Al, Fe, Pb*, and for multi-layer shield of *Al-Pb, Al-Fe, Fe-Pb, Al-Fe-Pb* as a function of shield thickness, atomic number, and order of the materials composing the shield are investigated for two photon energies of 0.662 MeV and 1.25 MeV. Two derived practical formulas to calculate the effective attenuation coefficient and build-up factor for multilayer shields are used. It is noticed that changing the order of the materials among the shield has no significant effect on the experimental result. Measurement agrees well with the trend of the suggested formulas for calculating the effective attenuation coefficient and the buildup factor. The linear attenuation coefficient is observed to have a strange dependency with the atomic number and photon energy. For single layer shield, the attenuation coefficient increases with decreasing atomic number at low photon energy and increasing with increasing atomic number at high photon energy.**

***Index Terms*—Attenuation coefficient, build-up factors, multilayer shields, radiation dose.**

I. Introduction

The use of gamma rays in medicine, surgery, industry, research and agriculture, made human subject to dangerous diseases. The lack of knowledge in radiation protection principles among which is the use of proper shielding materials increases this risk. In radiation protection, photon build-up factors, and attenuation coefficient, provide convenient information for calculating dose and exposure response after various shielding configurations. Since gamma rays are very penetrating radiation, selection of shielding materials becomes most important in many cases such as in nuclear accidents, nuclear reactors, research laboratories, in medical institutions, and in high space. People involved in those places may be victims to gamma ray exposure. Moreover, on 2009, NASA has identified the need for developing advanced radiation-shielding materials and structures to protect humans from the hazards of galactic cosmic radiation during lunar missions (NASA, Proposal Number: 09-1X4.01-8309, Sub-topic X4.01, NASA SBIR 2009 Solicitation). NASA proposed to develop lightweight, multi-layered shield with an outer layer of hydrogenous polymeric material. This shield is designed and fabrication of materials tailored to shield against hazardous radiation.

Mathematically methods to solve the problem for multilayer shield may be divided in two groups: the semi-empirical methods based on the use of experimental or theoretical data and method uses low order approximation of the transport equation and Monte Carlo program (Nelson,, Hirayama and Rogers, 1985). However, the relatively accurate solution of the gamma radiation transport equations is realized only for the simple geometrical configurations.

Buildup factor, which is important in calculating radiation shielding and absorbed dose, have been widely studied by various research groups (Shin, and Hirayama, 2001; Alamatsaz, and Shirani, 2002; Saudi, 2013). However, the variation of the buildup factor with penetration distance in multi-layered shield differs from that in homogenous media (Balwinder, et al., 2013). This variation depends on attenuation, buildup factor, and thickness for both penetrated layers.

In this research, experimental measurement for the buildup factor and attenuation coefficient for single and multi-layer shields at *Cs-137* and *Co-60* gamma energies will be carried out. The experimental result will be used to derive a practical formula for calculating the effective buildup factor and attenuation coefficient for multilayer shields. We believe that in practice the design of multi-layer shield for any purposes need a simple method of calculation with good accuracy.

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II. THE EXPERIMENTAL MODEL

In practice, broad beam geometry must be considered. The quantity of radiation transmitted through the shield, *I*, is given by;

$$I = BI_0 e^{-\mu x} \tag{1}$$

Where; I_0 is the incident intensity, *exp* $(-\mu x)$ is the attenuation factor and *B* is the buildup factor.

In the present work, three-layer shield geometry will be assumed as in Fig. 1. Photon beam with intensity, I_0, is assumed to be incident perpendicularly on the plane of the shield.

The intensity of the beam entering the second, third layer, and that leaving the third layer of the shield is given by;

$$I_1 = I_0\, B_1 e^{-\mu_1 x_1} \tag{2}$$

$$I_2 = I_1\, B_2 e^{-\mu_2 x_2} \tag{3}$$

$$I_3 = I_2\, B_3 e^{-\mu_3 x_3} \tag{4}$$

Substitute (I_1 and I_2) from (2) and (3) into (4), and rearrange the equation, we get;

$$\therefore \quad I_3 = I_0\ (B_1 B_2 B_3)\ e^{-(\mu_1 x_1 + \mu_2 x_2 + \mu_3 x_3)} \tag{5}$$

If we consider the shield as one unit, we can say;

$$I_3 = I_0\, B_{eff}\, e^{-\mu_{eff}\ x_{tot}} \tag{6}$$

From (5) and (6), we get;

$$B_{eff} = B_1 B_2 B_3 \tag{7}$$

and

$$\mu_{eff} = \frac{\mu_1 x_1 + \mu_2 x_2 + \mu_3 x_3}{x_{ToT}} \tag{8}$$

The present work aims to verify experimentally the validity of (7) and (8) by measuring μ_1, μ_2, μ_3, B_1, B_2 and B_3. The results obtained will then be used to calculate the effective buildup and attenuation coefficient for different multi-layer shields.

III. MATERIAL AND METHODS

The attenuation coefficient for single and multi-layered shields is carried out by using the narrow beam geometry shown in Fig. 2. The photon beam is directed perpendicular to plane of the shield. Measurements of the attenuation coefficient are carried out for three single elements of *Al, Fe, Pb***,** and for four multi-layer shield combinations of *Al-Pb, Al-Fe, Fe-Pb*, and *Al-Fe-Pb* are carried out. The effect of reversing the order of the materials among the shield is also investigated.

The Attenuation coefficients were measured using NaI (TI) scintillation detector connected to a multi-channel analyzer (MCA), having energy resolution of 12.5 % at 662 keV. Plane radioactive sources of Co^{60} and Cs^{137} with activities of $5\mu Ci$, $1\mu Ci$, and effective photon energy of 0.662 MeV, 1.25 MeV are considered for the sources respectively.

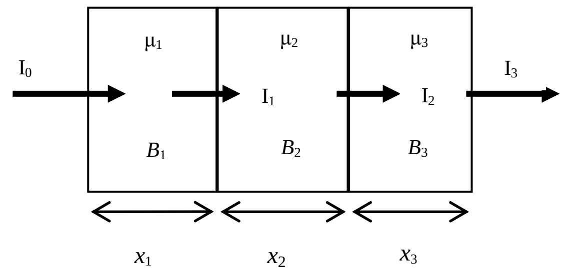

Fig. 1. The multi-layer shield geometry.

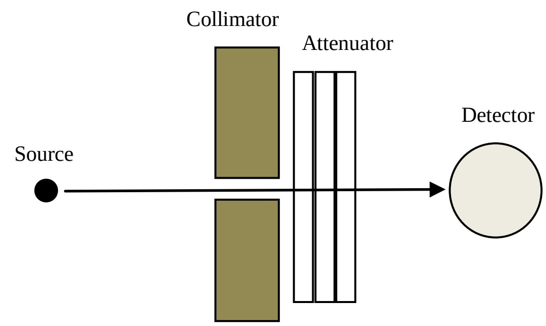

Fig. 2. The irradiation geometry

A broad beam and narrow beam geometries are used in measuring the buildup factor. The broad beam geometry is achieved by removing the collimator in front of the attenuator in Fig. 2. The build-up factor can be deduced experimentally as the ratio of the transmitted beam intensity from a broad beam geometry, *T`*, to that transmitted from a narrow beam geometry, *T*, and is given by;

$$B = \frac{T`}{T} = \frac{Be^{-\mu x}}{e^{-\mu x}} \tag{9}$$

Measurements for the buildup factor are carried out for three single elements of *Al, Fe, Pb***,** and for three multi-layer shield combinations of *Al-Pb, Al-Fe, Fe-Pb* at 0.662 MeV and 1.25 MeV photon energies. The effect of changing the order of the materials among the shield is also investigated in this study.

IV. RESULT AND DISCUSSION

A. The Effective Attenuation Coefficient

Measurement for the linear attenuation coefficient for single element of Al, Fe, and Pb at 0.662 MeV and 1.25 MeV are carried out using narrow beam geometry and the result are shown in Fig. 3 and Fig. 4.

The experimental result for the linear attenuation coefficients for the three single elements and that calculated by (Hubbel and Berger, 1987; Hubbell and Seltzer, 1996) are shown in Table I. The calculated values appear to be overestimating the experimental results.

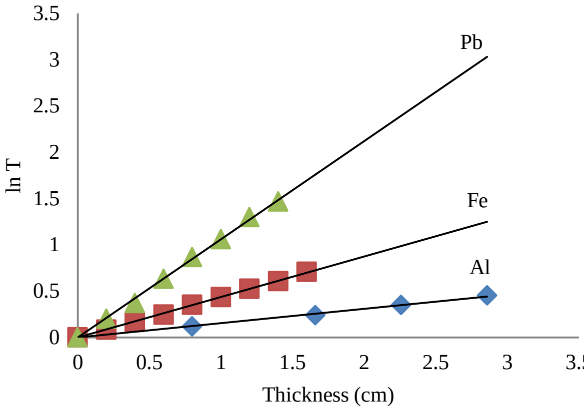

Fig. 3. The attenuation factor for *Al*, *Fe*, and *Pb* as a function shield thickness at 0.662 MeV

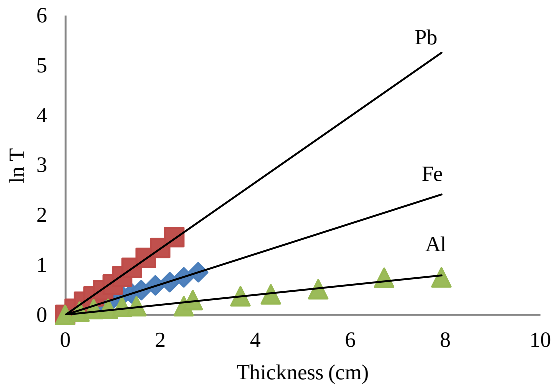

Fig. 4. The attenuation factor for *Al*, *Fe*, and *Pb* as a function shield thickness at 1.25 MeV

The measured attenuation coefficients for three multi-layer shields of Al-Fe, Al-Pb, and Fe-Pb at 0.662 MeV is shown in Fig. 5.

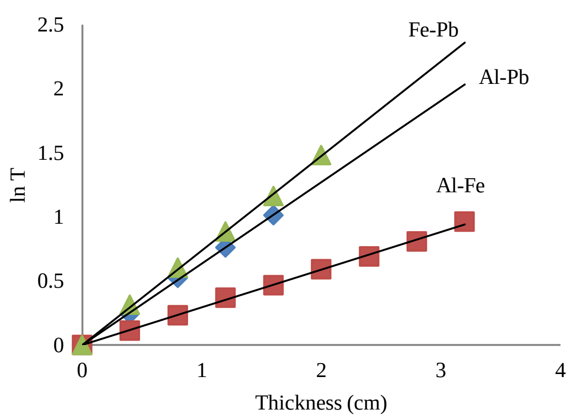

Fig. 5. The attenuation factor for *Al-Fe*, *Fe-Pb*, and *Al-Pb* shields as a function of shield thickness at 0.662 MeV.

The measured linear attenuation coefficients for single layer shields are then used to calculate the effective linear attenuation coefficient for the three multi-layer shield at 0.662 MeV using (8). Table II shows the calculated effective attenuation coefficient and the measured values for different multi-layer shield combinations. A good agreement between them is recorded. No significant effect for changing the order of the material of the shields is observed.

TABLE I
THE EXPERIMENTAL AND CALCULATED LINEAR ATTENUATION COEFFICIENT (CM^{-1})

	0.662 MeV		1.25 MeV	
Shield	Experimental	Calculated	Experimental	Calculated
Al	0.154	0.2003	0.0995	0.1482
Fe	0.437	0.578	0.3046	0.4793
Pb	1.059	1.322	0.6636	0.6418

TABLE II
THE EXPERIMENTAL AND CALCULATED LINEAR ATTENUATION COEFFICIENT (CM^{-1}) AT 0.662 MEV

Shield	Calculated	Experimental	% error
Al-Pb	0.608	0.635	4.4
Al-Fe	0.296	0.294	0.6
Fe-Pb	0.749	0.737	2.9

The validity of (8) for the multi-layer shield of *Al-Fe-Pb* is also checked at 0.662 MeV and 1.25 MeV photon energies and the result is shown in Fig. 6. It is clear from our result that no significant effect for changing the order of the material of the shield had been seen.

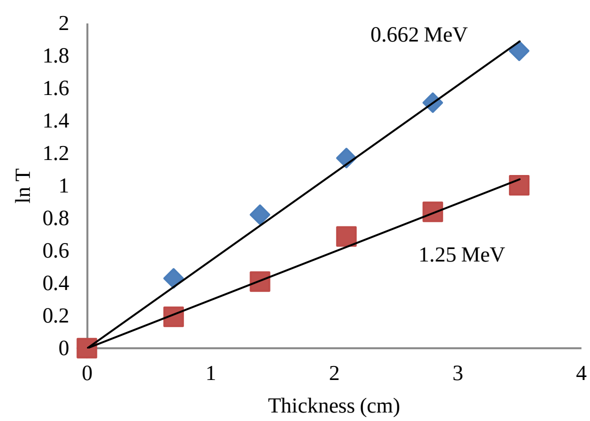

Fig. 6. The attenuation factor for *Al-Fe-Pb* shield as a function of shield thickness at 0.662 MeV and 1.25 MeV.

Table III shows the measured and calculated attenuation coefficient for Al-Fe-Pb shield at 0.662 MeV and 1.25 MeV. The experimental result is in a good agreement with that calculated by using (8).

 http://dx.doi.org/10.14500/aro.10057

TABLE III
CALCULATED AND EXPERIMENTAL LINEAR ATTENUATION COEFFICIENT IN UNIT OF (CM^{-1})

	0.662 MeV			1.25 MeV		
Shield	Experimental	Calculated	% error	Experimental	Calculated	% error
Al-Fe-Pb	0.5395	0.4947	9	0.2971	0.3192	5.9

B. The Build-up factor

The build-up factors, *B*, as a function of thickness in units of mean free path (*m.f.p*) for single elements of *Al*, *Fe*, and *Pb* are measured using a broad and narrow beam geometries at 0.662 MeV and 1.25 MeV, and are shown in Fig. 7 and Fig. 8.

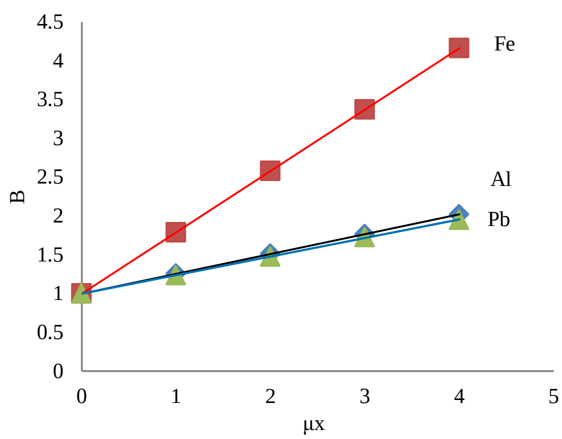

Fig. 7. The build-up factor for single layer shield as a function of shield thickness at 0.662 MeV

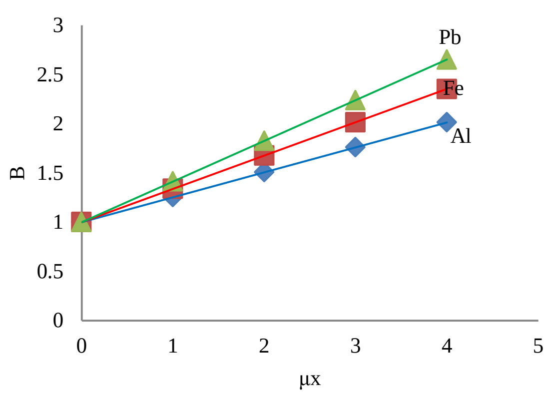

Fig. 8. The build-up factor for single layer shield as a function of shield thickness at 1.25 MeV.

We can see from Fig. 7 and Fig. 8 that the build-up factor at 1.25 MeV increases with shield thickness and with the atomic number of the shield material, while at 0.662 MeV, the build-up factor for *Al* is lower than that for *Fe* and become very close to that for *Pb*. This agrees well with other findings of some researchers (Abdulfattah, 2010; Al-Baiti, 2010; Jasbir, Barjinderpal and Gurdeep, 2012). They noticed that the build-up factor has a strange dependency with the atomic number and photon energy, increasing as atomic number decreasing at low energy and increasing with increasing atomic number at high energy.

The experimental values of build-up factor for single layer shields are then used to calculate the effective build-up factor for multi-layer shields of *Al-Pb*, *Al-Fe*, and *Fe-Pb*, according to (7) for 0.662 MeV and 1.25 MeV. The calculated and measured values are shown in Table IV. No significant effect for changing the order of the material in the shield is observed with the exception of the case for *Fe-Pb* and *Pb-Fe* shields where the % error increases to about 8 % at 0.662 MeV and 12 % at 1.25 MeV. The experimental measurements are in a good agreement with calculated values.

TABLE IV
CALCULATED AND EXPERIMENTAL BUILD-UP FACTOR

		0.662 MeV			1.25 MeV		
Shield	Thickness (cm)	Exp	Calculated	% error	Exp	Calculated	% error
Al – Pb	2 – 2	1.465	1.508	2.8	1.734	1.665	4.1
Pb – Al	2 – 2	1.408		6.6	1.678		0.7
Fe – Al	2 – 2	1.489	1.553	4.1	1.387	1.391	0.2
Al – Fe	2 – 2	1.557		0.2	1.455		4.2
Pb – Fe	2 – 2	2.081	2.013	3.3	2.037	2.004	1.6
Fe – Pb	2 – 2	1.847		8.0	1.76		12.1

V. CONCLUSION

It was shown that (7) is in a good agreement with the experimental results for both radiation qualities investigated in this research. It indicates that the effective attenuation coefficient for multi-layer shield is the sum of the fractional thickness multiplied by the attenuation coefficient of the materials composing the shield. No significant effect for changing the order of the materials of the shield on the measured effective attenuation coefficient is recorded.

It was also shown that (8) is in a good agreement with the experimental results for the radiation qualities investigated. It indicates that the effective build-up factor is the product of the build-up factor of the materials consist the shield. No significant effect for changing the order of the material of the shield on the measured build-up factor is observed. A strange dependency of the linear attenuation coefficient on the atomic number and photon energy is observed. It was observed that the attenuation coefficient for single elements increases with decreasing atomic number at low energy and increasing with increasing atomic number at high energy.

This paper concludes that (7) and (8) are simple, having a good accuracy and can be used to design a multi-layer shield of similar geometry used in this research.

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Mechanical Properties of Welded Deformed Reinforcing Steel Bars

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***Abstract*— Reinforcement strength, ductility and bendability properties are important components in design of reinforced concrete members, as the strength of any member comes mainly from reinforcement. Strain compatibility and plastic behaviors are mainly depending on reinforcement ductility. In construction practice, often welding of the bars is required. Welding of reinforcement is an instant solution in many cases, whereas welding is not a routine connection process. Welding will cause deficiencies in reinforcement bars, metallurgical changes and re-crystallization of microstructure of particles. Weld metal toughness is extremely sensitive to the welding heat input that decreases both of its strength and ductility. For determining the effects of welding in reinforcement properties, 48 specimens were tested with 5 different bar diameters, divided into six groups. Investigated parameters were: properties of un-welded bars; strength, ductility and density of weld metal; strength and ductility reduction due to heat input for bundled bars and transverse bars; welding effect on bars' bending properties; behavior of different joint types; properties of three weld groove shapes also the locations and types of failures sections. Results show that, strength and elongation of the welded bars decreased by (10-40%) and (30-60%) respectively. Cold bending of welded bars and groove welds shall be prevented.**

***Index Terms*— Deformed bar, heat input, strength and ductility reduction, welding, weld groove.**

I. Introduction

In the second half of the nineteenth century, the possibility of using reinforcement bars to reinforced concrete was found (Nilson, H., Darwin, D. and Dolan, W., 2004). From that time to now, thousands of studies have been performed on the reinforcement bars for determining the best performance of reinforcement in the concrete. In many cases of concrete building construction, it is required to weld concrete reinforcement for several reasons, as for anchors, dowels or lap splices. Welding also be may require in composite structural steel and reinforced concrete structures and during alterations in reinforced concrete or repairs in building. In all cases considerations such as stress level in the bars, consequences of failure and heat damage to existing concrete due to welding operations needs precautions and special restrictions must be placed both on the type of steel used and the welding procedures (Omer, et al., 1999; Marten, 2004; Franchi and Crespi, 2007; ACI 318, 2011).

For structural steel construction purposes welding is a very effective means to connect two or more pieces of materials together (Wai, and Eric, 2005; AWS A3.0M, 2010). Whereas, welding of reinforcing bars result in metallurgical changes that reduce yield and ultimate strength, ductility, toughness and bendability (Serna, et al., 2002; Hakansson, 2002; Nikolaou and Papadimitriou, 2004; CRSI, 2004; Nurnberger, 2005). During welding process, there is an interference of many factors that are all combined in the same time, factors and actions mainly effect welding may be mechanical, geometrical and chemical properties of reinforcement bars and welding electrodes, thermochemical and electrochemical actions, thermal stresses and welding fusion pressure and heat. Considering all of the mentioned actions means, there is still unknown reaction of the welded bars during and after welding has been finished; the unknowns shall be found by experimental evidence and research (Kim, et al., 1987; Alk, Savvopoulos. and Dimitrov, 2001; Franchi and Crespi, 2007).

II. Scope of the Work

Welding of deformed reinforced bars ASTM A615-09b (2009) tested according to ASTM A370-10 (2010) having diameters 8-25mm subjected to tensile stress. Clean bars, non-corroded nor coated, plain bars were excluded. Welding procedure and welding electrodes must be according to AWS A5.1M (2012). Welding thickness is the filled space between the ribs of the two bundled or lapped bars and both faces. Length and width of welding varies according to the bar diameter and the case studied.

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III. RESEARCH SIGNIFICANCE

In concrete building construction, sometimes it is required to weld concrete reinforcement for several reasons, like: headed anchors or dowels in footing, lap splices in slabs, beams, columns or staircases, also may be in composite structural steel-reinforced concrete structures. In residential houses projects, the engineers permit to weld metal doors or windows to the main beam or column reinforcement. It is common to weld reinforcement ties, stirrups and splices in seismic resistance buildings for post ultimate behaviors (Omer, et al., 1999; ACI 318, 2011). As welding of reinforcement is used in construction, therefore it is of great interest for designers and site engineers to have comprehensive idea, that how the welding will affect the mechanical properties of the welded bars interim of weldability, bendability, toughness and ductility (Omer, et al., 1999; Achillopoulou, Pardalakis and Karabinis, 2013).

IV. PROBLEM STATEMENT

In many cases, it is necessary to weld to existing reinforcing bars in a structure. It should be determined if precautions are in order, based on considerations such as stress level in the bars, consequences of failure, and heat damage to existing concrete due to welding operations (ACI 318, 2011). Welding of bars should be performed in accordance with AWS D1.4 (2011), whereas welding of wire or welded wire reinforcement to reinforcing bars or structural steel elements is not covered by AWS D1.4 (2011). If such welding are required on a project, the requirements or performance criteria for this welding should specified, the potential loss of yield strength and ductility achieved when reinforcement is heated by welding (Omer, et al., 1999; Popovic, et al., 2010; ACI 318, 2011). These potential concerns are not an issue for machine and resistance welding as used in the manufacture of welded plain and deformed wire reinforcement covered by ASTM A1064M-10 (2010).

V. WELDING DEFORMED REINFORCING BARS IN ACI 318 CODE (2011)

For understanding the code special considerations regarded to welding, the code provisions for welded and un-welded deformed reinforcement shall be compared. For this purpose the following cases can be discussed:

ACI 318-11 12.7 & 12.2

development length of welded bars is development length of un-welded bars times welding factor *(ψ_w)*, see (1), the factor is always (1.0), except when across bar exist in development length and this bar is at least 50mm away from critical section.

$$\psi_w = \left(\frac{f_y - 240}{f_y} \geq \frac{5d_b}{s}\right) \leq 1.0 \tag{1}$$

ψ_w: factor used to modify development length for welded deformed wire reinforcement in tension, f_y (MPa): yield strength of the welded bar. d_b (mm):nominal diameter of bar and, s (mm): is the spacing between the bars to be developed.

ACI 318-11 12.18 & 12.15

Lap splice required same length for welded and un-welded when provided reinforcement is less than double of that required by analysis (class B), for provided area more than double of required by analysis (class A), welded splices require 30% more length, bars of diameters larger than 16mm shall be increased by 50% (12.19). The overlap measured between outermost cross wires of each reinforcement sheet shall be not less than 50 mm (12.18.1). The total tensile force that can be developed at each section must be at least twice that required by analysis, and at least 140 MPa times the total area of reinforcement provided (12.15.5.3).

ACI 318-11 12.17

For column splices, butt welding can be applied but when stress level in the bars is ($\leq 0.5f_y$) for class A and B depending on area, whereas stress level is ($> 0.5f_y$) shall be class B, which is increased in splice length by 30%.

From the above comparisons, the following principles can be drawn, to prevent bond failure between weld metal and reinforcing bar;

1) Shorter development length or splice required, means stronger bond provided.
2) Smaller f_y leads to smaller ψ_w then shorter bond length required, means stronger bond exist, i.e. smaller fy leads to stronger bond in welded bars, for constant other parameters.
3) Smaller bar diameters, smaller ψ_w, shorter bond length required, stronger bond exist.
4) Cross bars can carry a stress component in tensioned bars, so the bond length can be reduced, whereas for the same length, the bond for welded bars with cross bars is stronger.
5) Cross bars less than 50 mm away from critical section are not effective and their mechanical properties also will be disturbed, due to the welding heat input.
6) When stress levels are low ($0.5f_y$) in the bar, butt welding which is relatively weak welding type for reinforcing bars is permitted, means technical welding always over that stress level i.e. $0.5f_y$ is 275MPa, 260MPa and 210MPa for G550, G520 and G420 respectively.
7) Minimum length of welding stated in ACI 318 (2011) is 50mm. Developed welded section shall transfer at least double required by analysis or 140MPa, i.e. minimum possible welded strength is 140MPa.

VI. EXPERIMENTAL INVESTIGATION

Experimental program illustrate the materials used, testing machines and the parameters investigated in the present research.

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A. Materials

Commonly used materials in construction projects were used for the data to be really reflecting the true practical case.

Welding Electrodes

Welding electrodes were manufactured by Golden Bridge welding materials group, Tianjin Yanqiao welding materials co. ltd, of type J38.12, with Ø3.2mm and 350mm length, conformed to GB/T 5117-2012, GB E4313 and AWS A5.1 E6013 as well as ISO 9001. The properties of the electrodes are shown in Table I.

TABLE I
PROPERTIES OF THE WELDING ELECTRODES E6013 AND AWS A5.1M (2012) SPECIFICATIONS

Chemical composition of deposition metal (%)					
Element (%)	C	Mn	Si	S	P
Manufacturer test	≤ 0.12	0.30-0.60	≤ 0.35	≤ 0.035	≤ 0.040
Specification	≤ 0.20	≤ 1.20	≤ 1.00	-	-
Mechanical Properties of Deposition Metal					
Parameter	Fy (MPa)	Fu (MPa)	Elongation (%)	Impact value, KV_2 (J) (0°)	
Manufacturer test	340	460-540	18-26	50-75	
Specification	≥ 330	≥ 430	≥ 17	≥ 47	

Reinforcement Bars

Deformed concrete reinforcing bars were used and tested according to ASTM A370-10 (2010). The measured parameters and the tested properties of the bars compared to ASTM A615-09b (2009) were shown in Table II and Table III, respectively.

B. Machines and Tools

Tensile Testing machine

Material Testing Equipment – Yuksel Kaya Makina, 600 kN capacity and 0.1 kN resolution.

Bending test machine

Universal Testing Machine – Controls, test range Ø6 to Ø32mm.

Welding Machine

AC Arc Welder- BX1-1000, 3-Phase model, dual mode voltage 220V and 380V, Current 180-1000 A.

Weighing Balance

CWT22 Dikomsan; 30kg capacity and 0.1g resolution.

Vernier Caliper

Mechanical Vernier; 200 mm capacity and 0.02 mm resolution.

C. Investigated Parameters

Mechanical tests were performed according to ASTM 370-10 (2010) and welding procedure was according to AWS D1.4 (2011) for all the bars welded, the welding consist of single pass and double welded faces (Hakansson, K., 2002), with filling the space between ribs, and one bar diameter left un-welded for both welded ends.

Group-1: Normal tests (15 specimens)

For determining the normal reinforcement mechanical bar properties, yield strength, ultimate strength, elongation and bending. Also the nominal parameters were measured, like: diameter, area, perimeter, mass, deformation and rib dimensions. Bar diameters were 8, 10, 12, 16 and 25mm, three specimens for each of the bar diameters were averaged.

Group-2: Welding strength (9 specimens)

Three specimens for each of the bar diameters: 8, 12 and 25 mm were used for finding the welding strength. For this purpose 10 mm length between two straight end bars was filled with melted pure weld, having the same bar cross sectional area. Since the welding has not a homogeneous matrix of particles, and it may be changed by specimen size effect, three specimens were averaged for each diameter.

Group-3: Strength and ductility reduction (9 specimens)

For investigating the effects of welding inputted heat, two bars in each of 10, 12 and 16 mm diameters were welded together for double face full length (500 mm) except a gap of 20, 100 and 200 mm was remained un-welded in the center of the bar. The group must determine the results of failure location and its distance away from welding edge, reduction in yield and ultimate strengths and as well as elongations.

Group-4: Transverse bars (3 specimens)

To study the effects of transverse reinforcement bars (like BRC mesh), three 16mm bars were tested having transverse 16mm cross bars with 150mm length. For first specimen one bar was welded in the center of tension, second specimen have two bars 50 mm away from the center and the third specimen has three welded bars, one in the center and another's are 100mm away from the center (ASTM A184M, 2005). All bars were welded in the four contact points (i.e. right, left, top and bottom).

Group-5: Bend test (9 specimens)

For understanding the effects of the welding on the properties of reinforcement bars subjected to bending test, three bars with 8, 12 and 25mm diameters and 700mm length, were tested by three ways, normal, lap welded and link welded. Welding length in the both cases was 100mm.

Group-6: weld groove shape (3 specimens)

For investigating the best end cut shape before welding, 16mm bars were tested for three section cuts, namely straight ends, square (‖) shape, bevel (I/) shape and (V) shape. Inclined surfaces were 45° from vertical edge and the welding lengths were 32mm (Omer et al., 1999; Wai, C. and Eric, M., 2005).

VII. Welding and Weldability

The welds made by the welding machines are electric resistance welds. This type of weld results from a fusion process that uses a combination of pressure and heat generated by electric impulses. In other words, the intersections of the steel bars and the welding electrodes are fused together. No foreign matter is introduced in the welding process (Omer, et al., 1999; CRSI, 2004).

Welding electrodes are classified to several hundred types (AWS A5.1, 2012); each kind has been specified for strength/welding position/coating material. In this work and similar studies (Nikolaou and Papadimitriou, 2004), electrodes of E6013 type were used which means: E indicates that this is an electrode. 60 indicate how strong this electrode is when welded, measured in (ksi). 1 Indicates in what welding positions it can be used (flat, horizontal, vertical, overhead). 3 Indicates the coating, penetration, and current type used.

E6013 coating is rutile potassium, with light penetration, current type: AC/DC (Weld-D-Arc, 2013). All position welding titanium low hydrogen type electrodes with ferrous powder in the coating. It has high welding efficiency, smooth appearance, stable arc and negligible spatter loss (Lincoln E., 2014).

In general, the strength of the electrode used should equal or exceed the strength of the steel being welded (AWS D1.4M, 2011). Finished welds should be inspected to ensure their quality. Inspection should be performed by qualified welding inspectors. A number of inspection methods are available for weld inspections, including visual inspection, the use of liquid penetrants, magnetic particles, ultrasonic equipment, and radiographic methods (Omer, et al., 1999; Wai and Eric, 2005; AWS A3.0M, 2010).

The used welding type was SMAW (Shielded Metal Arc Welding). SMAW is an arc welding process with an arc between a covered electrode and the weld pool (Nurnberger, 2005; AWS A5.1M, 2012; James, 2013). The process is used with shielding from the decomposition of the electrode covering, without the application of pressure, and with filler metal from the electrode (Bohler, 2005). SMAW is often used for bar-bar welding (Nikolaou and Papadimitriou, 2004) and it is filler material could be E6013 (AWS A5.1M, 2012). The minimum allowed preheat and interpass temperature is 27°C, whereas, best performance for preheat temperature is 150°C for Ø19mm and smaller, and 260°C for Ø22mm and larger (AWS D1.4M, 2011). Welding shall not allow below 4°C. In cold weathers preheating to reach to at least 27°C shall be applied. Cool down rate shall not exceed 55°C/hour (AWS A3.0, 2010; Lincoln E., 2014). Increasing in welding speed decreases the welding heat input and chance of formation of defects in weld metal. Whereas, decreasing the welding speed increases the hardness and yield strength of the base metal (Bahman and Alialhosseini, 2010); therefore, the travel speed of 15-45 cm/min is recommended (AWS A3.0, 2010; Lincoln, 2014).

As the technical welding is a sensitive process, the welder shall have an experience of the welding parameters like polarity, porosity, penetration, surface condition, welding sequence (Omer et al., 1999) and the factors that effect of producing best aspect and performance welding; in present study the welder has an experience of 31 years of welding. Performance of the welding is directly related to the amount of heat input during welding process, energy input depend on the factors shown in Eq.2 (GLA, 2000; Marten L., 2004; Popovic et al., 2010). Low heat input produce a porous weld and weak bonding, whereas overheating effect reversely on the strength and ductility of the welded bars, optimum E value is 0.7 kJ/mm (Omer, 1999; Popovic, et al., 2010).

$$E=0.06(U\times I\times T)/Lw \tag{2}$$

E: Energy (heat) inputted (kJ/mm), U: welding voltage (Volts), I: welding current (AMP), T: welding time (min), Lw: weld length (mm).

Thermochemical and electrochemical composition changes are greater at a low than at a high welding speed. Electrochemical reactions are enhanced by higher, total current flow per unit volume of weld metal. Thermochemical reactions at a low welding speed are enhanced by higher temperatures and longer reaction time before solidification (Kim et al., 1987; Bohler W. 2005).

When welding of reinforcing bars is required, the weldability of the steel and compatible welding procedures needs to be considered. The provisions in AWS D1.4 welding code cover aspects of welding reinforcing bars, including criteria to qualify welding procedures (ACI 318, 2011). For steel bars, the carbon equivalent shall be calculated in Eq.3, using the chemical composition shown in the mill test report (Omer, et al., 1999; AWS D1.4M, 2011; EN 1011-1/A1, 2010).

$$CE = \%(C) + \%(Mn/6) \tag{3}$$

CE: Carbon Equivalent (%), C: carbon content (%), Mn: Manganese (%).

For the used electrodes in this study CE range is 0.17-0.22. If CE is less than 0.53, the reinforcement is intrinsically weldable, if larger, then the hard and brittle microstructural constituents may be formed, these constituents may be detrimental for good behavior of steel to dynamic loading (Nikolaou and Papadimitriou, 2004; Elijah, 2010). Weldability is improved by decreasing the carbon content, increasing the nickel content and by stabilization (Nurnberger, 2005; Popovic, et al., 2010).

VIII. Test Results

The results for groups of reinforcement bars numbered 1, 2, 3, 4, 5 and 6 are shown in Tables II & III, IV, V&VI, VII, VII and IX, respectively.

TABLE II
TEST RESULTS OF G1: MEASURED PARAMETERS VS. ASTM A615-09B LIMITATIONS

Bar des. No.	nominal dimensions*								deformation requirements (mm)					
	nominal mass (kg/m)		diameter (mm)		cross sectional area (mm^2)		perimeter (mm)		maximum average spacing		minimum average height		maximum gap**	
	test	spec.	test	spec.	test	spec.	test	spec.	test	spec.	test	spec.	test	spec.
8	0.399	0.394	8.0	8.0	50.8	50	25.3	25.1	4.60	5.6	0.69	0.32	1.20	3.1
10	0.595	0.560	9.8	9.5	75.8	71	30.9	29.9	6.32	6.7	0.50	0.38	1.46	3.6
12	0.850	0.844	11.7	12.0	108.3	113	36.9	37.7	7.66	8.4	0.69	0.48	1.60	4.6
16	1.573	1.552	16.1	15.9	203.6	199	50.6	49.9	9.66	11.1	0.94	0.71	2.50	6.1
25	3.963	3.973	25.4	25.4	504.8	510	79.6	79.8	15.64	17.8	1.37	1.27	3.24	9.7

* The nominal dimensions of a deformed bar are equivalent to those of a plain round bar having the same mass per meter as the deformed bar.
** Chord of 12.5 % of nominal perimeter.

TABLE III
TEST RESULTS OF G1: TESTED PARAMETERS VS. ASTM A615-09B SPECIFICATION

Bar designation No.	Yield strength (MPa)		Tensile strength (MPa)		Elongation (%)		Bending (inner roller diameter, bending angle)	Sample Grade
	test	spec.	test	spec.	test	spec.		
8	675.4	550	782.8	725	11.7	7	Pass: Ø32,180°	G550
10	689.8	550	820.3	725	10.9	7	-	G550
12	617.6	550	742.2	725	17.2	7	Pass: Ø44, 180°	G550
16	447.5	420	654.0	620	17.7	9	-	G420
25	552.7	420	667.1	620	17.6	8	Pass: Ø128, 180°	G420

TABLE IV
TEST RESULTS OF G2, WELD METAL MECHANICAL PROPERTIES

Bar des. No.	Diameter (mm)	Nominal weld area (mm^2)	Mass of weld per 10mm (g)	Weld density (kg/m3)		Yield strength (MPa)		Guaranteed yield strength & Bar stress level	Ultimate Strength MPa		Combined Elongation (%)	
8	8.07	51.12	4.03	7883		409.5			539.5		2.6	
8	8.03	50.62	3.97	7843	7863	527.9	475.4	409.5 (0.61fy bar)	576.3	558.3	1.9	2.2
8	8.06	51.00	4.01	7863		488.7			559.2		2.1	
12	11.76	108.56	8.56	7885		392.1			563.3		3.1	
12	11.72	107.83	8.42	7809	7850	411.7	415.4	392.1 (0.63fy bar)	428.5	503.4	2.5	2.8
12	11.74	108.19	8.50	7857		442.5			518.3		2.7	
25	25.30	502.47	39.27	7815		356.3			395.1		4.9	
25	25.30	502.47	39.23	7807	7824	315.8	317.5	280.3 (0.51fy bar)	446.2	432.9	5.6	5.4
25	25.36	504.86	39.63	7850		280.3			457.3		5.6	

TABLE V
TEST RESULTS OF G3, STRENGTH REDUCTION

Bar des. No.	Un-welded center gap (mm)	Yield Load					Ultimate Load				
		un-welded (kN)	double bar welded (kN)	welding resisted load* (kN)	single bar resisted load (kN)	reduced strength (%)	un-welded (kN)	double bar welded (kN)	welding resisted load* (kN)	single bar resisted load (kN)	reduced strength (%)
10	20	52.3	73.1	12.6	30.3	42.1	62.2	100.1	17.2	41.5	33.3
10	100	52.3	79.3	13.6	32.9	37.1	62.2	105.9	18.2	43.9	29.4
10	200	52.3	91.2	15.7	37.8	27.7	62.2	115.0	19.8	47.6	23.5
12	20	66.9	109.5	16.3	46.6	30.3	80.4	138.8	20.7	59.1	26.5
12	100	66.9	112.2	16.7	47.8	28.6	80.4	140.9	21.0	60.0	25.4
12	200	66.9	119.1	17.7	50.7	24.2	80.4	148.4	22.1	63.2	21.4
16	20	91.1	174.8	19.8	77.5	14.9	131.1	249.0	28.1	110.5	15.7
16	100	91.1	175.9	19.9	78.0	14.4	131.1	253.8	28.7	112.6	14.1
16	200	91.1	177.6	20.1	78.8	13.5	131.1	260.8	29.5	115.7	11.7

* Calculated from the true applied stress, which is uniformly distributed over the bars and the welded area.

TABLE VI
TEST RESULTS OF G3, DUCTILITY REDUCTION AND FAILURE DATA

variables		Elongation					welded strength		Grade	
Bar des. No.	un-welded center gap (mm)	un-welded (%)	welded vs. specification (%)	reduction (%)	welded length in half of tension range (mm)	failure location from weld edge (mm)	Yield strength (MPa)	Ultimate strength (MPa)	normal	welded*
10	20	10.9	04.2 < 11	61.5	90	50	399.6	547.3	550	Fail
10	100	10.9	05.0 < 11	54.1	50	51	433.9	579.0	550	Fail
10	200	10.9	06.1 < 11	44.0	00	45	498.5	627.8	550	Fail
12	20	17.2	06.7 < 12	61.0	90	48	430.2	545.6	550	Fail
12	100	17.2	08.2 < 12	52.3	50	45	441.3	553.9	550	Fail
12	200	17.2	10.3 < 12	40.1	00	48	468.0	583.4	550	Fail
16	20	17.7	07.1 < 12	59.9	90	40	380.7	542.8	420	Fail
16	100	17.7	09.7 < 12	45.2	50	42	383.1	553.2	420	Fail
16	200	17.7	12.2 > 12	31.1	00	52	387.1	568.4	420	G280

* Most welded bars failed because of the reduced elongations were not conformed to the specification limit.

TABLE VII
TEST RESULTS OF G4, TRANSVERSE REINFORCEMENT

Bar des. No.	No. of cross bars	Yield Strength (MPa)				Ultimate Strength (MPa)				Elongation (%)			
		uw	w	w/uw	r (%)	uw	w	w/uw	r (%)	uw	w	w/uw	r (%)
16	1	447.5	446.5	1.00	0.2	654.0	657.8	1.01	- 0.6	17.7	10.2	0.58	42.4
16	2	447.5	442.6	0.99	1.1	654.0	648.3	0.99	0.9	17.7	10.1	0.57	42.9
16	3	447.5	445.5	1.00	0.5	654.0	651.8	1.00	0.3	17.7	10.3	0.58	41.8

uw: un-welded, w: welded, r: reduction. The (-) sign means that the value has been increased. The transverse bars were spaced 100 mm c/c.

TABLE VIII
TEST RESULTS OF G5, REINFORCEMENT BENDING

Bar des. No.	Test variable	Sample Grade	Inner roller diameter	Hook angle	Result	Failure mode
8	Normal	G550	Ø32 mm	180°	Pass	Perfect bend, No cracks
8	Lap connected	G550	Ø32 mm	180°	Pass	Perfect bend, No cracks
8	Link connected	G550	Ø32 mm	180°	Fail	Bar rupture, weld failure
12	Normal	G550	Ø44 mm	180°	Pass	Perfect bend, No cracks
12	Lap connected	G550	Ø44 mm	180°	Pass	Perfect bend, No cracks
12	Link connected	G550	Ø44 mm	180°	Fail	Bar rupture, weld failure
25	Normal	G420	Ø128 mm	180°	Pass	Perfect bend, No cracks
25	Lap connected	G420	Ø128 mm	180°	Fail	Bar deeply cracked
25	Link connected	G420	Ø128 mm	180°	Fail	Welding bond failure

TABLE IX
TEST RESULTS OF G6, WELD GROOVE SHAPE

Bar des. No.	Weld length mm	Groove shape	un-welded			welded			welded/un-welded			Reduction (%)		
			Yield (MPa)	Ultimate (MPa)	Elongation (%)	Yield (MPa)	Ultimate (MPa)	Elongation (%)	Yield	Ultimate	Elongation	Yield	Ultimate	Elongation
16	32	Square	447.5	654.0	17.7	251.1	317.8	1.6	0.56	0.49	0.09	43.9	51.4	91.0
16	32	Bevel	447.5	654.0	17.7	332.1	388.3	3.5	0.74	0.59	0.20	25.8	40.6	80.2
16	32	Vee	447.5	654.0	17.7	391.9	479.0	5.1	0.88	0.73	0.29	12.4	26.8	71.2

IX. ANALYSIS OF THE TEST RESULTS

Group-1: Normal Tests

In normal test results each data point is the average of three test specimens. All tested parameters are conformed to specifications, except in case of 12 and 25mm bars, the nominal area are less by 5mm^2. Bar deformations can have an important role in welded bars, because height of deformation and ribs will increase the total contact area for bar and welding metal bond strength, whereas during tensile test, such heights will produce points of stress concentration. Therefore the maximum spacing of deformations restricted by specification, as by increasing such points the tensile stress will better distribute over the bar length.

Group-2: Weld metal mechanical properties

In ASD (allowable stress design), the strength of welds is expressed in terms of allowable stress. In LRFD (load and

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resistance factor design), the design strength of welds is taken as the smaller of the design strength of the base material (expressed as a function of the yield stress of the material) and the design strength of the weld electrode (expressed as a function of the strength of the electrode EXX). These allowable stresses and design strengths are summarized in Table X (AISC-LRFD, 2005; Wai and Eric, 2005). During design using ASD, the computed stress in the weld shall not exceed its allowable value. During design using LRFD, the design strength of welds should exceed the required strength obtained by dividing the load to be transmitted by the effective area of the welds (Omer et al., 1999; Franchi, A. and Crespi, P., 2007).

In Table X, the guaranteed allowable stresses from test results are so close to the allowable stresses for smaller bars with a little deviation for Ø25mm, which refers to the non-homogeneous matrix of weld metal particles and for size effects. ACI 318 (2011, pp. 47 & 219) stated that deformed wire larger than Ø16mm is treated as plain wire because tests show that Ø20mm wire will achieve only approximately 60 percent of the bond strength in tension.

TABLE X
ALLOWABLE TENSILE STRESS FOR THE WELDED BARS

Design method	Allowable tensile stress	Ø8 mm	Ø12 mm	Ø25 mm
ASD	0.6fyb	405.2	370.6	331.6
	0.5fub	391.4	371.1	333.6
LRFD	0.9fyb	607.9	555.8	497.4
	0.9fyw	427.9	373.9	285.8
Allowable stress on the welded bars		391.4=0.58fyb	370.6=0.60fyb	285.8=0.52fyb
Guaranteed allowable stress from test results		409.5=0.61fyb	392.1=0.63fyb	280.3=0.51fyb

fyb: bar yield strength, fyw: weld metal yield strength, fub: bar ultimate strength.

The strength of the weld metal varies inversely with cross-sectional area (Shultz and Jackson, 1973), as shown in Fig. 1–a and Fig. 1-b, especially for the yield strength which decrease in a steeper slope. The case is referring to have more weak points in a larger sample. Reducing strength for constant density material means, the material is going to be more ductile, with increased elongation (Fig.1-c). Density of the weld metal is near to 7850 kg/m^3 of reinforcement bars (Fig. 1-d), also for the strength, whereas ductility is much smaller. This smaller original ductility with the heat input effects, will produce a brittle welded reinforcement bars in the welding points (Omer, et al., 1999; Popovic, et al., 2010).

Group-3: Strength and ductility reduction

Theoretically, the strength results for this group reinforcement bars must at least as strong as double of the normal un-welded single bars, if the resistance provided by the additional area of weld is ignored, but it is clear in Table V and Table VI that the strength is decreased. Actually the reduction is caused by the heat input during welding (CRSI, 2004; Wai, and Eric, 2005; AWS A3.0M, 2010; Popovic, et al., 2010), high heat input result in low strength, low hardness and low toughness, whereas low heat input (≤ 60°C) will give risk of hydrogen cracking in the weld (Scott, 1999; Hakansson, 2002).

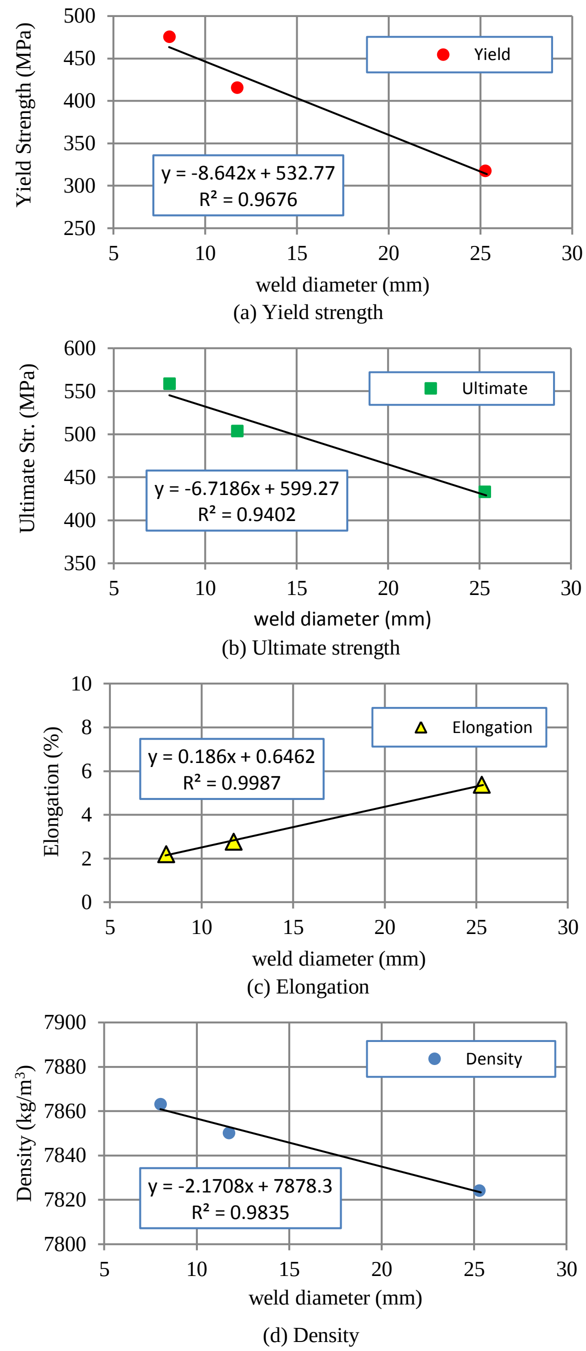

Fig. 1. Results of G2: weld material properties vs. weld diameter

In Fig. 2 the reduction in the yield and ultimate strength is mostly depend on the bar diameter and the welded length. When the bar diameter is less the effects of the welding heat is appeared more which leads to more strength reduction (Popovic, et al. 2010; Achillopoulou, Pardalakis and

Karabinis, 2013). When the welding length is increased there is more heating effects and the strength reduction is more. The reduction ratio in the yield strength is always more than that in the ultimate strength. Research stated 30% reduction in yield and 10% reduction in ultimate strength shall be expected (Scott, 1999).

In Fig. 2-c the reduction in the elongation is so large 31-62% (Nikolaou and Papadimitriou, 2004) stated as 50%), in which the remained post weld elongation is no more conformed to the specification limits as shown in Table VI. Reduction in elongation leads to decrease the failure time from yield point until the ultimate strength and then failure, so the plastic range safety is decreased and sudden failures should be expected.

The mentioned welding heat effects will gradually reduce when the bar diameters are of larger sizes, when the bar diameter is larger the generated welding weakening heat can't penetrate to the core of the bar like the smaller bars. This fact can be seen in the failure section as in the smaller bars (like 10 mm) the boundary between the bars' surface and the welding can't be separated, whereas in the larger bars (like 16 mm) the separation line can be seen easily, in more simple words, the welding heat input caused re-crystallization of the particles for smaller bar diameters (Omer, et al., 1999; Popovic, et al., 2010).

Group-4: Transverse bars

Welding of crossing reinforcing bars can lead to local embrittlement of the steel (ACI 318, 2011; AWS D1.4M, 2011) and during tension test the bar will rupture in the point directly to the edge of welding. The inputted heat of welding is the cause for this local weakening (Hakansson, 2002; CRSI, 2004; Nurnberger, 2005). For the same reason ACI 318 (2011, pp. 219) had not permitted reduction in welded development length and welded splice, when a cross bar exist less than 50mm from critical section. This case is different from cold welding for deformed welded wire meshes or mats manufactured in mill that has not considerable changes in properties caused by welding (ASTM A184M, 2005; ACI 318, 2011).

The term "tack welding" has become firmly established and embedded in building codes and in design and construction specifications to describe the connection of crossing bars by small arc welds (CRSI, 2004). Tack welding can seriously weaken a bar at the point welded by creating a metallurgical notch effect. This operation can be performed safely only when the material welded and welding operations are under continuous competent control, as in the manufacture of welded wire reinforcement (Omer, et al., 1999; Serna, et al., 2002; Nikolaou and Papadimitriou, 2004; ACI 318, 2011). During preparation of test samples in this group, the welding was well controlled considering (continuous competent control); therefore the test results shown in Table VII and Fig. 3 are of negligible reduction in yield and ultimate strengths. The reduction in ductility was around 40% of original elongation, but the retained elongation (10%) is still conformed to specification requirements (9% min.).

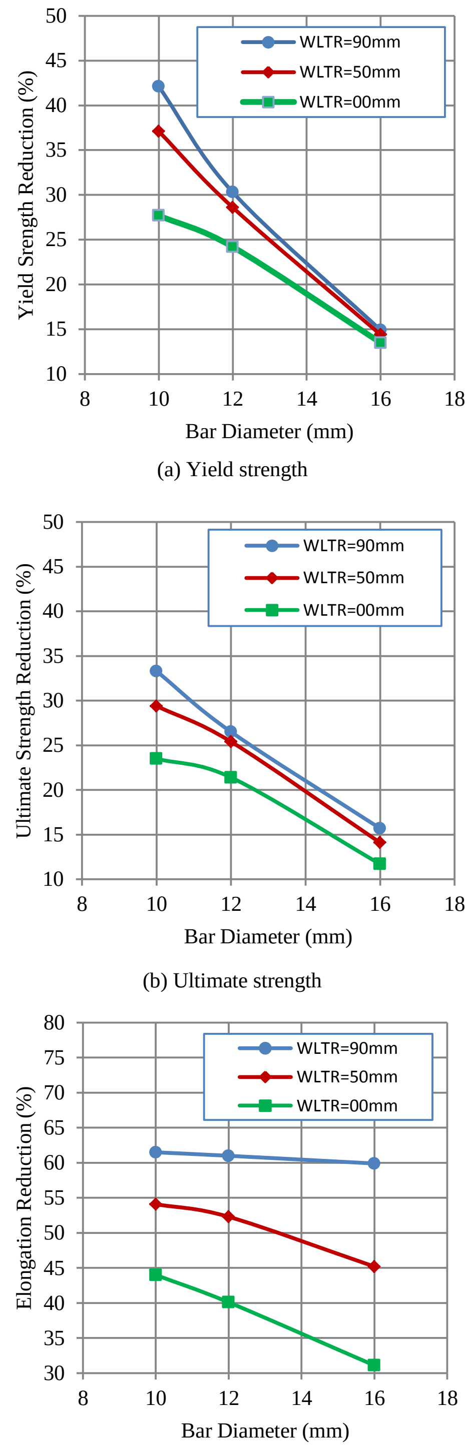

Fig. 2. Results G3: reduction s vs. different bar diameters for different WLTR (weld length in tension range, between grips).

The test simulation is different from reaction of transverse bars during loading in a real structure, because there is already stresses in the cross bars and it is required complex procedure to consider three dimensional stress analyses. But the purpose of the investigation is determining pure effects of the welding due to the tack welds and to avoid interference of stresses in the cross bars. In the other side tests demonstrate that cross

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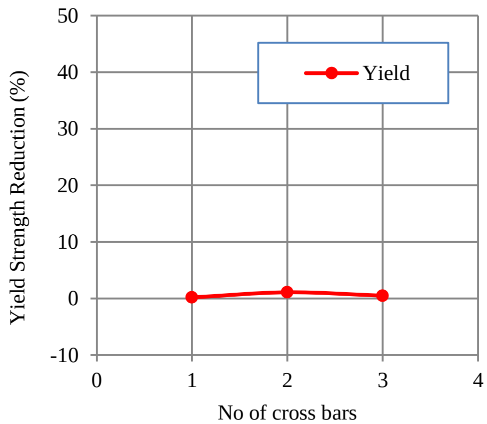
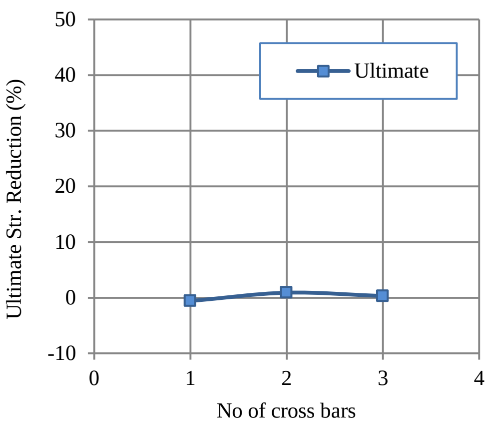
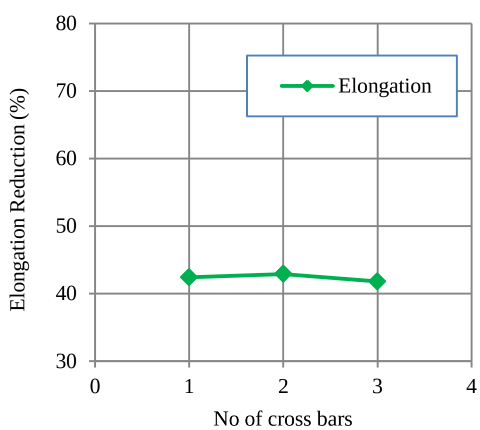
reinforcement rarely yields during a bond failure (ACI 318, 2011, pp.211).



(a) Yield strength



(b) Ultimate strength



(c) Elongation

Fig. 3. Results of Group 4: No of cross bars vs. reduced parameters

Group-5: Bending of reinforcement

The results of this group are shown in Table VIII, normal bars were passed perfectly from the test without local angles and visible surface cracks; whereas the lapped welded bars can't resist relatively large bending load in case of 25mm diameter bars, the case was different for small diameters (like 8 and 12mm) as they were passed from the test. In case of linked welded bars all the bars were failed to bend, because of the un-connected main bars together, so the critical point was at the center of the bar, therefore the high stresses leads to bond failure between weld. In fact the outer part from neutral axis of the bar was subjected to tensile stress, which is directly related to the elongation limits of the bars. Whereas the reduced elongations due to the heat of welding (shown in Table VI, VII and IX, will not permit the outer surface of the bar to extend like the un-welded bars, this will cause the rupture of the bars and welding, and then a brittle failure was happened (Serna, et al., 2002).

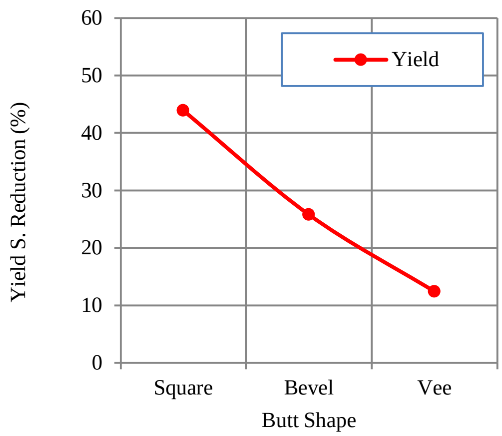
Welded wire reinforcement can be used for stirrups and ties. The wire at welded intersections does not have the same uniform ductility and bendability as in areas that were not heated. These effects of the welding temperature are usually dissipated in a distance of approximately four bar diameters (ACI 318, 2011) or the effect may extend to 100mm from the weld toe (AWS A3.0M, 2010). Tests have shown that ASTM-A615 G280 & G420 reinforcing bars can be cold bent and straightened up to 90 degrees at or near the minimum diameter. If cracking or breakage is encountered, heating to maximum temperature of 820°C may avoid this condition for the remainder of the bars (ACI 318, 2011, pp.90).

Group-6: Weld groove shape

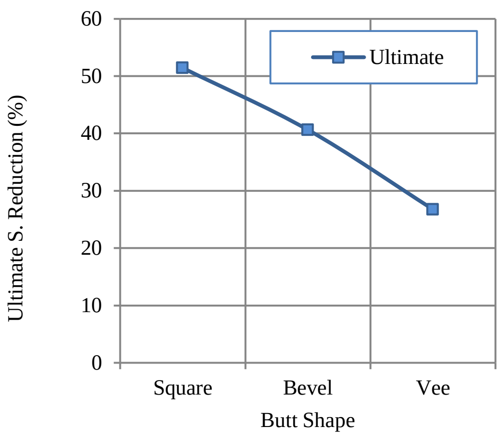
Welded connections are connections whose components are joined together primarily by welds. Welds can be classified according to: the types of welds (groove welds, fillet welds, plug welds, and slot welds), the positions of the welds (horizontal welds, vertical welds, overhead welds, and flat welds) and the types of joints (butt, lap, corner, edge, and tee) (Omer, et al., 1999; AISC, 2005; Wai, and Eric, 2005).

The test results of this group are shown in Table IX and Fig. 4, by noting the strength of the groove shapes, easily it can be concluded that the V-shaped groove will be the most strong type, and the state may be justified by the principle of: the larger contacted surface between the bar and weld metal, gives larger effective bonding area, thus stronger bond had been produced.

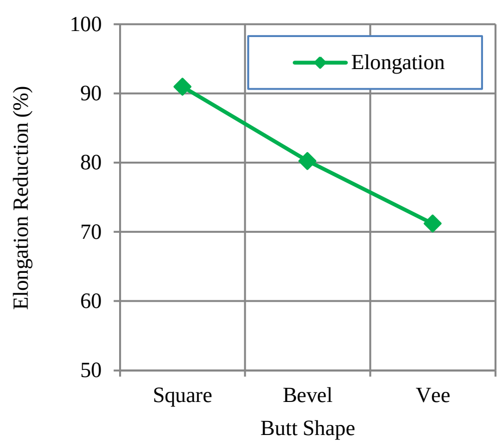
The groove welds chosen were used in welding of an informal construction projects, and their strength may be still in the range of permitted levels by AISC code (2005) for low stress level not exceeding 0.5fy especially for V-shape. Whereas these types of welding shall be completely avoided for alterations in reinforced concrete using SMAW welding, for quality works (Lincoln E., 2014), because of the brittle joints, which leads to sudden rupture of the bars or welds, may be before appearing visible cracks in concrete (Choi, et al., 2013). The reason is the reduction in elongation of the joint; other welding methods like flash butt pressure welding or robot welder showed accepted results (Hakansson, 2002; Nurnberger, 2005; Chvertko, Skachkov and Chvertko, 2011).



(a) Yield strength



(b) Ultimate strength



(c) Elongation

Fig. 4. Results of Group 6: weld groove shape (parallel to tensile force) vs. reduced parameters.

Although fillet welds are generally weaker than groove welds, they are used more often because they allow for larger tolerances during erection than groove welds. Groove welds are expensive to make and they do not provide much reliability in transmitting tensile stresses perpendicular to the faying surfaces. Furthermore, quality control of such welds is difficult because inspection of the welds is rather arduous (Omer, et al., 1999; Wai and Eric, 2005). As a result it is recommended to connect reinforcement bars using fillet weld to have horizontal or overhead welding positions with edge, lap or linked lap joints with cross-sections shaped V-flare perpendicular to tensile force (Bohler, 2005).

X. Failure Planes and Explanatory Images

Images shown in Fig. 5 can explain more aspects of welding heat input, failure sections and critical points during the tensile test and the bending tests.

XI. Conclusions

1) The strength of welding metal is directly related to the size of weld bead and thickness, increasing welding area 2 and 10 times, the yield strength will decrease 13% and 33%, respectively. Weld metal density is same as for carbon steel bars about 7850 kg/m^3.
2) The strength and elongation of the welded base metal decreased by (10-40%) and (30-60%) respectively, depending on the weld size. To avoid catastrophic failure in concrete structures, the stress level in welded bars shall not exceed 0.5f_y of the bars.
3) Technical welding of transverse bars has negligible effects in strength of the bars, whereas it should be determined that precautions regards to ductility are in order, as elongation may reduce by 40%. Therefore, reducing the heat input to the minimum allowable is preferred.
4) Cold bending of the welded bars shall be prevented especially for bar diameters of 16mm or more, or else the bar shall be heated at least to 160°C prior to bending.
5) Groove welds shall be prevented, as these types of welds will not provide the required elongation which will reduce by (70-90%), therefore groove welds will fail more likely as brittle materials than ductile steel bars.

XII. Recommendations

1) Welding may be required in many cases in reinforced concrete construction, therefore it is important for designers and site engineers to have comprehensive information about metallurgical changes of base metal caused by welding.
2) Technical welding (which is not common in Kurdistan) shall be performed by professional welder or expert welders for critical locations; under continuous competent control. It shall be inspected and tested, before casting of the surround concrete.
3) It is recommended to connect reinforcing bars using fillet weld to have flat and overhead welding positions with edge, lap or linked lap joints with cross-sections shaped V-flare perpendicular to tensile force direction.


Test bars 25/16/12/10/8mm


Heat input during welding


Bars Measuring's


Welding Electrodes E6013


Prepared Bars (all)


Fillet weld, V-flare lap joint


Failures of G2 25mm bars


Failures of G2, 8,12,25mm


Failure of a specimen in G3


Failure sections in G3


Prepared bars G4

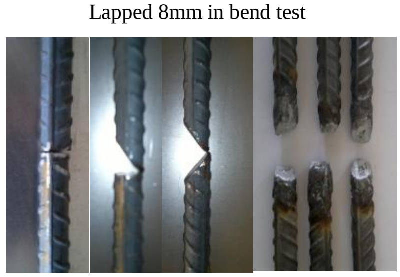

Failure planes for G4


Prepared for bending


Lapped 8mm in bend test


pass/fail specimens-bend test


Crack/bond failure in bend test


Prepared/failure bars in G6


Tensile testing machine

Fig. 5. Failure of specimens and explanatory images

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Effect of Fatty Acids on Production and Immunological Status of Vaccinated Broiler Chickens

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***Abstract*—This study was conducted on 400 one day-old male broiler chicks (Ross-308) randomly divided to 2 main groups, 1st main group (GA) feeding basal diet with medium chain fatty acid (MCFA) at rate of 0.15% and divided to four subgroups, 3 subgroups vaccinated with different routes with Newcastle Disease (ND) and non-vaccinated group. The 2nd main group (GB) feeding basal diet without MCFA and divided as the same 1st main gruop. The parameters used in this study included: body weight (BW), phagocytic index (PI), stress index (SI) and weight of spleen and bursa of Fabricious. The aim of this study to evaluate the effect of (MCFA) on these parameters. The experiment lasted for 42 days. Results indicated that additional dietary fatty acid (FA) significantly increased average body weight during the different weeks of the experiment over the basal diet group of birds. Data of PI revealed that birds fed FA supplemented diet had lower values of PI than the basal diet on 2W and the reverse was true on 4W of the experiment. The non-vaccinated birds, on the other hand, showed lowest PI values on 2W and 4W of age. As for, SI a pronounced difference was found due to the two types of diet, and the vaccination methods, as well.**

***Index Terms*—Broiler, fatty acid, newcastle disease, phagocytic index, stress index.**

I. INTRODUCTION

Newcastle disease (ND) is a highly contagious avian disease and one of the major causes of economic loss in the poultry industry (Rasolia et al., 2014). Although all Newcastle disease virus (NDV) isolates belong to a single serotype, significant genetic diversity has been described among NDV isolates (Zhang, et al., 2014). Newcastle disease (ND) remains a constant threat to poultry producers' worldwide, in spite of the availability and global employment of ND vaccinations since 1950s (Kapczynski, Afonso and Miller, 2013). The clinical signs seen in affected birds due to this disease vary widely and are dependent on factors like the virus strain, host species, age of birds, immune status, environmental stress and concurrent infection (Al-Habeeb, Mohamed and Sharawi, 2013). Various approaches have been used for identifying the specific components of the immune system involved in protection (Al-Shahery, Al-Zubeady and Al-Baroodi, 2008). Feed additives are often used to improve physical diet characteristics, feed acceptability and bird health according to (Leeson and Summers, 2008).

Currently, it has been found that natural additive such as herb and medical plants have some properties as growth enhancement to replace synthetic drugs. The antimicrobial effect of the medical plants is well documented by (Mahmmod, 2013). EOs enhance production of digestive secretions, stimulate blood circulation, exert antioxidant properties, reduce levels of pathogenic bacteria and may enhance immune status (Brenes and Roura, 2010). Using these medicinal plant oil in the diet showed significant effects on performance, carcass quality, feed conversion ratio FCR and body weight gain of treated chicks (Ashan, 2011). Many nutrients are capable of modulating the immune system as stated by (Korver, 2012).

Different types of dietary fatty acids have been shown to have variable effects on bacterial clearance and disease outcome through suppression or activation of immune responses (Harrison, Balan and Babu, 2013). By using Aromatic herbal extract, an increase broiler performance (body weight gain, feed conversion, and carcass quality), and enhanced of the immunological performance. HI titer of Newcastle disease virus was significantly higher with addition of aromabiotic, and weight of lymphoid organs (thymus, Bursa of Fabricius) were increased a combined with improvement of leukocytes (heterophil, lymphocyte and eosinophil were noticed by (Tollba, Shahbaan and Abdel-Mageed, 2012). Supplementation the feed with Aromabiotic poultry lead to better growth performances, where average

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daily gain was significantly better in the starter and grower period of broiler chicks (Isaac, et al., 2013).

II. Material and Methods

A. Experimental Birds and housing

Four hundred one day-old male broiler chicks (Ross-308) were obtained from a commercial (VANO) hatchery in Erbil city. The chicks represented a very homogenized sample in the initial where it ranged from 43-44 gm. This was achieved by weighing 400 birds of the sexed male broiler chicks individually and only those lied within aformentioned range was kept for running experiment. Thereafter the 400 chicks were divided into two groups named GA and GB, where the GA (200 birds) group of chicks reared on FA supplemented 0.15% starting, grower, and finisher pellet diet from factory (Agree land) in Erbil city, Table I. The added FA is characterized by being medium chain fatty acid (Aromabiotic) produced by Vitamix Belgium Company. The other GB (200 birds) group of chicks were reared on the same basal diet without FA added. Each of GA and GB chicks where subdivided to 4 groups, 50 birds each, and was subjected to different methods of vaccination against ND, orally, oculonasal, S/C, and control (non-vaccinated). Vaccination was applied when birds were 10 days-old. The sub groups were symbolically named G1, G2, G3 and G4 for birds of GA, according to the three vaccination methods and control, respectively. By the same talking G5, G6, G7 and G8 were referred to the birds of GB. The treatment chicks were reared in floor pen (2.5×1m) on chicken paper liter allowed the access of water and subjected to 24 hour light. The electrically heated house was furnishing the birds with a temperature schedule consist of an initial temp of 34ċ was reached on day of the experiment. Feed was given ad-libitum with feed through space held constant for all birds. Extra care was taken to secure biosecurity during the course of the experiment.

B. Body Weight

At the end of each of the last 5 experiment weeks, body weight were determent for each treatment replicate.

C. Blood Collection

Blood samples (2ml) from a wing vein of six birds of each treatment were collected at 2W and 4W of age after starting the experimental diet and vaccination program on day 10 of age. The blood samples were placed onto labeled slides and smears were fixed to determine the Stress index, from the data H/L ratio according to (Redmond et al., 2011) and the Phagocytic index according to (Park, Fikrig and Smithwick, 1968).

D. Immune Organs

Immune organs, represented by Bursa of Fabricius and Spleen were excised from 6 slaughter birds of each of the experimental treatment. Percent of the organs were determent base on live body weight of the birds according to this formula {(organ weight/body weight) × 100} at 2 and 4 weeks of age, for the purpose organ mass was normalized for body weight as somatic index (Keil, et al., 2008).

TABLE I
Composition and Chemical Analysis of the Basal Diet Feed to the Experimental Birds

No	Ingredients	Starter % (1-2wks)	Grower % (3-4wks)	Finisher % (5-6wks)
1	Corn	380	390	450
2	wheat	160	200	200
3	bran	85	80	70
4	Soybean	324	270	218
5	Oil	10	19	23
6	Lysine	1	1.5	1.5
7	Methionine	1	1.25	1.25
8	Colin	1	1	1
9	Calcium	15	14	13
10	Di-calcium hosphate	15	14	14
11	Vitamin	3	3	3
12	minerals	0.2	0.2	0.2
13	Anticoccidia	0.5	0.5	0.5
14	Enzyme	0.75	0.75	0.75
15	Antifungal	1	2	1
16	Salt	2.55	2.8	2.8
	Chemical analysis			
1	Crude protein	22.06%	20.12%	18.04%
2	Energy	2817.4	2916.45	3011.97
3	Methionine	0.45	0.45	0.42
4	Methionine and cysteine	0.74	0.72	0.68
5	Lysine	1.28	1.18	1.04
6	Calcium	0.99	0.92	0.87
7	Available phosphate	0.43	0.41	0.40
8	Sodium	0.16	0.16	0.16
9	Crude fiber	2.96	2.87	2.73
10	Crude fat	3.26	4.18	4.69

Supplied per Kg of diet: Vit. A, 10 000 IU; Vit. D3, 2 000 IU; Vit. E,10 mg; Vit. K3,2 mg; Vit. B1, 2mg; Vit. B2, 6 mg; Vit. B6, 2 mg; Vit. B12, 10 mcg; Niacin, 30mg; Pantothenic acid, 10mg; Folic acid,0.75mg; Biotin, 50mcg; Choline,300mg; Copper, 4 mg; Iron, 40mg; Manganese, 70mg; Zinc,40mg; Iodin

III. Statistical Analysis

Data for each parameter was analyzed by a tow way general linear model analysis of variance (Sigma Stat Ver. 31. 2012) with source of variation being affected of dietary FA, vaccination methods and their inter actions. The statistical analysis of trait (BW, SI, PI, Bursa and Spleen percent) was done based on tow way analysis of variance being the effect of FA, vaccination method and their interaction are the main affecting factors, within each age period. The dunncans test used for comparing the means.

IV. Results and Discussion

The effects of feed additives FA on body weight, immune organs weight and (phagocytic and stress indexes) of the broilers during the different phases of experiment are shown in Table Π, Table Ш, Table IV, Table V and Table VI.

A. Body Weight

Chicks fed diet containing 0.15% FA were significantly

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heavier (p<0.05) in weekly body weight than chicks fed the basal diet as showed in Table Π, this is due to MCFA act as an alternative of antibiotic and high energy diet. These results are agreement with (Kessler at el., 2009) who showed that the broilers fed the fat-supplemented diets presented higher weight gain as compared to those fed diets with no FA addition, it could be inhibit the excessive growth of a harmful intestinal microorganism, with the result may positively affect poultry health and productivity. Elagib, et al. (2012) stated that aromatic plants and their oil extracts are becoming more important in poultry production as growth promotants. Also (Ashan, 2011) showed that significant effect of medical plant oil on Body Weight (BW) and Body Weight Gain (BWG) and carcass quality. As for the effect of vaccination method, the 2 weeks body weight was significantly the least among birds subjected to oral vaccine, whereas 3rd and 4th week body weight were heavier for birds orally vaccinated and the control groups than those received vaccine via oculonasal an S/C groups. Data of 5th and 6th week body weight show some kind of superiority for birds received no vaccine over dose subjected to vaccination against ND. Data of interaction indicated that within each of two dietary groups, the control chicks showed heavier body weight at 6th week of age than the bird subjected to the ND vaccine through oral, oculonasal and S/C methods, these results are in accordance with those of (Kogut, 2009) who found that a vigorous immune response (vaccination) reduce bird growth, it may be due to use large amount aminoacids to produce Abs in birds against ND vaccine instead of growth Performanc. (Miller, et al., 2010) reported that broilers selected the high fat and energy diets since the first days of age, which leads to better poultry production.

TABLE II

BODY WEIGHT (MEAN ± SE) OF BROILER CHECKS AS AFFECTED BY DIETARY (FA) AND VACCINATION METHOD AT DIFFERENT AGES.

	Treatment	Age, Week				
		2W	3W	4W	5W	6W
Diet	FA	330.2±1.4a	902.3±6.4a	1521.1±6.1a	2331.4±6a	2849±14.4a
	without FA	322.3±1.8b	835.8±7.1b	1285.9±5.5b	2176.5±5.6b	2705.4±6.34b
Vaccination	Orall	325.1±2.52c	881.2±4.1a	1480.8±18b	2245.2±18 c	2761.9±17.3bc
	Oculonasal	330.7±3.8ab	828.5±11b	1423.5±15c	2228±24.9b	2746.5±23.4c
	subcutaneous	330.6±4.32a	859.3±16c	1456±24.8a	2267.8±25a	2793.5±35.5ab
	Control	334.5±1.1ab	907±11.9d	1453.5±24.8a	2274±27.6a	2806.8±24.7a
Interaction(GA)	G1	331.7±3.2b	890±2.9a	1538.1±4.2ab	2300.5±3.9b	2813.7±10.9a
	G2	342.2±0.3a	863.7±3.6b	1473.3±6.2d	2309.97±4b	2821.5±10.2a
	G3	344.6±0.5a	911±4.87c	1537.8±3.3bc	2350.6±5.9a	2879±50.9a
	G4	333.5±1.4b	944.3±2.2d	1535.2±2.9ac	2364.6±4.9a	2881.8±13.2a
Interaction(GB)	G5	318.5±0.7bc	872.5±6.1a	1423.5±10.3d	2190±15.7b	2710.2±11a
	G6	319.3±3.2ab	793.4±4.3b	1373.7±3.1bc	2146±4.4b	2671.6±8a
	G7	316.6±1.9ac	807.5±4.2c	1374.6±5.2ab	2165±4.15a	2708±7.4a
	G8	334.7±1.9d	869.7±8.1d	1371.5±4.6ac	2183.3±7.1a	2730.±14.4a

B. Phagocytic Index (PI)

Diet supplementing with FA cause lower PI on 2W than the basal diet group of birds and the reverse was true as bird aged to 4W, Table Ш, may be the FA not influence the cell membrane of the heterophils at the early stage of life. (Kogut, 2009) showed that is largely due to a qualitative impairment of the avian innate host defenses characterized by a functional inefficiency of heterophils and macrophages for the first W to 2W days of life in chickens. On 2W of age the highest significant value of PI was noticed in birds subjected to ND vaccine via S/C method and the lowest was in the non-Vaccinated (control) birds. On the other hand, data of 4W of age revealed some statistical variation in PI values due to the different method of vaccination with the lowest values noticed in the control group, it is due to activation of immune cell after vaccination. As observed in the study of (Rue et al., 2011) that the host innate immune response to virus infection is an immediate reaction designed to retard virus replication and aid the host in developing specific protection from the adaptive immune responses. Data of inter action factors during both ages, indicated that with GA group none of the sub group treatment showed statistical different in PI means. However, with the GB group the S/C group of vaccination resulted in highest PI mean when birds 2W of age. (Baiao and Lara, 2005) showed that the biological point of view fatty acids, antioxidants are defined as compounds that completely protect the biological systems against the harmful effects or reactions that cause the oxidation of macromolecules or cellular structures.

C. Stress Index (H/L) Ratio

H/L ratio proved that within each age period, FA supplemented diet significantly (p<0.05) improved the SI parameter compared to the diet without FA groups of birds as shown in Table IV, it is due to direct transporting the FA into the immune cells. As indicated previously by (Gomes and Aoki, 2003) reported that the MCFA is transported through the mitochondrial membrane independently of the carnitine palmitoil-transferase (CPT) system. As for vaccination methods, no differences were detected in SI means during 2W and 4W of age due to different vaccination methods. In this regard, the control (non-vaccinated) birds showed statistically highest SI means over each of vaccination methods. (St-Onge and Jones, 2002) observed that the MCFA absorbed directly into the portal circulation and transport to the liver for fast rate of oxidation leads to greater energy expenditure to immune cells. Some plant bioactive may play a role in the development of immune response in birds by protecting cells from oxidative damage and enhancing the function and proliferation of these cells which is supported by (Bozkurt at el., 2012). The data present here suggest an obvious involvement of FA in enhancing body weight a combined with improvement in healthy condition of the broiler chicks. Experimental investigations have confirmed that several fatty acids exert changes in the phospholipids of plasma membrane which affect the membrane fluidity and they also alter eicosanoid production (Pablo, at el., 2002).

D. Immune Organs

The ratios of both (Bursa of fabricius and spleen) showed no significant differences due to diet with FA verses diet without FA at 2W and 4W of age. Also, the different vaccination methods and interactions with types of diet had no effect the Bursa of Fabricius and spleen ratios, accept significant lower percent of spleen in birds vaccinated orally at 2W of age compared to the oculonasal, S/C, and control groups was recorded, as clarified in Table V and TableVI . These results supported by (Bozkurt, at el., 2012) who showed that the weight of the liver or bursa of Fabricius was not affected by fatty acid (P<0.05).

TABLE III
PHAGOCYTIC INDEX (MEAN ± SE) OF BROILER CHICKS AS AFFECTED BY DIETARY (FA) AND VACCINATION METHOD AT DIFFERENT AGES.

	Treatment	Phagocytic Index	
		2W	4W
Diet	FA	39.17±1.35b	46.58±1.15a
	without FA	47.29±2a	38.8±1.22b
Vaccination	Orall	41.42±2.44a	46.08±2.3ab
	Oculonasal	40.17±1.83a	43.17±2.11ac
	subcutaneous	51.67±3.12b	44.8±1.6bc
	Control	39.67±1.61a	37.42±2.44d
Interaction(GA)	G1	36.33±3a	51±1.57a
	G2	36.33±2.11a	48.7±1.65a
	G3	42.16±2.46a	47.17±2.75a
	G4	41.83±2.79a	39.5±4.5a
Interaction(GB)	G5	46.5±2.6a	41.17±3.59a
	G6	44±2.1a	37.67±2.01a
	G7	61.168±0.87b	41±0.82a
	G8	37.5±1.33c	35.33±2.03a

Means with no common superscripts within treatment period cell (age) are significantly different (p<0.05).

TABLE IV
STRESS INDEX (MEAN ± SE) OF BROILER CHECKS AS AFFECTED BY DIETARY (FA) AND VACCINATION METHOD AT DIFFERENT AGES.

	Treatment	Stress Index	
		2W	4W
Diet	FA	0.196±0.003a	0.173±0.003a
	without FA	0.202±0.002b	0.256±0.006b
Vaccination	Orall	0.194±0.003a	0.205±0.014a
	Oculonasal	0.196±0.002a	0.204±0.012a
	Subcutaneous	0.196±0.002a	0.208±0.011a
	Control	0.209±0.006b	0.242±0.016b
Interaction(GA)	G1	0.188±0.003a	0.163±0.003a
	G2	0.195±0.003a	0.167±0.005a
	G3	0.193±0.004a	0.172±0.004a
	G4	0.210±0.011a	0.190±0.001a
Interaction(GB)	G5	0.201±0.003a	0.247±0.001a
	G6	0.198±0.003a	0.242±0.007a
	G7	0.200±0.002a	0.243±0.006a
	G8	0.209±0.008a	0.293±0.005a

Means with no common superscripts within treatment period cell (age) are significantly different (p<0.05).

TABLE V
BURSA OF FABRICIUS OF BROILER CHICKS AS AFFECTED BY DIETARY (FA) AND VACCINATION METHOD AT DIFFERENT AGES.

	Treatment	Bursa	
		2W	4W
Diet	FA	0.168±0.014a	0.793±0.026a
	without FA	0.162±0.009a	0.732±0.029a
Vaccination	Orall	0.191±0.029a	0.791±0.034a
	Oculonasal	0.166±0.007a	0.819±0.034a
	subcutanius	0.143±0.009a	0.692±0.046a
	Control	0.159±0.01a	0.749±0.035a
Interaction(GA)	G1	0.192±0.057a	0.812±0.055a
	G2	0.168±0.008a	0.854±0.058a
	G3	0.144±0.009a	0.728±0.026a
	G4	0.166±0.01a	0.776±0.066a
Interaction(GB)	G5	0.189±0.02a	0.769±0.045a
	G6	0.163±0.013a	0.784±0.036a
	G7	0.142±0.016a	0.655±0.091a
	G8	0.153±0.018a	0.721±0.036a

Means with no common superscripts within treatment period cell (age) are significantly different (p<0.05).

TABLE VI
SPLEEN OF FABRICIUS OF BROILER CHICKS AS AFFECTED BY DIETARY (FA) AND VACCINATION METHOD AT DIFFERENT AGES.

	Treatment	Spleen	
		2W	4W
Diet	FA	0.088±0.004a	0.360±0.025a
	without FA	0.084±0.005a	0.312±0.021a
Vaccination	Orall	0.065±0.007b	0.325±0.020a
	Oculonasal	0.087±0.008a	0.313±0.021a
	Subcutanius	0.098±0.007a	0.361±0.052a
	Control	0.095±0.006a	0.344±0.031a
Interaction(GA)	G1	0.064±0.005a	0.328±0.030a
	G2	0.091±0.01a	0.349±0.037a
	G3	0.101±0.009a	0.407±0.091a
	G4	0.099±0.007a	0.355±0.011a
Interaction(GB)	G5	0.065±0.009a	0.323±0.03a
	G6	0.084±0.011a	0.277±0.07a
	G7	0.095±0.004a	0.315±0.051a
	G8	0.091±0.01a	0.333±0.062a

Means with no common superscripts within treatment period cell (age) are significantly different (p<0.05).

V. Conclusion

We can conclude from the results that feed additive given for Broiler chicks by supplying 0.15% MCFA to the basal diet significantly improves their performance. MCFA did not affect weight of spleen and bursa of Fabricuis at day 14 and 28 of their live. In addition, MCFA was not involved in enhancing innate immunity assessed by phagocytic stress index of 14 and 28 days old Broiler chicks.

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Optical Properties of the Synthesized Cr_2S_3 Nanoparticles Embedded in Polyvinyl Alcohol

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***Abstract*—Polyvinyl alcohol (PVA) based nanocomposite, with different concentrations of chromium sulfide Cr_2S_3 nanoparticles, were prepared by reduction of $Cr(NO_3)_3$ and Na_2S in an aqueous PVA solution, using the chemical reduction rote, and casting technique. Effect of Cr_2S_3 nanoparticles on optical parameters such as absorbance, absorption coefficient, refractive index, and extinction coefficient have been investigated using UV-Visible spectroscopy. The study reveals that all these parameters are affected by the Cr_2S_3 nanoparticles concentration. The study has been also extended to investigate the changes in the optical band gap energies, the band tail width for the samples using Tauc and Urbach relations respectively. The optical energy band gap reduced from (6.17 eV) for pure PVA to (4.14 eV) for 0.04M Cr_2S_3; while the Urbach tail increased from (0.216 eV) for pure PVA to (0.523 eV) for 0.04M Cr_2S_3. The significant change of the optical properties of PVA with embedded Cr_2S_3 nanoparticles suggested their applicability in optical devices.**

***Index Terms*—Cr_2S_3 nanoparticles, filler effect, optical properties, polymer nanocomposite, solution cast technique.**

I. Introduction

In the past several years, considerable researches have been carried out focusing on the synthesis of the polymer nanocomposite materials with various nanoparticle filler to understanding their physical and chemical properties. By combining polymer and nanoparticle, the resulting composites can possess advantages of both organic polymers and inorganic nanoparticle (Jeon and Baek, 2010). Incorporating a small amount of nano-sized fillers into the polymer matrix, could lead to a significant change in optical, electrical, and mechanical properties (Ayandele, et al. 2012).

Optical properties of different polymers based nanocomposite have received considerable attention in recent literatures (Liu, et al. 2007; Luo, et al. 2007), it is still meaningful to extend the research on such materials as a promising material for sensors, rechargeable batteries, optoelectronics applications such as light emitting diodes LEDs, and electromagnetic interference shielding (Gurunathan, et al., 1999).

Due to their superior physical and chemical properties, polyvinyl alcohol (PVA) based nanocomposite, has attracted more attention among the other organic nanocomposite (Abdullah, et al., 2011). Major characteristics of PVA include excellent film forming capacity, good transparency, high tensile strength, tear and chemical resistance, and good insulating material which makes important for many applications in industry (Yang and Wu 2009; Gautam and Ram 2010; Ravi, et al., 2011).

The investigation of optical absorption, especially, the absorption edge, the band gap energy, and the band tail of localized state is importance for different applications (Deshmukh, et al., 2008; Abdullah, et al., 2011).

In the present work, an aqueous solution of PVA used as host matrix for $Cr(NO_3)_3$:Na_2S reaction to produce nano Cr_2S_3/polymer nanocomposite. The characterization and analysis focused on the influence of Cr_2S_3 nanoparticle concentration on the optical parameters of the PVA, to optimize the optical properties for desired applications.

II. Materials and Methods

The homogeneous and transparent solution of polyvinyl alcohol (PVA) was prepared by dissolving (2 gm) of low molecular PVA supplied by Alfa Aesar in 50 ml distilled water using a hot plate magnetic stirrer at 90^{o}C for 1 hr. Chromium nitrate $Cr(NO_3)_3$ (molar mass=238.0108 g/Mol.) and Sodium sulfide Na_2S (molar mass=78.0445 g/Mol.) as Cr^{3+} and S^{2-} ion source respectively, were dissolved in the 5 mL distilled water separately with different molar concentrations (0.00, 0.01, 0.02, 0.03 and 0.04) at ambient temperature. Then $Cr(NO_3)_3$, and NaS solution with ration 2:3, prepared separately and then added drop by drop to the homogeneous solution of PVA at 40^{o}C. For maximum dispersion, the solution was further stirred for 30 minutes without heating. The production process of Cr_2S_3 was according to the following reaction:

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$$2Cr(NO_3)_3 + 3Na_2S \rightarrow Cr_2S_3\ (solid)\ + 6NaNO_3\ (aqueous)$$

The mixture of the prepared solution was casted onto a clean plastic Petri dish and allowed to evaporate slowly at room temperature for two weeks. For continuous drying with blue silica gel, the produced films transferred into desiccators. The prepared films have a uniform thickness in the range of (0.17-0.21) mm. The measurements of absorbance and transmittance spectra of the prepared films were carried out at room temperature using double beam Ultraviolet-visible spectrophotometer (Lambda-25) in the wavelength region of (190-1100) nm.

III. Results and Discussion

Fig. 1 shows the absorption spectra of the PVA films filled with different concentrations of Cr_2S_3. The pure PVA film exhibits a main peak at 284 nm as well as a shoulder at about 333 nm. The main peak attributed to the absorption of the carbonyl group, while the shoulder assigned to the -(CH=CH)3CO- structure (El-Khodary, 2010; Abdullah, et al. 2013).

The nanocomposite films with different contents of Cr_2S_3, showed two broad bands approximately centered at (415 and 570)nm in the visible region, which are related to surface plasmon resonance (SPR) that correlated to the Cr_2S_3 nanoparticle (Massoumi, et al. 2013). The SPR bands of the nanoparticle are sensitive to the shape and size of the particle size (Noguez 2007; El-Brolossy, et al. 2008). The intensity of these bands increases with increasing salt concentration providing evidence for the incorporation of the Cr_2S_3 into PVA matrix. The observed blue shift of the two bands comparing to the Cr(III) spectra (421 and 592) nm in reference (Subramaniam, et al. 2013), attribute to the quantum confinement effect (Seoudi, et al. 2012), Whereas the shift in onset of absorption spectra towards the higher wavelength upon increasing Cr_2S_3 confirm the increase of the average size of nanoparticles (Deshmukh, et al. 2012).

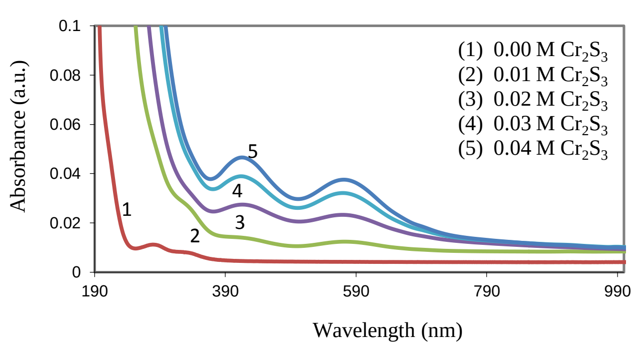


Fig. 1. The absorption spectra of pure PVA, and PVA/Cr_2S_3 nanocomposite.

The optical absorption coefficient α is defined as the ability of a material to absorb light of a given wavelength; it provides the most valuable optical information such as the electronic band structure and the optical energy band gap for material identification. The variation of optical absorption coefficient α with wavelength can be calculated from the optical absorption spectrum using the Beer-Lambert's relation (Abdullah, et al. 2013; Ballato, et al. 2003):

$$\alpha = \frac{2.303A}{d} \quad (1)$$

where, d is the sample thickness in (cm), and A is absorbance defined as $log(I_o/I)$ where I_o and I are the intensities of the incident and transmitted beam light respectively (El-Khodary, 2010).

Figure 2 shows the dependence of the absorption coefficient on the photon energy for pure PVA sample and the Cr_2S_3/PVA nanocomposite samples. The absorption coefficient increases with the increasing of Cr_2S_3 concentration.

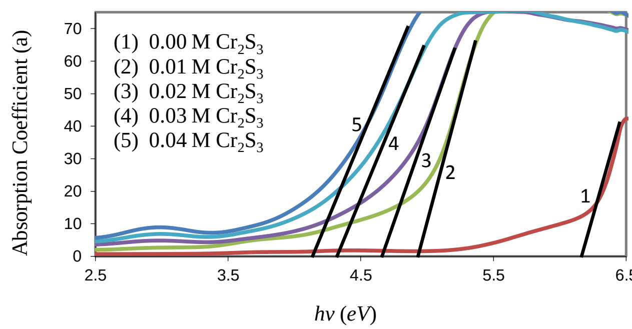


Fig.2. The optical absorption coefficient for pure PVA and PVA/Cr_2S_3 nanocomposite.

The refractive index is a fundamental characterization of the optical study, the values of refractive index (n) could be determined from the optical reflectance (R) of the investigated films, using the Fresnel formulae as follows (Yakuphanoglu, et al. 2007):

$$n = \left(\frac{1+R}{1-R}\right) + \left[\frac{4R}{(1-R)^2} - k^2\right]^{1/2} \quad (2)$$

where ($k = \alpha\lambda/4\pi$) is the extinction coefficient, λ is the incident photon wavelength.

Fig. 3 shows the variation of the refractive index of nanocomposites as the function of photon energy. The refractive index increases as a result of increasing the concentration of Cr_2S_3 nano-filler, this behavior can be attributed to the increasing of the packing density of nanocomposite as a result of filler content (Amma, et al., 2005).

The variation of the extinction coefficient (k) with photon energy for PVA/Cr2S3 nanocomposites is as shown in Fig.4. The extinction coefficient increases with increasing of Cr2S3 nanoparticles concentration. This behavior of extinction coefficient can be ascribed to the variation of the absorption coefficient since k directly proportional to α.

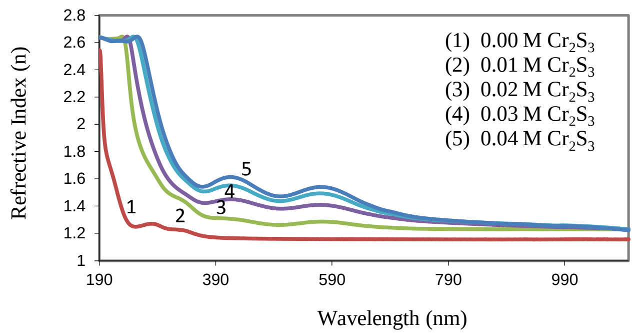


Fig. 3. The refraction index of PVA/Cr_2S_3 nanocomposite as a function wavelength.

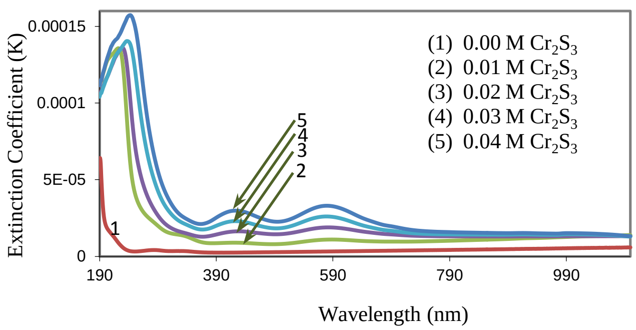


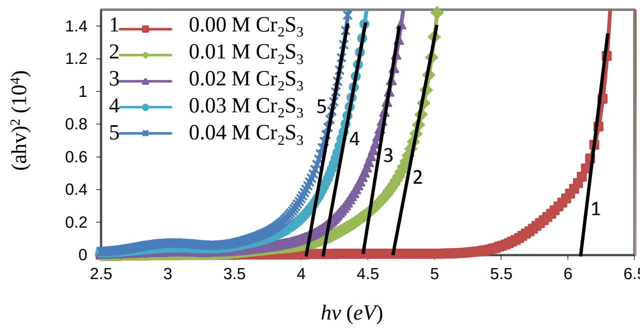
Fig. 4. The extinction coefficient for PVA/Cr_2S_3 nanocomposite as a function of wavelength.

The optical absorption spectra for the near absorption edge, can be used to determine the nature of the transition (direct or indirect), and the value of the optical energy band gap E_g. The present optical data can be investigated in view of the models proposed by Tauc (1970);

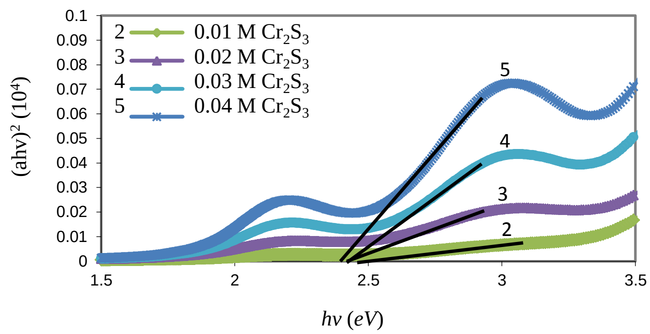
$$\alpha = B\frac{\left(h\nu - E_g\right)^r}{h\nu} \tag{3}$$

Where, B is a constant, $h\nu$ is the incident photon energy, and r is the power that characterizes the optical transition process. The exponent r determines the type of electronic transitions causing optical absorption, it can take values 1/2, 3/2, 2 or 3 for transitions designated as direct allowed, direct forbidden, indirect allowed, and indirect forbidden respectively (El-Khodary, 2010).

Figure 5 shows the plots of $(\alpha h\nu)^{1/2}$ versus the photon energy ($h\nu$) for the present experimental data near the absorption edge. The linearity of the data suggests the presence of indirect allowed transitions in the PVA and its composite. Extrapolation of the linear portion of the plots to the abscissa yields the indirect optical energy band gaps of PVA/Cr_2S_3 nanocomposite and Cr_2S_3 nanoparticles. The values of optical energy band gaps are given in Table 1. The obtained data revealed that the optical energy band gap decrease significantly with increasing nano Cr_2S_3 concentration, which may be explained on the basis of the fact that the incorporation of small amounts of dopant forms charge transfer complexes in the host matrix (Abdullah, et al. 2013). These charge transfer complexes increase the electrical conductivity by providing additional charges, this result in a decrease of the optical energy band gap, by facilitating the transfer of charge carrier between the localized states (Abdelrazek, et al., 2013; Sangawar, et al., 2007).



(a)



(b)

Fig. 5. $(\alpha h\upsilon)^{1/2}$ versus photon energy ($h\nu$) for; (a) PVA/Cr_2S_3 nanocomposite and (b) Cr_2S_3 nanoparticles.

The width of the localized tail states in the forbidden gap (Urbach tail), is an indicator of the defect levels in the forbidden band gap (El-Khodary, 2010).The absorption coefficients just below the fundamental gap can be used to calculate the Urbach energy using following relations (Urbach 1953):

$$\alpha = \alpha_o \exp\left(\frac{h\nu}{E_u}\right) \tag{4}$$

where α_o is a constant and E_u is the Urbach energy interpreted as the width of the tails of the localized state in the forbidden gap. The exponential dependence of α on the photon energy ($h\nu$) for the investigated samples indicates that it obeys Urbach's formula. The Urbach plot is presented in Fig.6, in which the natural logarithm of absorption coefficient α was plotted as a function of photon energy ($h\nu$). The magnitudes of the Urbach energy E_u were estimated, by taking the reciprocal of the slopes of the linear portion. The optical band gap and band tails of the localized state of the samples are summarized in Table I.

The Urbach energy tail E_u was found to be proportional to the Cr_2S_3 concentration in PVA/Cr_2S_3 nanocomposites. Increasing Cr_2S_3 content may cause the localized states to overlap and extend into the mobility gap in the polymeric matrix (Reda, and Zahrani 2012; Abdelrazek, et al., 2013). The observed increase in the Urbach energy with increasing Cr_2S_3 concentration, correlated with the decrease of the energy gap, and absorption edge accordingly.

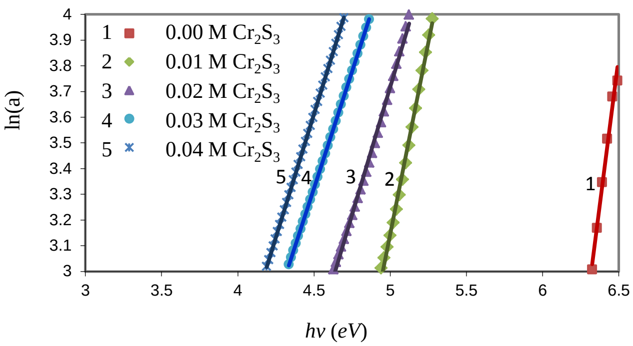


Fig. 6. The relation between *ln(α)* and photon energy (*hν*), for PVA at different Cr_2S_3 nanoparticles concentration.

TABLE I
VALUES OF THE ABSORPTION EDGE (E_E), DIRECT ENEGRGY GAP (E_G), FOR PVA/Cr_2S_3 NANOCOMPOSITE, ENERGY GAP OF Cr_2S_3 NANOPARTICLES (EN) AND BAND TAIL ENERGY (EU)

Cr_2S_3 (M)	E_e (eV)	E_d (eV)	E_n (eV)	E_u (eV)
0.00	6.17	6.10	-	0.216
0.01	4.93	4.69	2.50	0.336
0.02	4.67	4.47	2.44	0.503
0.03	4.33	4.17	2.43	0.550
0.04	4.13	4.04	2.40	0.523

IV. CONCLUSIONS

Chemical reduction rote and solution cast method and have been used to prepare polymer nanocomposite films of PVA with different concentrations of Cr_2S_3 nanoparticles, and their optical properties have been investigated. The absorbance, absorption coefficient, extinction coefficient, and refraction index of Cr_2S_3 doped PVA films increase with increasing of doping concentration. The decreasing trend of the optical band gap of nanocomposite, with increasing the Cr_2S_3 nanoparticles concentration, was attributed to formation charge transfer complexes, while the increase of Urbach energy suggests the presence of the deeps localized state in the band gaps. The decrease of the optical band gap of nanoparticle upon increasing Cr_2S_3 additions suggested the smaller Cr_2S_3 nanoparticles were synthesized in a small amount of Cr salt.

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