JOURNAL OF SCIENTIFIC PERSPECTIVES JSP

International Peer-Reviewed and Open Access Electronic Journal

ABOUT THE JOURNAL

JOURNAL OF SCIENTIFIC PERSPECTIVES JSP

EDITORIAL BOARD

JOURNAL OF SCIENTIFIC PERSPECTIVES JSP

THE REFEREES IN THIS ISSUE

Prof. Dr. Valerii PLOTNIKOV, Odessa National Academy of Food Technologies, Ukraine, vmplotnik@gmail.com

Prof.Dr. Sergii NESTERENKO, National Polytechnic University, Ukraine, sa_nesterenko@ukr.net

Prof. Dr. Cemal Varol TOK, Çanakkale Onsekiz Mart University, Faculty of Arts and Science, Biology Department, Turkey, cvtok44@gmail.com

Prof. Dr. Cüneyt AKI, Çanakkale Onsekiz Mart University, Faculty of Arts and Science, Biology Department, Turkey, cuneytaki@gmail.com

Prof. Dr. Levent ŞIK, Celal Bayar University, Faculty of Arts and Science, Biology Department, Turkey, jesuislevent@gmail.com

Assist. Prof. Dr. Hanife AKYALÇIN, Çanakkale Onsekiz Mart University, Faculty of Arts and Science, Biology Department, Turkey, hakyalcin@comu.edu.tr

Prof. Dr. Münevver SÖKMEN, Konya Food and Agriculture University, Faculty of Agriculture and Natural Sciences, Department of Plant Production and Technology, Turkey, munevver.sokmen@gidatarim.edu.tr

Prof. Dr. A. Hakan AKTAŞ, Süleyman Demirel University, Faculty of Science and Arts, Chemistry Department, Turkey, hakanaktas@sdu.edu.tr

Assoc. Prof. Dr. Necati KAYA, Canakkale Onsekiz Mart University, School of Applied Sciences, Department of Energy, Turkey, necatikaya@comu.edu.tr

Assist. Prof. Dr. Ozan DENİZ, Canakkale Onsekiz Mart University, School of Applied Sciences, Department of Energy, Turkey, ozandeniz@comu.edu.tr

Assoc. Prof. Dr. Bahadır KIRILMAZ, Canakkale Onsekiz Mart University, Faculty of Medicine, Department of Cardiology, Turkey, bahkard@yahoo.com

Assoc. Prof. Dr. H. Fatih AŞGÜN, Canakkale Onsekiz Mart University, Faculty of Medicine, Cardiovascular Surgery Department, Turkey, hfasgun@yahoo.com

Assist. Prof. Dr. Şenol KARTAL, Nevşehir University, Mathemetics and Science Education, Turkey, senol.kartal@nevsehir.edu.tr

Assoc. Prof. Dr. Ali DELİCEOĞLU, Erciyes University, Department of Mathematics, Turkey, adelice@erciyes.edu.tr

Prof. Dr. Ayhan ESİ, Adiyaman University, Department of Mathematics, Turkey, aesi23@hotmail.com

Prof. Dr. Neşet AYDIN, Çanakkale Onsekiz Mart University, Faculty of Arts and Sciences, Department Mathematics, Turkey, neseta@comu.edu.tr

Assist. Prof. Dr. Vladlen SHAPO, National University "Odessa Maritime Academy", Ukraine, vladlen.shapo@gmail.com

THE AIM AND SCOPE OF THE JOURNAL

Journal of Scientific Perspectives provides open access to its content, embracing the principle of increasing the global sharing of information on free scientific research. This journal is a material in which academic studies are included and so,it provides a social service for the benefit of institutions and individuals engaged in scientific research as. In this context, it is aimed at providing readers with a common platform to share and improve the quality of recent research advancements in the fields of basic sciences, engineering, natural sciences and health sciences. Thus, It is aimed at promoting research worldwide and publishes basic and advanced research work from the fields above.

The journal accepts only original works of quality which are products of a new solution approach or give a new view of an existing knowledge. In this context, it is open to any kind of constructive, creative and institutionalized knowledge providing that they contribute to universal science and technology. Thus, it is aimed to index the journal with various international indexes.

The study fields covered by the journal are

Basic Sciences and Engineering

- ❖ Chemical Engineering
- ❖ Computer Engineering and Informatics
- ❖ Constructional Engineering
- ❖ Environmental Engineering
- ❖ Electrical and Electronic Engineering
- ❖ Food Engineering
- ❖ Geology Engineering
- ❖ Industrial Engineering
- ❖ Mechanical Engineering
- ❖ Mining Engineering
- ❖ Physical Engineering
- ❖ Textile Engineering
- ❖ Other Engineering Fields
- ❖ Chemistry
- ❖ Physics
- ❖ Mathematics
- ❖ Statistics
- ❖ Materials Sciences (Material and Metallurgy Engineering, Topographical Engineering etc.)
- ❖ Space Sciences
- ❖ Earth Sciences
- ❖ Architecture
- ❖ Urban and Regional Planning
- ❖ Astronomy and Astrophysics

Health Sciences

- ❖ Medical Sciences (Surgery, International Medicine, Basic Medical Sciences)
- ❖ Dentistry
- ❖ Pharmacology and Pharmaceutics
- ❖ Nursing
- ❖ Nutrition and Dietary
- ❖ Veterinary Medicine

Natural Sciences

- ❖ Biology
- ❖ Environmental Sciences
- ❖ Food Science and Technology
- ❖ Animal Husbandary
- ❖ Forestry
- ❖ Marine, Aquatic Sciences and Fisheries
- ❖ Agricultural Science

There are no limits to the fields in which the study will be accepted to the journal. The journal is open to all works aimed at contributing to the national and international developments of the professional organizations and individuals who follow the developments in the field of health, science and engineering and to create a resource in these fields.

PUBLICATION POLICIES

1. *Journal of Scientific Perspectives* has begun publication in July 2017. It is an internationally peer-reviewed and periodical journal published regularly in four issues per year in **January, April, July and October**, in the fields of **basic sciences, engineering, natural sciences** and **health sciences**. All articles submitted for publication are evaluated by the editor in chief, field editor, editorial board and referees.
2. Journal only accepts the studies written in **English.** Original research papers, technical notes, letters to the editor, discussions, case reports and compilations are published in our journal.
3. Only the original scientific researches are included. It is essential that the information created in scientific study needs to be new, suggest new method or give a new dimension to an existing information
4. Journal of Scientific Perspectives is an **open access electronic journal**. All articles published in the journal are assigned the **DOI number**. Researchers worldwide will have full access to all the articles published online and can download them with zero subscription fees. In addition, because of the influence of your research, you will quickly become an Open Access (OA) author, because an OA article has more chances to be used and the plods through the subscription barriers of traditional publishing models.
5. The editor-in-chief and the relevant field editor have the authority not to publish the articles, to make regulations based on the format or to give back to the author

for correction that do not comply with the conditions of publication within the knowledge of the editorial board. All studies submitted to *Journal of Scientific Perspectives* are sent to at least **two referees** after the initial review of the editor in chief, relevant field editor and editors related to the study issue with respect to formatting and content. After having positive feedbacks from both of the referees, the manuscripts are published. In case of having one positive and one negative feedback from the referees, the manuscript is sent to **a third referee**. Identities of authors are kept in the posts to be sent to the referees (Double-blind peer review). In addition, the authors are not informed about the referee

6. It is general essential that studies which aren't seemed enough need to be changed in accordance with suggests of referees. Studies which aren't reached intended level or aren't seemed enough in terms of scientific are refused with unexplained reason. The works are published with the condition to be taken in order

7. The referee process is carried out by the **editor in chief.** A study that the chief editor does not find suitable or does not accept is not included in the journal. In this regard, authors can not create a liability for the journal and other boards of the journal.

8. After the field editor has been appointed by the editor in chief, **7 days** are given to him/her for the appointment of the referee. While he/she appoints the referees, he takes the views of the other editors related to the study issue. The studies sent to the referees for evaluation are expected to be answered within **30 days**. In case this is overcome, the editor makes a new referee appointment and withdraws the request from the former referee.

9. Required changes must be made by the author within **15 days** after the decision of "Correction required" given in article acceptance decision.

10. The studies submitted for publication in the journal must have not been published elsewhere or have not been sent another journal to be published. The studies or their summaries which were presented in a conference or published can be accepted if it is indicated in the study. In addition, if the work is supported by an institution or is produced from a dissertation, this should be indicated by a footnote to the title of the work. Those who want to withdraw their publications for publication for some reason must apply to the journal management with a letter. The editorial board assumes that the article owners agree to abide by these terms.

11. All responsibility of the studies belong to the authors. Studies should be prepared in accordance with international scientific ethics rules. Where necessary, a copy of the ethics committee report must be added.

12. The articles submitted to the *Journal of Scientific Perspectives* are sent to the referees after they have been checked with the "iThenticate" plagiarism scanning program to see if they are partially or completely copied (plagiarism) from another study. Regulation is demanded from the author for the articles which are high in the plagiarism result (60% and over). If the required regulation is not made within **60 days**, the study is rejected.

13. Copyright of all published studies belongs to the *Journal of Scientific Perspectives*.

14. **No copyright payment** is made.

15. For the studies accepted for publication in our journal, copyright transfer form signed must be added to the system or mail to

16. No study has differentiation or superiority from another study. Each author and study has the same rights and equality. No privileges are recognized.
17. Studies submitted for publication in our journal must be prepared according to the rules of spelling of journal. Spelling and template are included in are included in the "Author Guidelines" heading
18. Articles submitted for evaluation must not exceed 25 pages after they are prepared according to the specified template. Article summary should not exceed 300 words and minimum 3 and maximum 7 keywords should be written.

ETHICAL GUIDELINES

Journal of Scientific Perspectives (JSP) is committed to meeting and upholding standards of ethical behavior at all stages of the publication process. It strictly follows the general ethical guidelines provided by the Committee on Publication Ethics (COPE), the Open Access Scholarly Publishers Association (OASPA) and Cambridge Journals Ethical Standards and Procedures. Depending on these principles and general publication requirements, editors, peer reviewers, and authors must take the following responsibilities in accordance to professional ethic and norms. The proper and ethical process of publishing is dependent on fulfilling these responsibilities

The Responsibilities of Editor(s)

❖ The editor in chief and relevant editor(s) should acknowledge receipt of submitted manuscripts to the authors within ten days. The editor in chief and relevant editor(s) have responsibility in order to determine which of the submitted manuscripts could be published.

❖ Editors should adopt editorial policies that encourage maximum transparency, complete, impartial and honest reporting

❖ The submitted manuscripts will be controlled by the editor and the associate editor(s) in case of the plagiarism possibility. In this stage, the detected plagiarized manuscripts by the The editor in chief and relevant editor(s) will be rejected by the editor and associate editor(s). No way that the plagiarized manuscripts will be taken in the consideration process.

❖ The unpublished data and method in the submitted manuscripts should not be exploited/use by anyone in her/his study without the written permission of the author.

❖ The submitted manuscripts should be evaluated in accordance to the framework of solely intellectual norms in regardless of social, religious, cultural, economical background.

❖ The submitted manuscripts should not be disclosed no one other than the reviewer, the publisher, the editor assistants and the author(s) of such manuscripts by The editor in chief and relevant editor(s).

❖ When obtained interest struggle/conflict among the submitted manuscripts and other author(s) and/or institution, such submitted manuscripts should be recuse himself or herself from the review process.

❖ The final decision concerning the acceptance or rejection of the submitted manuscripts belongs to the editor in chief. This situation will be decided with reference to the originality and significance of the submitted manuscripts.

❖ The editor in chief should not oblige the authors to cite any articles or papers in the journal as the submitted manuscripts of the authors to be able to accept in the journal.

The Responsibilities of Reviewer(s)

❖ The reviewers have responsibility to the editor to inform the editor and the associate editors regarding the review process of the submitted manuscript in case

the reviewers do not feel enough qualified in order to review the assigned manuscript of if they cannot complete the review process on time.

❖ The reviewers should complete her/his task in the respect to principle of secrecy. Reviewers should not share or discuss any data regarding the submitted study with no one except the editors.

❖ The reviewer should not disclose and share any data/content and opinions of the submitted manuscripts and should not use personal interest. Furthermore, the reviewers should not use any data of the unpublished paper.

❖ The criticism of the reviewers should be based on objective and scientific perspective and also the reviewers should avoid from personal criticism against the author(s). The reviewers are supposed to support her or his opinions by providing clear and tangible proofs.

❖ If the reviewers detect any similarities between the assigned manuscript and another published articles in the journal or in an another journal, they are supposed to notify the editor about this situation.

❖ The reviewers should not take any part in evaluation process of the submitted manuscripts with author(s) who have competition, cooperation or other kind of relations or links.

❖ Reviewers should conduct the work they agree to evaluate on time.

The Responsibilities of the Author(s)

❖ The author(s) should not send the same study manuscript to more than a/one journal simultaneously.

❖ The authors should gather the data relating the studies in the framework of principle of ethic. The publisher, the editor and the reviewer could demand the raw data from the author(s) which the study is based on.

❖ The studies which are sent to the journal should provide details and references/sources in an adequate level. Dishonesty and incorrect statements are unacceptable due to causing unethical principles.

❖ The submitted manuscripts should be original and the originality of the study should be ensured by the author(s). If others' papers and/or words are used in the context of the submitted manuscript, the reference should be provided in accordance to appropriate style. Also excerpts should be in an appropriate style in accordance to the writing rules of the journal and scientific ethics. The authorities are supposed to refer to other publishments which effect the essence of their submitted studies.

❖ The authors are supposed to notify a conflict of interest, financial sources and foundations if any of them are supported their studies.

❖ All the person(s) who contributed to the submitted manuscript in the respect of design, interpretation or implementation should be written on the submitted manuscript. All participations contributed in essence, should be listed respectively. Also apart these persons should be added to the part of "Acknowledgement".

❖ If the author detects any flaw or error(s) in the context of the submitted manuscript, the author is responsible to urgently notify this situation to the editor or the publisher in behalf of collaboration in order to correct such error(s) or flaw(s).

JOURNAL OF SCIENTIFIC PERSPECTIVES JSP

AUTHOR GUIDELINES

INSTRUCTION FOR AUTHORS

The authors are cordially invited to submit significant new findings of their research work papers in word and pdf formats to the journal office via online submission or e-mail:jsp@ratingacademy.com.tr along with a JSP cover letter. The journal will cover the topics related to the fields of **basic sciences, engineering, natural sciences** and **health sciences.** All articles submitted for publication are evaluated by the editor-in-chief, field editor, editorial board and referees. The original research papers, technical notes, letter to the editor, debates, case presentations and reviews only in *English* are published in the journal.

The editorial board of JSP welcomes original novel contributions and reviews in word format. By submission of a manuscript an author certifies that the work is original and is not being considered simultaneously by other journals. All articles are subjected to critical reviews by referees.

Cover Letter

The cover letter should be prepared and sent to the Editor-in-Chief via e-mail.

Software and Format

❖ Regular paper should describe new and carefully confirmed findings, and experimental procedures should be given in sufficient detail for others to verify the work. The length of a full paper should be the minimum required to describe and interpret the work clearly. The total length of any manuscript submitted must not exceed **25 pages.**
❖ Papers should be written in clear, concise language (*English*).
❖ Manuscripts should be prepared in English using a word processor. MS Word for Windows and .docfiles are preferred. Manuscripts may be prepared with other software provided that the full document (with figures, schemes and tables inserted into the text) is exported to a MS Word format for submission.
❖ Do not use desktop publishing software such as Aldus PageMaker or Quark XPress. If you have prepared your manuscript with one of these programs, export the text to a word processing format.
❖ Times New Roman font is preferred. The font size should be 12 PT.
❖ The first line of the paragraph should be shifted by 1,25 cm from the left margin. Paragraph spacing after a single paragraph (6 nk) should be given.
❖ Papers should be single spaced with ample margin. The page setup is A4 size.
❖ The manuscript, which does not show the names of the authors, must include the followings: Title, Abstract, Keywords under the abstract, introduction, main text, conclusion, references and appendix.
❖ No footer, header or page numbers required.
❖ Name each file with your last name of the first author.

1. Title of the paper: The title must concise and informative and should not exceed the 60 characters (12-15 words) including spaces (with key words appropriate for retrieval purposes) and provide peer readers with a quick overview of the paper contents. Avoid abbreviations and formulae where possible.

Title of the paper set in the midst, should be written in bold, in Times New Roman 12 font size and 1,5 spaced.

Headings and subheadings must be numbered 2., 2.1., 2.1.1. as etc decimally with bold letters. All headings should be written in bold but only the first letters of the subtitles should be capital. Spacing before and after a heading (6 nk) should be given.

2. Name of the author(s) with titles and the name and address of the institution where the work was done must be given. Provide, also, with the e-mail address of first and/or the corresponding author so that an immediate communication with the editor is possible. But these are not shown on the manuscript. They must be registered to the system while uploading the manuscript and indicated in the cover letter.

3. Abstracts and Key Words: All papers must have an abstract not more than 300 words of clear, informative and giving significant objectives, methodology, results and conclusion in the paper. Between **3** and **6** key words must be provided for the purpose of indexing and information retrieval. Abstract and key words must be written in Times New Roman 11 font size and single spaced. It also should be in *italic letters*. Presentation of numerical results should be avoided as far as possible in the abstract.

4. **Text**: The paper must be divided into sections and subheadings starting preferably with Introduction and ending with Conclusion followed by Acknowledgement.

5. Tables: Tables should be single spaced. The tables should be kept to a minimum and be designed to be as simple as possible. Tables are to be typed single-spaced throughout, including headings and footnotes. Each table should be numbered consecutively in Arabic numerals and supplied with a heading and a legend. The title should be placed at the top. Explanatory information and experimental conditions should be given as a note at the bottom. Explanatory information and experimental conditions should be given as a note at the bottom of the columns. Tables should be self-explanatory without reference to the text. The same data should not be presented in both table and graph form or repeated in the text.

The headlines of the tables must be written in Times New Roman 12 font and with bond letters. References for the tables (figure of graph) must be below the table (figure or graph) with a font size of 11 font.

6. Figure: Illustrations must be numbered consecutively in Arabic numerals. They should be cited in the text as Figure 1, Figure 2, and so on. Begin each legend with a title at the bottom of the illustration and include sufficient description so that the figure is understandable without reading the text of the manuscript. Graphics should be prepared using applications capable of generating high resolution (300 dpi) JPEG before pasting in the Microsoft Word manuscript file.

The headlines of the figures must be written in Times New Roman 12 font and with bond letters. References for the tables (figure of graph) must be below the table (figure or graph) with a font size of 11 font.

7.Citations: All papers cited in the text, tables, and figures must be included in the references and all papers cited the references section should be cited in the text. Authors should monitor references at all phases of manuscript preparation. References in the text should be cited by author and year. Single author: Clark (2004) or (Clark, 2004). Two authors: Gupta and Clark (2015) or (Gupta and Clark, 2012). More than two authors: Gupta *et al.* (2015) or (Gupta *et al.*, 2015). In the event that an author cited has had two or more works published during the same year, the reference, both in the text and in the reference list, should be identified by a lower case letter like a and b after the date to distinguish the works.

8.References: References should be listed at the end of the paper in alphabetical order. Articles in preparation or articles submitted for publication, unpublished observations, personal communications, etc. should not be included in the reference list. Journal names are abbreviated according to Biological Abstracts and correctly format the references of your paper. Authors are fully responsible for the accuracy of the references. All the references must be in the following order.

Books :

SURNAME, NAME, Publication Year, *Name of Book*, Publishing, Place of Publication, ISBN.

MERCER, P.A. and SMITH, G., 1993, *Private Viewdata in the UK*, 2

Journals:

SURNAME, NAME , Publication Year, Name of Article, *Name of Journal*, Volume Number and Page Numbers.

EVANS, W.A., 1994, Approaches to Intelligent Information Retrieval, *Information Processing and Management*, 7 (2), 147-168.

Conferences:

SURNAME, NAME , Publication Year , Name of Report, *Name of Conference Bulletin*, Date and Conference Place, Place of Publication : Publishing , Page Numbers

SILVER, K., 1991, Electronic Mail: The New Way to Communicate, *9th International Online Information Meeting*, 3-5 December 1990, London, Oxford: Learned Information, 323-330.

Thesis :

SURNAME,NAME , Publication Year, Name of Thesis, Master's Degree/Doctorate, Name of Institute

AGUTTER, A.J., 1995, The Linguistic Significance of Current British Slang, Thesis (PhD), Edinburgh University.

Maps:

SURNAME, NAME , Publication Year, Title, Scale, Place of Publication: Publishing.

MASON, James, 1832, Map of The Countries Lying Between Spain and India, 1:8.000.000, London: Ordnance Survey.

Web Pages:

SURNAME, NAME, Year, Title [online], (Edition), Place of Publication , Web address: URL

HOLLAND, M., 2002, Guide to Citing Internet Sources [online], Poole, Bournemouth University, http://www.bournemouth.ac.uk/library/using/guide_to_citing_internet_sou rc.html, [Date Accessed: 4 November 2002].

 Identification: It is particularly important that the authors get their biological material authentically identified and quote at least once, on its first citation in the paper, the technical name of the species concerned in full preceded by its popular name where possible, e.g. The water bug *Sphaerodema rusticum* (Fabr). Genus and species names should be italic.

Footnotes: Footnotes should be avoided as far as possible. Essential footnotes may, however, be indicated by superscribed reference marks (*, †, ‡,).

Statement of human and animal rights

When reporting experiments on human subjects, authors should indicate whether the procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation (institutional and national) and with the Helsinki Declaration of 1975 (revised in 2000). If doubt exists whether the research was conducted in accordance with the Helsinki Declaration, the authors must explain the rationale for their approach, and demonstrate that the institutional review body explicitly approved the doubtful aspects of the study. When reporting experiments on animals, authors should   be   asked   to indicate whether the   institutional and national guide for the care and use of laboratory animals was followed.

Statement of Informed Consent

Patients have a right to privacy that should not be infringed without informed consent. Identifying information, including patients names, initials, or hospital numbers, should not be published in written descriptions, photographs, and pedigrees unless the information is essential for scientific purposes and the patient (or parent or guardian) gives written informed consent for publication. Informed consent for this purpose requires that a patient who is identifiable be shown the manuscript to be published. Authors should identify Individuals who provide writing assistance and disclose the funding source for this assistance.

Identifying details should be omitted if they are not essential. Complete anonymity is difficult to achieve, however, and informed consent should be obtained if there is any

doubt. For example, masking the eye region in photographs of patients is inadequate protection of anonymity. If identifying characteristics are altered to protect anonymity, such as in genetic pedigrees, authors should provide assurance that alterations do not distort scientific meaning and editors should so note.

Submission: The manuscript should be submitted preferably by our online manuscript submission centre in the following URL: http://www.ratingacademy.com.tr/jsp/ or as e-mail attachment to the Editorial Office via: info@ratinacademy.com.tr. All contacts shall be by e-mail. All the corresponding authors should have an e-mail id. All submissions will be acknowledged within a short time.

Brief checklist for submission.

1. Have you provided a Cover Letter?
2. Have you provided the informations of the correponding author and the other authors to the system?
3. Have you provided an Abstract of 300 words ?
4. Have you provided Keywords?
5. Are your Tables denoted by Arabic numerals, and are they in order as cited in the text?
6. Are your Figures denoted by Arabic numerals, and are they in order as cited in the text?
7. Are your References cited in the required format of the Journal?
8. Is institutional approval number provided for the mammalian animal used for the experiment?
9. Have you obtained permission and submitted documentation for all Personal Communications cited?

Technical Notes: Technical notes are shorter than research articles and may be used to describe a new methodology or to present results from new techniques or equipment. A technical note should not exceed 20 pages with no more than 5 figures and tables. These rules are valid for debates and case presentations.

Proofs and Reprints: Electronic proofs will be sent (e-mail attachment) to the corresponding author as a PDF file. Corrections should be restricted to typesetting errors. Authors are advised to check their proofs very carefully before return, since inclusion of late corrections cannot be acceptable Corrected proofs are to be returned to the publishers.

Page proofs are considered to be the final version of the manuscript. The Editorial Board reserves the right to make changes like typographical or minor clerical errors if necessary in the research articles. No changes will be made in the manuscript at the proof stage.

Authors will have free electronic access to the full text (PDF) of the article. Authors can freely download the PDF file from which they can print unlimited copies of their articles.

The Editorial Board reserves the right to make changes if necessary mainly to improve the quality of the paper.

JOURNAL OF SCIENTIFIC PERSPECTIVES JSP

The responsibility of the contents rests upon the authors and not upon the publisher.

Authors are requested to prepare the manuscript according to our journal "Instructions for authors" guidelines.

Subscription Rates and Terms: Those who are interested to obtain the electronic copy of the JSP, he/she can download it free of charge.

ABSTRACTING & INDEXING

ProQuest

Google Scholar

Base

 Academic Resource Index: ResearchBib

 Academic Keys

 PKP Index

DIIF

SCIWIN (Scientific World Index)

 INTERNATIONAL INSTITUTE OF ORGANIZED
RESEARCH (I2OR)

Cosmos Impact Factor

ISRA:Journal-Impact-Factor (JIF)

JOURNAL OF SCIENTIFIC PERSPECTIVES JSP

International Servıces For Impact Factor And Indexıng (ISIFI)
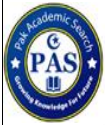
PAK Academic Search (Pending)

CrossRef

DOI

Scientific Indexing Services

Scilit

 OALib

OCLC WorldCat

Turkish JournalPark

Scipio

 Scopemed

Journal Index

AcademicKeys

CONTENTS

Basic Sciences and Engineering

JOURNAL OF SCIENTIFIC PERSPECTIVES JSP

Health Sciences

Natural Sciences

ALGORITHM AND COMPLEX INFORMATION TECHNOLOGY FOR SOFTWARE PROJECTS RISKS EVALUATION

Vladlen SHAPO* & Valeriy VOLOVSHCHYKOV** &
Viktor GUZHVA*** & Oryna MISHCHENKO****

*National University "Odessa Maritime Academy", UKRAINE
E-mail: vladlen.shapo@gmail.com
ORCID ID: https://orcid.org/0000-0002-3921-4159

** National Technical University "Kharkiv Polytechnic Institute", UKRAINE
E-mail: valera@kpi.kharkov.ua
ORCID ID: https://orcid.org/0000-0003-4454-2314

*** National Technical University "Kharkiv Polytechnic Institute", UKRAINE
E-mail: guzhva.v.a@gmail.com
ORCID ID: https://orcid.org/0000-0001-6832-4480

**** National Technical University "Kharkiv Polytechnic Institute", UKRAINE
E-mail: arinochka012@gmail.com
ORCID ID: https://orcid.org/0000-0002-6783-673X

ABSTRACT

Problem of software projects risks evaluation is identified. Review of modern approaches to risks evaluation is carried out. Analysis of software projects risks evaluation methods is performed. Analysis of sensitivity, scenarios method, simulation modeling, expert assessment are reviewed. Conclusions on importance of risks evaluation for "Software as a Service" software application systems at design stage are performed. It's proposed to perform software projects risks evaluation with expert assessment using by realization of corresponding information technology.

Mathematically risks evaluation technology is realized by Delphi method and ranking. Term of confidence interval is used as stopover criterion in computational procedure of Delphi method with the goal of coherent expert opinion obtaining. Calculating procedure envisages initial expert data correction by expert opinions revision and correction of expert group personnel. Consistency of expert opinions in mathematical technology on ranking method is checking with using of Kendall concordance coefficient, and its significance is evaluating on the basis of Pearson criterion. Presented mathematical apparatus formalizes solution of risks evaluation problem.

Methods of software projects risks evaluation and theirs mathematical technologies requires a big amount of calculating operations. Information support increases the rate and precision of such

operations, ensures initial data and obtained results accumulation. Information support of software projects risks evaluation is realized as software application system. At development of software application system functional and nonfunctional requirements, database model and its structure were defined. Principles of object oriented analysis, data modeling, modern design patterns, CASE software tools were used.

It's proposed to realize software application system of information technology in accordance with client-server architecture, dedicated application server with distributed access rights with using of IDE NetBeans by PHP means under MySQL control. Conclusions on possibility of software application system using by performed validation and verification with expertise and PHP Unit using are made. Results of this work may be used for development of software projects risks evaluation information technology.

Keywords: *Risk evaluation, software project, expert assessment, Delphi method, ranking method, requirements, model, structure, software application system.*

1. INTRODUCTION

During performing of software projects (SP) at every stage [1] of software systems (SS) lifecycle (LC) it's possible to face to a greater or lesser extent with probable losses. For example, final SS quality decreasing, growing of costs at its developing, delay of finishing at developing, etc. Such losses occur as a consequence of risks, which arise in LC SS. That's why one of primary and inalienable problem, which has to be solved, is identification and evaluation of risks at SP realization.

Problem of software projects risks evaluation. At present time questions of risks evaluation are quite actual in different application fields. Without reference to any field of activity it's possible to claim on the base of analysis [2, 3, 4], that projects risks evaluation may be investigated with using of two approaches: qualitative and quantitative.

Main aspect of qualitative approach is in risks identification holding, risks evaluation and developing of actions on struggle with them. Quantitative analysis is based on toolkit of probability theory, mathematical statistics and theory of fuzzy set. Quantitative analysis in numeric dimension evaluates the influence of risky factors modifications to modification of project efficiency.

Significant growing of IT field, increasing of SP sizes, attitude to SP as to product with own specific technologic process leads to growing of SP risks evaluation problem. Accordingly to analysis [3, 4] it's possible to claim that SP risks may be categorized in multiple ways. One of possible alternatives: design risk, technical risk and business risk. This means that every group, which has own features, has to use own approaches for research [3, 4]. In turn this means that adaptation of existing approaches becomes important as from mathematical point of view as well as information point of view.

Therefore it's possible to claim, including relying to analysis [4, 5], that problem of SP risks evaluation is complex, multidimensional and needs to be solved.

Analysis of existing methods. As was mentioned above, methods of SP risks evaluation may be divided into quantitative and qualitative [6-8]. Quantitative methods are sensitivity analysis, method of scenarios and method Monte Carlo simulation [6, 7]. Generally believed that expert evaluation is qualitative method [8].

Sensitivity analysis is relatively simple method, which allows to clear up, which precisely factors it's possible to categorize to most risky. Most often this method apply for

clarification of the level of project realization conditions modification influence to values of any indicator. During this analysis will be determined the level of project persistence against influence of external or internal factors.

Scenario analysis is method of non-formalized description of project risk, which includes evaluation of sensitivity of most significant factor for such project before set of factors modification, and also evaluation of common factors action possibility. At scenario analysis using may be calculated expected indicator value, standard deviation and coefficient of variation. Coefficient of variation for specific project must be compared to coefficients of variation for analogue projects. If coefficient of variation is greater than coefficient of variation of analogue project, it mentions about significant risk.

The goal of simulation is in reconstruction of behavior of the researched system on the base of analysis results of most significant relationships between its elements or, in other words, in developing of researched subject field simulator for different experiments carrying out. Simulation on Monte Carlo method allows to create mathematical model for project with uncertain parameters values. In turn with knowing of probability distribution of project parameters and correlation between parameters to obtain distribution of project risks.

Methods of interviewing are necessary for qualitative probability evaluation and risks after-effects for entire SPs. Risks interviewing with project interested sides and experts may become the first step in the process of qualitative risks analysis. Necessary information depends on type of probabilities distribution, which will be used. Qualitative SP risks analysis includes ranks positioning for identified risks. For identification and analysis of risks in expert evaluation the most often used methods are brainstorming, Delphi, control lists and ranking. Analysis and evaluation of risks are carrying out with the goal of converting of data, obtained during identification, into information, which allows to make important decisions. Main result of qualitative analysis process is the list of ranking risks with calculated evaluations.

Problem statement. Analysis of papers [1, 4, 5] shows, that qualitative SP risks evaluation is important stage in SS LC, in particular risks at design stage in such SS type as Software as a Service (SaaS). Accordingly, automation of solution of the task on qualitative risks evaluation in SP is actual. For solution of the task on SP risks evaluation the using of expert evaluation by Delphi and ranking methods is proposed in this paper. These methods increase the possibility of qualitative probable result obtaining, which is deprived of individual experts suggestions subjectivity. Procedures of these methods using take into consideration obtaining of results, which match to coordination of experts suggestions. Obtained results allow to rank risks and to display theirs indicators clearly.

Realization of SP risks evaluation procedure may allow to create effective procedures of risks control. Among other things, as a result, to avoid these risks or decrease them. Accordingly, problem of the SP risks evaluation remains quite actual. In conditions of permanent increasing of SP complexity and volumes the developing of corresponding information technologies becomes also important.

Thus, the purpose of this paper is developing of SP risks evaluation information technology.

2. MAIN TEXT

Technology of software projects risks evaluation. At risks evaluation of SaaS-type SPs in this paper following formalizations of Delphi method and ranking method are proposed.

Will assume, that K questions are highlighted, each of them is presented qualitatively in following form: $q_k,\ k = \overline{1, K}$. Let the group from N experts is created for obtaining of answers.

Each *i*-number expert forms self evaluation S_i and gives numeric evaluation q_k^i for q_k question, using the scale from 1 to 10. For the purpose of data analysis have to be calculated following indicators.

Group average evaluation:

$$\bar{s} = \frac{1}{N} \sum_{i=1}^{N} s_i;$$

(1)

simple evaluations:

$$a_k = \frac{1}{N} \sum_{i=1}^{N} q_k^i, k = \overline{1, K};$$

(2)

weighted average evaluations:

$$w_k = \frac{\sum_{i=1}^{N} s_i q_k^i}{\sum_{i=1}^{N} s_i}, k = \overline{1, K};$$

(3)

medians:

$$m_k = Me\left\lfloor q_k^i, i = \overline{1, N} \right\rfloor k = \overline{1, K};$$

(4)

confidence intervals $c_k = \left[\underline{c}_k, \bar{c}_k \right]$ on the base:

$$\underline{c}_k = q_k^{min} + \frac{q_k^{max} - q_k^{min}}{4}, k = \overline{1, K};$$

(5)

$$\bar{c}_k = q_k^{max} - \frac{q_k^{max} - q_k^{min}}{4}, k = \overline{1, K};$$

(6)

$$q_k^{min} = \min_{i=1,N} q_k^i, k = \overline{1, K};$$

(7)

$$q_k^{max} = \max_{i=1,N} q_k^i, k = \overline{1, K};$$

(8)

lengths of confidence intervals:

$$l_k = \overline{c}_k - \underline{c}_k, k = \overline{1, K}. \tag{9}$$

Obtained results have to be analyzed by experts and in the case of necessity must be corrected, while generalized suggestion using length of confidence interval criterion will be obtained.

In accordance with results, obtained by Delphi method, it's possible to reach conclusions about the threat of risks, formulated as K questions. For this a_k must be ranked. Value $\max\limits_{i=1,K} a_k$ is corresponding to the most dangerous risk, and so on. Respectively the reaction to such risks must be performed firstly. Other indicators are auxiliary and may be used in further development of risks control schedule.

Assuming that experts may perform risks ranking strictly by decreasing of importance and to assign to these risks the numbers from 1 to K, ranking method may be applied for SP risks evaluation. In this case the output information is R_{ik} – the rank, which must be assigned by number i expert accordingly to number k risk.

Generalizing R_{ik}, it's necessary to calculate ranks $\overline{R}_k = \sum\limits_{i=1}^{N} R_{ik}$, on the basis of which risks are ranked. Risks with the biggest rank is most dangerous.

At Rik analyzing it's recommended to define the coherence of experts suggestions. To realize this in this paper it's proposed to apply the Kendall concordance coefficient:

$$W = \frac{12 \sum\limits_{k=1}^{K} \left(\sum\limits_{i=1}^{N} R_{ik} - \frac{N(K+1)}{2} \right)^2}{N^2(K^2 - K)} \tag{10}$$

$\underline{5}$

With the purpose of concordance coefficient relevance verification it's proposed to use the Pearson criterion:

$$\chi^2 = N(K-1)W. \tag{11}$$

Information support of software projects risks evaluation. In contemporary conditions the solution of most tasks is impossible without using of modern information technologies, and the task of SP risks evaluation is not an exception. With the purpose of information technology SP risks evaluation software component realization the kit of functional and non-functional requirements was formed, corresponding database (DB) and system components representation model were designed.

Functional requirements are shown at Figure 1 as Unified Modeling Language (UML) precedents diagram.

Figure 1 – Precedents diagram
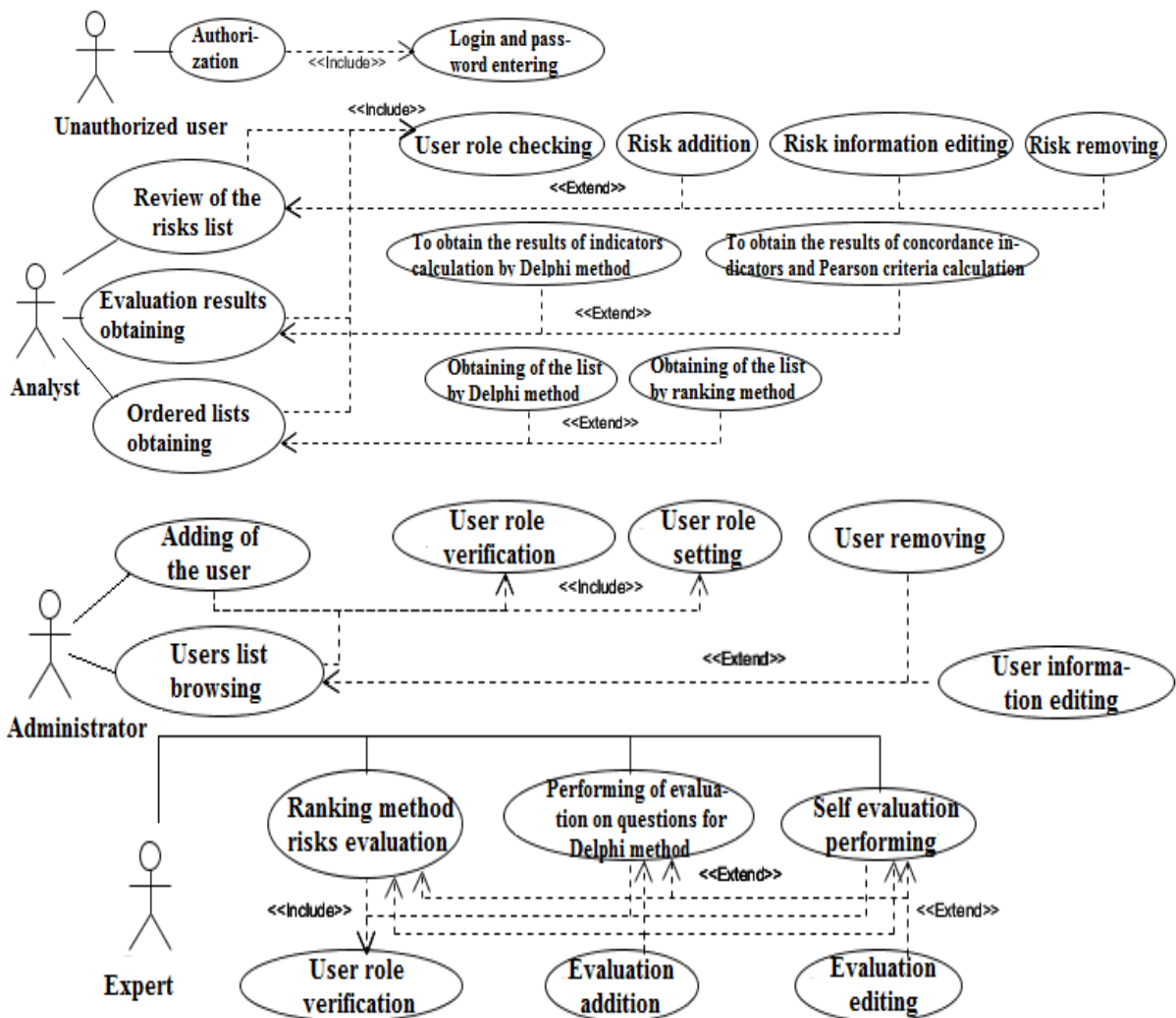
To key non-functional requirements should be included the following: user's interface must be minimized and intuitively comprehensible, software system must be convenient at using and to realize declared functionality.

Facilitation of information storing and processing is provided by DB means. In this work DB project is realized by ERWin CASE system means in the form of model, presented at Figure 2. Proposed structure provides the storing of output information (Risk), research results (QuestionsMarks, Delfi_Lap, Results_MethodDelfi, RangingConsensus, Rang_Lap, RangingConsensus, Rangs) and users' personal data (User, Expert, Analyst).

Figure 2 – DB logical model
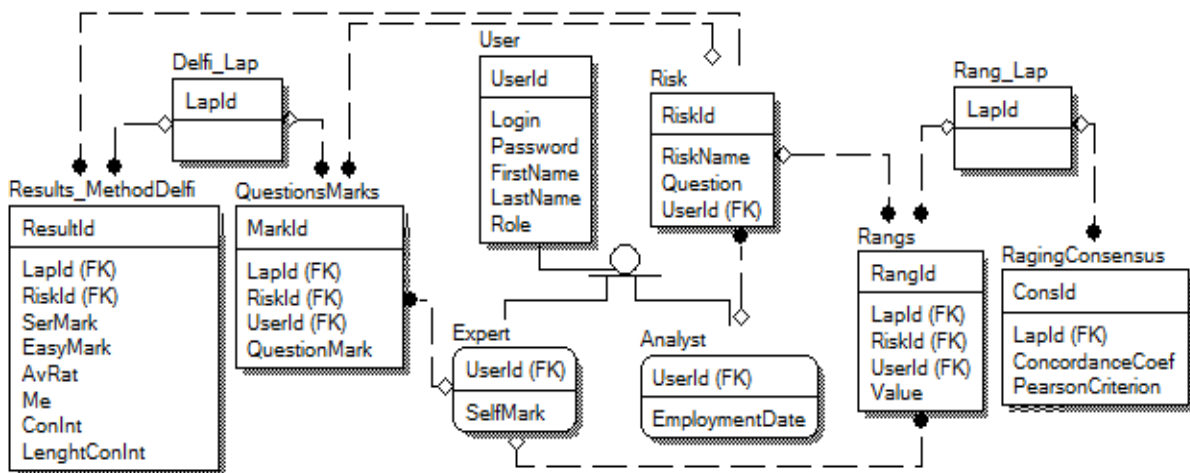
Components diagram, presented at Figure 3, illustrates physical presentations of system's components at the base of MVC pattern.

Figure 3 – Components' diagram

7
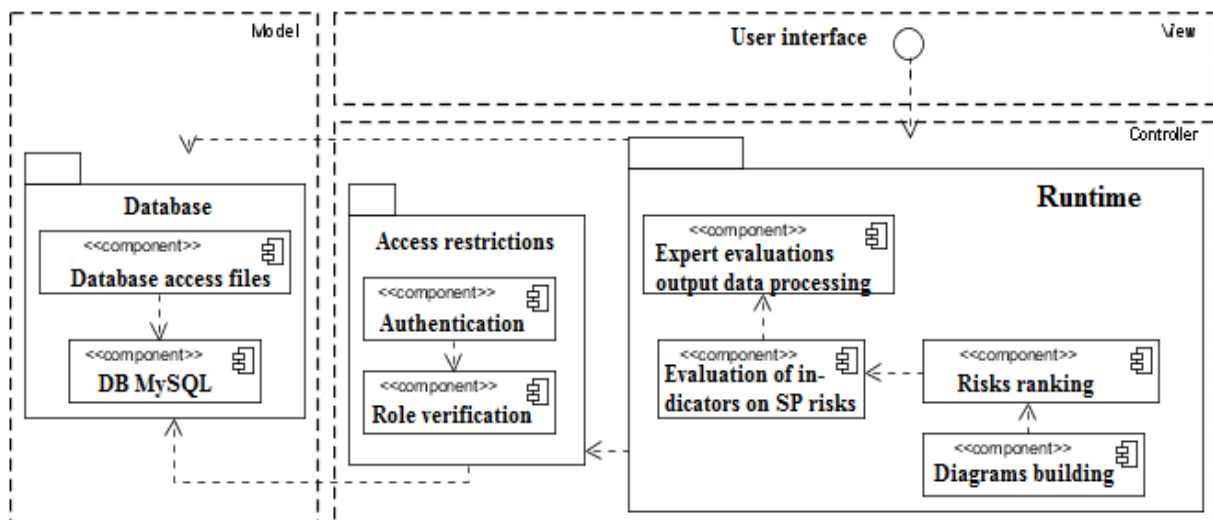
At Controller node the components for expert evaluations, calculation of indicators, risks ranking processing and building the diagrams at their base are deployed. This node also provides authentication and user role checking.

Information visualization forms are presented in user interface at View node.

Model node realizes software components on DB accessing.

Software system is realized in integrated development environment NetBeans by PHP language means and is functioning under control of MySQL DB control system. Software system validation is realized with expertise implementation. Verification is realized by means of module testing with PHPUnit using.

Algorithm, which describes roles, activities and sequence of actions for all participants of SPs evaluation process, is presented at figure 4.

Figure 4 – Roles, activities and sequence of SPs evaluation process participants actions
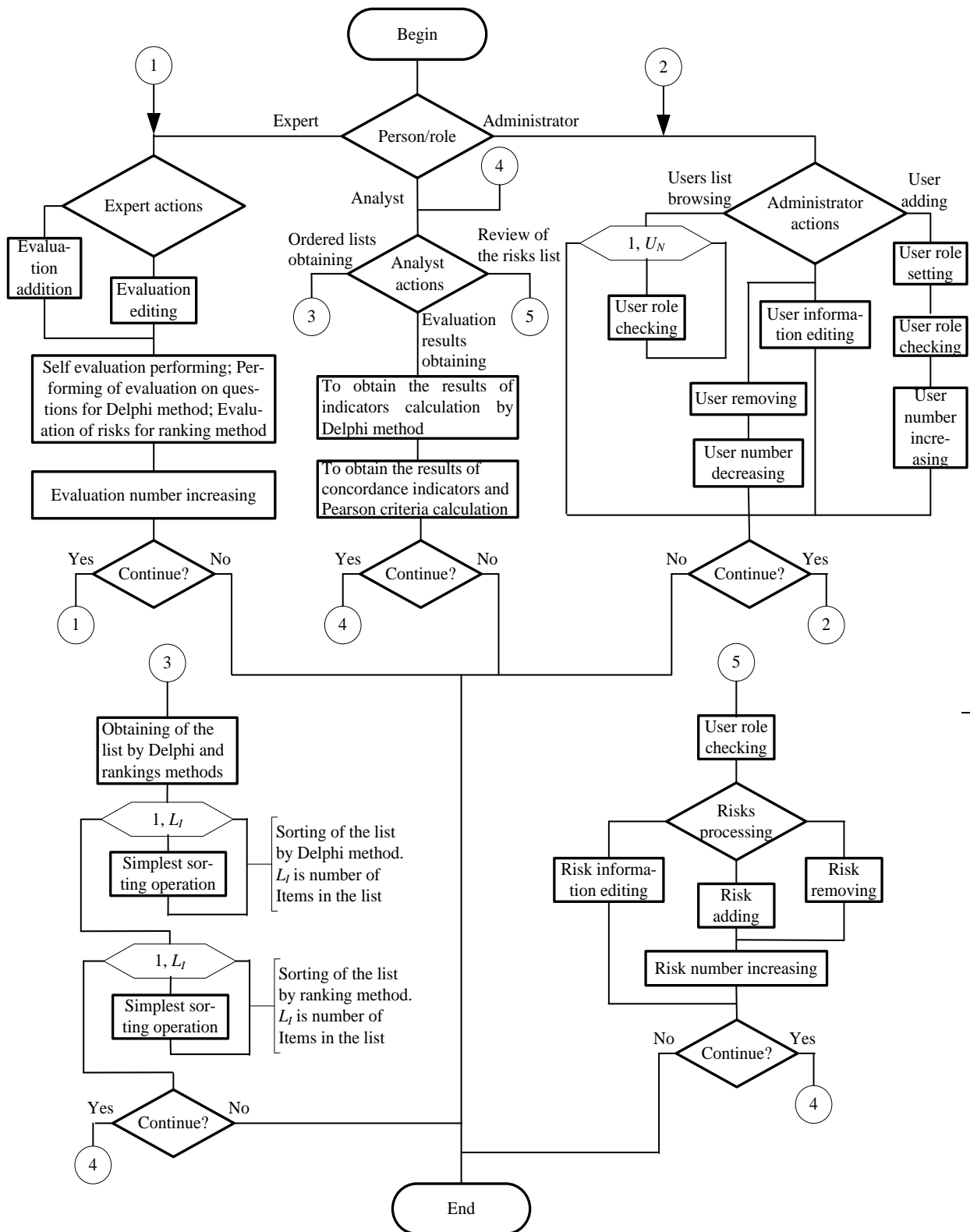
Form of expert survey is presented at Figure 5.

Figure 5 – Expert survey form

Expert panel / Risks evaluation (Delphi method)

Please, evaluate proposed risks in the range from 1 to 10, where 1 is the least dangerous risk, 10 is the most dangerous risk:

Question ID	Question										
1	What is the risk of project detailing insufficient level ?	◉	○	○	○	○	○	○	○	○	○
		1	2	3	4	5	6	7	8	9	10
2	How strong the risk of software project failure in the absence of sufficient number of interested investors and stockholders?	◉	○	○	○	○	○	○	○	○	○
		1	2	3	4	5	6	7	8	9	10
3	What is the risk of incomplete list preparation of possible project development alternatives?	◉	○	○	○	○	○	○	○	○	○
		1	2	3	4	5	6	7	8	9	10

3. CONCLUSION

Proposed formulas (1) – (11) describe mathematical model of risks evaluation process and its components. Created UML diagram and algorithm allow to automate processes of complex software projects evaluation from conceptual and practical points of view at design, database development and coding stages. This paper is logical follow-up to paper [12]. Complex technology of software projects risks evaluation is proposed in this paper. Software system is realized on the base of MVC pattern, described at the line of diagrams, complies to "client-server" architecture with dedicated application server and allows to automate the process of software projects risks evaluation. Proposed information technology allows to make rational decisions on the basis of expert data. Further elaboration will be guided to the direction of software projects risks control models developing and corresponding information support.

REFERENCES

1. Elkina O. S. Ekonomika proyektnogo upravleniya: riski na raznykh stadíyakh zhiznennogo tsikla proyekta. Chast'1 [Economics of project management: risks at different stages of the project life cycle. Part 1]. *Sibirskiy torgovo-ekonomicheskiy zhurnal* [Siberian Trade and Economic Journal]. Omsk, Omsk Institute (branch) RGTEU, 2015. № 2 (20), pp. 12-15.

2. Shkurko V.E. *Upravleniye riskami proyektov* [Project risk management]. Ekaterinburg, Publishing house Ural. University, 2014. – 184 p.

3. Knight, F. Kh. *Risk, neopredelennost' i pribyl'* [Risk, uncertainty and profit]. Moscow, Delo, 2003. – 360 p.

4. Smirnov A. A, Kovalenko A. V, Yakimenko N. N., Dorensky A. P. Problemy analiza i otsenki riskov informatsionnoy deyatel'nosti [Problems of analysis and evaluation of information activity risks]. *Sistemi obrobki ínformatsíí* [Systems of information processing]. Kharkov, Ivan Kozhedub Kharkiv University of Air Forces, 2016. – Vip. 3 (140), pp. 40-42.

5. Kolodenkova A. E. Otsenka riskov sozdaniya programmnogo obespecheniya informatsionno-upravlyayushchikh sistem dlya vysokoriskovykh promyshlennykh predpriyatiy v usloviyakh interval'noy neopredelennosti iskhodnykh dannykh [Risk assessment of creating information management systems for high-risk industrial enterprises in the context of interval uncertainty of input data]. *Vestnik Ufimskogo gosudarstvennogo aviatsionnogo tekhnicheskogo universiteta* [Bulletin of Ufa State Aviation Technical University]. – Ufa, USATU, 2015. V.19, № 1 (67), pp. 192–199.

6. Project Management Institute. *A Guide to The Project ManagementBody of Knowledge (PMBOK)*, 2001. – 211 p.

7. Lipaev V. V. *Analiz i sokrashcheniye riskov proyektov slozhnykh programmnykh sredstv* [Analysis and risk reduction of complex software projects]. – Moscow, SINTEG, 2005. – 224 p.

8. Slobodsky A. L. *Risks in personnel management* [Risks in personnel management]. – St. Petersburg, SPSUEF, 2011. – 155 p.

9. Fatrell R. T., Schafer D. F., Schafer L. I. *Upravleniye programmnymi proyektami. Prakticheskoye rukovodstvo po razrabotke uspeshnogo programmnogo obespecheniya* [Software Project Management: Achieving Optimal Quality with Minimal Cost]. – Moscow, Williams, 2003. – 1136 p.

10. Kantor M. *Upravleniye programmnymi proyektami. Prakticheskoye rukovodstvo po razrabotke uspeshnogo programmnogo obespecheniya* [Management of software projects. A practical guide to developing successful software]. – Moscow, Williams, 2002. – 176 p.

11. Bragina T. I., Tabunshchik G. V. Analiz podkhodov k upravleniyu riskami v programmnykh proyektakh s iterativnym zhiznennym tsiklom [Analysis of risk management approaches in software projects with an iterative life cycle]. *Radíoyelektroníka, ínformatika, upravlínnya* [Radio electronics, informatics, management]. – Zaporizhzhya, ZNTU, 2011. № 2. pp. 120–124.

12. Mishchenko O. O, Volovshchikov V. Y., Shapo V.F. Modeli otsinky ryzykiv prohramnykh proektiv [Models of risk assessment of software projects]. *XXVI Mizhnarodna naukovo-praktychna konferentsiya MicroCAD-2018* [XXVI International Scientific and Practical Conference MicroCAD-2018]. – Kharkiv, NTU "KhPI", May 2018. – P. 25.

BORON COMPOUNDS WITH MAGNETIC PROPERTIES AND THEIR APPLICATION AREAS IN INDUSTRY

Engin MEYDAN*

* Canakkale Onsekiz Mart University, Ezine Vocational School, Department of Food Processing, TURKEY, E-mail: enginmeydan@comu.edu.tr
ORCID ID: https://orcid.org/0000-0002-1860-1715

ABSTRACT

The importance of boron compounds with magnetic properties provide great convenience increasing day by day. In this study, boron compounds with magnetic properties and their application areas were investigated. In the study, firstly the boron element is given, then the usage of boron elements, the importance of boron compounds with magnetic properties and the methods of obtaining boron compounds with magnetic properties are mentioned. Finally, it was given information about catalytic applications of boron compounds and the study was completed by mentioning the contributions from agriculture to industry, medicine and food. In this study, document analysis method and content analysis were used.

Keywords: *Boron, magnetism, nanoparticle, catalytic activity*

1. INTRODUCTION

In this study, the structure, physical and chemical properties of boron elements, various boron minerals, the places where these minerals are located in nature and which sectors are used will be given. In the following stages, boron doped nanostructures will be explained and the studies about boron doped magnetic nanoparticles will be examined. When the literature is examined, there are many studies and compilation of boron atoms. However, the contribution of boron minerals has not been observed in recent technological developments. With this study, information is given about the purpose and how to use boron compounds in new generation technologies.

1.1. Boron

Boron; from glass industry to ceramics industry, from cleaning products to late burning agents, from agriculture to metallurgy, nuclear applications, where it is used is an important element and it's using increases everyday. In the known elements, the boron, which is considered to be the hardest element after diamond, has several amorphous and six polymorphic

allotropes (Werheit et al., 2010). The structural and chemical proporties of boron (Tombal et al., 2016) and physical proporties (Bilgiç and Günık, 2013) are examined in the below tables.

Table 1.1. Boron atom structure

Atomic diameter	1.17 Å
Atomic volume	4.63cm^3/mol
Electron array	1s^{2}2s^{2}2p^1
Valence electrons	2s^{2}p^1
Electron number (no load)	5
Ion diameter	0,23 Å
Proton units	5
Number of neutrons	6
Crystalline	Rhombohedral

Table 1.2. Boron chemical proporties

Electronegativity (Pauling)	2,04		
Electrochemical equation	0,1344 g/amp-sa		
Potential energy of valence electrons (-eV)	190		
Ionization potential (eV)	1. İonization value 8,298	2. ionization value 25,154	3. ionization value 37,93
Fusion heat value	50,02 kj/mol		

Table 1. 3. Boron physical proporties

Atomic Mass	10,811
Appearance	Yellow-brown ametalic and crystal
Conductivity	Electrical: 1.0 E - 12 106 / cm
Thermal Expansion coefficient	0.0000083 cm / ºC (0ºC)
Density	2,34 g/cc - 300K
Hardness	Mohs: 9,3 (Vickers: 49000M.N.m^{-2})
Flexibility status	Bulk: 320/GPa
Enthalpy	573,2 kj/mol (25ºC)
Enthalpy (Fusion)	22,18 kj/mol
Enthalpy (Evaporation)	480 kj/mol
Heat (Evaporation)	489,7 kj/mol
Pressure value (Steam)	0,348Pa – 2300 ºC
Melting point	2573K - 2300ºC – 4172 ºF
Specific heat value	1,02 J/g.K
Boiling point	4275K - 4002ºC – 7236 ºF
Molar volume	4,68 cm^3/mol
Physical form	20ºC ve 1atm: Solid state

Compared to other elements in nature, boron is the 51st element in the world. There are about 230 minerals in the boron, and can not be found in the free state on the earth. Turkey and the United States are removed most reserves of mineral resources, but the world is limited. While the amorphous boron can react immediately with any substance, its tendency to react decreases as its crystallinity increases, and completely crystalline boron does not react with anything. It reacts with water at high temperatures and forms boric acid (Demir, 2006).

1.2. Usage Areas of Boron Element

Boron element used in many areas of industry; insulation, ceramics and their derivatives, cleaning materials, fire extinguishers, agricultural areas, material engineering technologies, health, detergent, cosmetics, construction sector, especially in the construction of many sectors such as cement. It is used in many industrial sectors to get more energy and efficiency. It is thought to bring many innovations from the technological point of view (Garrett, 1998).

For example, boron element is used to increase the hardness and durability of the steel. Up to 50 ppm of boron can be added to the structure of steel. This process is called boronizing. The surfaces of the steels produced by boronizing to convert steel more harder. In this way, some steel types used in heavy industries (such as large drills, hydraulic machines of construction machinery) become more durable (Şengönül et al., 2016).

Boron minerals are frequently used in the production of glass and its derivatives. The boron minerals are added to the prepared molten glass intermediate to increase the flowability of the material obtained and at the same time increase the surface resistance of the final product. Boron and its derivatives in glass industry are commonly used in glass fibers which are used as insulation intermediates. However, it is also used in sports equipments. In recent years, it has started to be used in aerodynamic industries such as planes, space ships, and all air platforms which based on aerodynamic properties (Yiğitbaşıoğlu, 2004).

Boron compounds can be used in aircraft as part of the fuel. The high flammability, though flammable, shows that it is advantageous for use in the transportation sector. Boron compounds can be also used in missile (rockets.. etc.) fuels because boron compounds give high performance to them (Çetin et al., 2003).

In nuclear reactors, many compounds are used such as boron carbide, boron-containing steels and titanium-boron alloys because of the neutron retention feature in the storage of waste (Karaçay et al., 2012).

Boron, which helps the balance of calcium, magnesium and phosphorus in metabolism, also increases the development and resistance of bones, muscles, allergic symptom treatments, psychiatric disorders. Boron compounds is used in the destruction of cancer cells and it is widely used in medicine (Proximity and Root, 2016).

Boron derivatives such as sodium perborate are widely used in the cleaning and hygiene industry. Boron and its derivatives which have many effects such as bleach, bactericidal and whitening, give effective results in cleaning stages thanks to the active oxygen which is found abundant in content. It also performs many processes such as softening, strengthening and extensively in cosmetic areas (Yenmez, 2009).

Boron derivatives such as colemanite, which are used in the development of the cement sector, provide many properties to cement structure such as water and gas permeability, durability. In addition, these compounds reduce by %25-30 the amount of CO_2 released into nature (Yenialaca, 2009).

In the glaze formation and generally in the ceramics industry, boron compounds are used between %8-24 in proportion to their weight. In this way, the mechanical resistance of the ceramics and also their thermal expansion increases. At the same time, infrastructure is formed in various coloring processes (Benedict, 1994).

Boron element, which has many effects on plant cell functions, undertakes various tasks in primarily cell division and photosynthesis processes. Because of the effects on sugar metabolism, it was determined that plants can not produce enough fruit or seed without boron. In many structures such as roots, flowers and buds, boron element is shown as one of the main production sources of plants (Ediz and Özdağ, 2001).

Boron compounds are used such as fire extinguishers or decelerators. In various polymers such as PVC, which we use in our daily lives, addition of boron compounds such as zinc borate to the structure as a additives, combustion retardant polymers are obtained. At the same time, the release of toxic gases to the nature can be prevented in the case of combustion (Aydın et al., 2016).

1.3. Importance of Boron Compounds with Magnetic Properties

In virtue of the boron and densely metal atoms in the transition metal borates, it is found suitable for use in new generation technologies and the studies are continuing in various fields. Through formed by using metal atoms in the magnetic field, the materials obtained can be collected or removed from the medium. Transition metal borates using in magnetic fields can be used in various reactions (Kronmüller, 2007).

When the transition metal borates are examined, the elements with the highest magnetic effect in the metals which are found as pure in nature are Fe, Co, Ni elements which are below the Curie temperature. These elements exhibit ferromagnetic properties, that is, they can have 1000 times more magnetic effects than a normal paramagnetic material. It has also been found that these compounds have these ferromagnetic properties in their compounds (Berg et al., 2001).

Boron containing compounds are used to direct magnetic interactions between the exchange mechanism and all metal ions. Therefore, magnetism has been used for a long time in various materials with boron content and metal added and it is aimed to produce promising technologies for the future (Spaldin, 2006).

Boron hydrides are substances which can be used as a very good hydrogen carrier and storage. Among the boron hydrides, sodium boron hydride compound is the most widely used industrial field. This compound is used in various sectors such as textile, paint, paper and agriculture for various purposes. The fact that the amount of hydrogen stored by boron derivatives is quite good, because it is compatible with nature shows the potential to be used as fuel in the future. Furthermore, there are many studies related to boron hydrides used in particularly the reduction of toxic waste and in the synthesis of magnetic metal nanoparticles. (Yılmaz and Şefik, 2017).

2. MATERİAL AND METHODS

Before this study, the use of boron, its derivatives, their effects in industrial areas, and the latest technological developments about using boron have been examined. As a result of the investigations, studies that are different from each other and open to innovation are examined and processed in this article. Boron and its derivatives, which have a very important place among the promising technologies, have been determined as a result of the studies. In this study, document analysis was carried out on qualitative research methods. "Document review, the investigation includes examination of written materials containing information about the

targeted case or cases" (Yıldırım and Şimşek, 2006). Although this approach is generally used in the field of social sciences, it is possible to use it in the state tray in the field of quantitative sciences in relation to the works to be carried out.

3.RESULTS

3.1. Usage of Boron-containing Magnetic Metal Nanoparticles

As industrialization increases and industrialization is carried out almost everywhere in every passing day, the chemicals that are mixed as waste into nature give great damages to the earth. Many natural catastrophes are realized due to the inability of inadequatly audits, the lack of adequate filtering, low recycling of industrial enterprises and the increasingly desensitization of societies. Due to the boron doped metal nanoparticles, some of these harmful compounds can be removed from the nature. In recent years, the catalytic effects of magnetic nanoparticles have been investigated by transformations in various organic compounds. Due to its stable and high surface area, it has taken its place in the scientific world as heterogeneous catalysts. Therefore, it has been determined that it has many advantages such as being cheap and having high surface area and also having the advantage of being more and more effective catalyzable and being recyclable by using magnetic effect. Studies have shown hopeful results (Ekomasov et al., 2015).

For example, gold, under normal conditions do not tend to react, but gold nanoparticles which are nanometric dimension showed various catalytic activities. They also exhibit various functional properties along with nanoparticle formation in other metals which are inert under normal conditions. The desired catalytic yield can also be increased by the materials used for the formation of nanoparticles. Highly effective nanocatalysts can also be synthesized by incorporation of compounds such as boron-containing sodium borohydride into the formation of nanoparticles (Buil et al., 2010).

Nanocatalysts are heterogeneous catalysts prepared as metal nanoparticles to accelerate catalytic processes. Boron and derivatives such as sodium boron hydride can be used in the synthesis. As they have high surface areas, they form more activated complex and their catalytic activity is higher than their equivalent catalysts. Metals can be recovered by various properties such as magnetic effect (Fukui et al., 2004).

The modified metal nanoparticles are more stable in the environment when compared to metal nanoparticles that do not contain any function. In nanoparticle synthesis, micelles can be formed using surface activating agents and nanoparticles can be synthesized. It is seen as a disadvantage that they are too close to be affected by van der Waals force. Because the active surface area is reduced as they are collected (Roucoux et al., 2002).al., 2002).

Methylen blue is used as a colorant in tissue analysis, in the leather industry, in the photocopy industry, in the photographic industry, in semiconductors, in the fluorescent light. Although there are many advantages, methylene blue has a high percentage of poison content. This compound contaminates the soil and water as a waste. At the same time, it is damaged in living creatures. It is possible to disintegrate and become harmless via boron compounds (Xia et al., 2011).

The nitro compounds, which are widely used in the industry, are polluted soil and water by factory wastes. No matter how little the content of nitro-based compounds are inhaled or in contact with the body, it may cause poisoning and death by affecting the components in the structure of the blood. For this reason, it is possible to remove these compounds polluting the nature or, if possible, to be reduced to the recyclable amine compounds which can be reused in the industry using a variety of catalysts. Many operations are carried out to remove this factory waste. There are many methods such as photocatalytic decay, ectrokoagulation, microwave

15

assisted catalytic oxidation, adsorption, electro-fenton method, elelectrochemical processes (Chuang and Chen, 2009).

Aromatic nitro compounds which damage the nature can be reduced to aromatic amine groups which can be used as intermediate raw materials in various industrial areas such as pharmaceuticals, cosmetics, drugs by reduction-oxidation method. At the same time, methylene blue can be disintegrated from the nature by this method. In this study, the removal of the substances which damage the nature by using the reduction-oxidation method of boron-containing metal nanoparticles were investigated. Microemulsion technique was used to obtain boron compounds with magnetic properties. The boron-containing magnetic metal nanoparticles synthesized by this technique and it have been used in the reduction of nitro compounds to amine compounds (Chuang and Chen, 2009).

3.2. Catalytic Studies of Boron-containing Magnetic Metal Nanoparticles

If Chuang and Chen's study is examined, chitosan is preferred to obtain nanoparticle because of its active surface area and most importantly it is one of the polymer derivatives in nature. The surface of chitosan, a natural polymer, was coated with oxidized compounds of iron, a magnetic element, to give magnetic properties to chitosan. Then it was modified by adsorption to this structure synthesized using Au nanoparticles. These prepared Au-based magnetic nanoparticles were studied as catalysts in catalytic experiments. The catalytic performance of the nitro compounds in the reduction reaction to the amine compounds was analyzed in the presence of $NaBH_4$. The reduction reaction was determined by using UV-Vis spectroscopy. When the obtained data were analyzed, it was determined that the reduction reaction took place in a shorter period compared to the equivalents in the literature (Chuang and Chen, 2009).

Boron doped nanoparticles formed with metal ions having different oxidation steps such as Co, Fe, Ni, Ru, Cu, Au, which are placed in the hydrogel can give a reduction reaction in the hydrogel. These hydrogel-supported metal nanoparticles can be effectively used for the reduction of toxic substances such as nitro compounds, dye-added compounds, chlorohydro carbons, pesticides. In this study, preparation of structures, their catalytic effects and the frequency of change in the amount of toxic substances were analyzed (Sahiner, 2013).

The hydrolysis of $NaBH_4$ using Co and Ni metal nanoparticles based on micro gels was investigated. As a result of the studies, boron-containing Co nanoparticles have been found to have an effective catalytic performance (Sahiner and Sağbaş, 2013).

It has been found that metal nanoparticles containing hydrogel-supported sodium boron hydride with magnetic properties can be used to remove pollutants and toxic metal ions. The studies carried out by Uv-Vis. device repetitively. Removed metal ratios were also calculated (Sahiner et al., 2009).

The catalytic effect of the nanoparticles synthesized using silver metal and boron-containing substances together with the $NaBH_4$ reductant was investigated. It is aimed to obtain the amine compounds which are used in the pharmaceutical and agricultural industries by reducing the nitrogenous substances which are thrown into the nature and toxic compounds. For this purpose, the reduction reactions of 4-Nitrophenol, 4-Nitroaniline and 2-Nitrophenol were analyzed. The catalytic effects in all reactions were determined under UV-Vis.spectroscopy. It has been found when Ag metal nanoparticles used as catalysts in the presence of $NaBH_4$, started the reduction of aromatic nitro compounds and converted nitro groups to amine groups (Pradhan et al., 2002).

Si / Pd nanoparticles were synthesized to used for methylene blue degradation reaction and silver nitrate solutions were used as support. This nanocatalyst, which is very fast and has

high catalytic activity, is disadvantageous due to the use of expensive metals. In this study, copper microspheres was used as a catalyst to decompose dyes such as synthesized, eozin y (EY) and methylene blue (MB). These micro-scale and metal-based substances give effective catalytic activity results in the degradation reactions of dyes. It has been determined that the catalytic activities of the same microspheres have continued as a result of repetitvely well. Since the Cu element is cheap and can be found abundantly and also has a high surface area, it is considered advantageous to use it as a catalyst (Xia et al.).

Metal-containing chronographs were synthesized. Catalytic effects of methylene blue degradation and reduction of nitro compounds were investigated. In this study, metal nanoparticles were synthesized with using $NaBH_4$ and Co, Fe, Ni, Cu metals. Then, methylene blue degradation, reduction of 4-Nitrophenol to 4-Aminophenol were investigated the presence of Uv-Vis. spectrophotometry. Compared to the literature is quite good activation energy, enthalpy and entropy values were determined (Sahiner et al., 2015).

In the doctoral thesis of Meydan (2018), Co nanoparticles which have many advantages such as high surface area, cheap metal preparation and magnetic properties were synthesized. Because of the factory wastes and agriculturel wastes, nitro compounds come to exist and pollute all the enviroment. It is necessary to destroy these nitro compounds which are very harmful before damaging the nature. These nanoparticles are intended to be used as catalysts in order to convert harmful nitro compounds to amine groups that can be used as raw materials in the pharmaceutical industry. In addition to the conversion of aromatic nitro compounds to aromatic amine groups, the activation energy values required for the actual transformation are also important parameters. The studies have been compared with the reduction reactions of the nitrophenol compound by using different nanoparticles with different contents of different scientists. The table which is formed by finding the activation energies of the nanoparticles that other scientists have synthesized for the reduction reaction of nitro compounds is given below. As a result of the comparisons, it was determined that the activation energy value of Co nanoparticles obtained was lower than the activation energies obtained in other studies. The activation energy value found at 32.1 kj / mol was found to be quite low from the values in all other studies. Therefore, in order to realize a chemical reaction, the particles with the lowest energy value to be exceeded were determined as a result of the data compared to the studies examined with Co nanoparticles (Meydan, 2018).

Table 3.1. Comparison of activation parameters

Catalysts	Ea $(kJmol^{-1})$	ΔH $(kJmol^{-1})$	ΔS $(J\ mol^{-1}\ K^{-1})$	References
G4-(Cu_{16})	65,5	-	-	Nemanashi and et al. 2013
PS–PEGMA–Ag system	62,0	-	-	Lu and et al. 2006
Au nanocatalyst	51,2	-	-	Chuang and Chen 2009
Co-Ni-rGo composite	49,94	-	-	Prasad and et al. 2016
p(APTMACl)-Cu composite microgels	47,90	-	-	Rehman and et al. 2015
Co Nanoparticles	32,1	-	-	Meydan 2018

It is known that the nanoparticle with the lowest activation energy has the fastest catalytic effect. As a result of the investigations, it was found that the nanoparticle having the lowest activation energy was the metal nanoparticles synthesized by Meydan and the reduction of nitrophenol to the aminophenole was faster than the other nanoparticles.

4. DISCUSSION

In this study, boron and its derivatives, their industrial applications, boron compounds with magnetic properties are given. It has been seen that boron compounds which have magnetic properties through previous research have an important place in many industrial fields from agriculture to construction, from medicine to food. Thanks to its useful properties, it has been found that boron compounds which have magnetic properties provide advantages in many sectors within the usage areas and they are important for the future.

It has been determined that boron-containing nanoparticles with magnetic properties can destroy many nature-threatening compounds such as plants and agricultural wastes or convert them into other substances that can be used as intermediates. Promising results were found for the future. For this reason, studies on boron compounds with magnetic properties can be developed and also economic, healthly, environmentally, human life-facilitating products can be worked on and various projects can be designed to prevent the pollution of nature.

5. RECCOMMENDATION

In our country, the use of boron element, which is abundant as a raw material mine compared to other countries in the world, can not be processed enough. And it is also very important in terms of strategic aspect. For this reason, new technologies should be brought to our country for the use of boron. Activities, seminars and conferences related to boron and its derivatives should be increased. In our country, all our mines, such as boron found in abundance, should be explained to the generations to start with primary school. The main point is to process new technologies rather than using them as raw materials. The use of this precious mine is very important for the advancement of new generation technologies in our country. It can also make a significant contribution to our country's economy.

18

Recycling systems can be increased by using new generation catalytic systems and factory waste which is one of the biggest problems of today can be destroyed. Thanks to the new generation of catalytic systems and catalysts to be prepared through new generation technologies, harmful substances which poison nature and humanity can be transformed into useful products for humanity. Therefore, we need to know more about the importance of our values and work harder. In this way, a cleaner world can be left to future generations.

REFERENCES

Aydın Y. D., Gürü M., Ayar B., Çakanyıldırım Ç., 2016. Bor bileşiklerinin alev geciktirici ve yüksek sıcaklığa dayanıklı pigment olarak uygulanabilirliği, *Bor Dergisi*,Cilt 1, 1,33-39.

Benedict, T. L. 1994. A New Twist to Glass Fiber. 47. *Ceramic Ind.*, v. 143, pp. 60-61.

Berg K. C., Chapman K. J., 2001. Determination of the Magnetic Moments of Transition Metal Complexes Using Rare Earth Magnets, *Journal Chemical Education*, 78(5), 670.

Bilgiç M.,Dayık M., 2013. Borun Özellikleri ve Tekstil Endüstrisinde Kullanımıyla Sağladığı Avantajlar, *Tekstil Teknolojileri Elektronik Dergisi Cilt*: 7, No: 2, 27-37.

Buil M. L., Esteruelas M. A., Niembro S., Olivan M.,Orzechowski L., Pelayo C., Vallribera A., 2010. Dehalogenation and Hydrogenation of Aromatic Compounds Catalyzed by Nanoparticles Generated from Rhodium Bis (imino) pyridine Complexes, *Organo metallics*, 29 (19), 4375–4383.

Chuang Y. C., Chen D. H., 2009. Catalytic Reduction of 4-nitrophenol by Magnetically Recoverable Au Nanocatalyst, *Journal of Hazardous Materials*, 165, 1-3, 664-669.

Çetin İ., A., Ordu İ., Kolip A., 2003. Yakıt Hücresi Teknolojisinde Bor Uygulamaları, *Sakarya University Journal of Science*, Cilt 7, 2, 257 – 264.

Demir C., 2006. *Bor Minerallerinin Enerji Kaynağı Olarak Değerlendirilmesi*, Selçuk Üniversitesi Kimya Mühendisliği Bölümü Yüksek Lisans Tezi, Konya, Türkiye.

Ediz N., Özdağ H., 2001. Bor Mineralleri ve Ekonomisi, *Dumlupınar Üniversitesi Fen Bilimleri Enstitüsü Dergisi*, 2, 133-151.

Ekomasov E. G., Murtazin R. R., Nazarov V. N., 2015. Excitation of magnetic in homogeneities in three-layer ferro magnetic structure with different parameters of the magnetican isotropy and exchange, *Journal of Magnetism and Magnetic Materials*, 385, 217–221.

Fukuia T., Murataa K., Oharab S., Abec H., Naitoc M., Nogic K., 2004. Morphology Control of Ni–YSZ cermetanode for lower temperature operation of SOFCs, *Journal of Power Sources,* 125, 17-21.

Garrett D., 1998. Borates: Handbook of Deposits, Processing, Properties and Use, *San Diego, Academic Press*, 11-14, USA.

Kronmüller H., Parkin S., 2007. vol. 5: Spintronics and Magnetoelectronics, John Wiley and Sons Ltd., USA.

Karaçay E., Alp E., Cabbar H. C., 2012. Sol-Jel Yöntemiyle Bor Karbür Üretimi ve Karakterizasyonu, *Gazi Üniversitesi Mühendislik-Mimarlık Fakültesi Dergisi*, Cilt 27, 2, 417-428.

Lu Y., Mei Y., Walker R., Ballauff M., Drechsler M., 2006. 'Nano-tree'- typesphericalpolymerbrushparticles as templatesformetallicnanoparticles, Polymer, 47, 4985–4995.

Nemanashi M., Meijboom R., 2013. Synthesis and characterization of Cu, Ag and Audendrimer-encapsulated nanoparticles and their application in ther eduction of 4-nitrophenol to 4-aminophenol*, Journal of Colloid and Interface Science*, 389, 260-267

Meydan, E., 2018. Manyetik Özelliğe Sahip Bor Bileşikleri ve Bunların Katalitik Uygulamaları. Çanakkale Onsekiz Mart Üniversitesi Fen Bilimleri Enstitüsü Yayınlanmamış Doktora tezi, 90 s. Çanakkale.

Pradhan N., Pal A., Pal T., 2002. Silver nanoparticlecatalyzed reduction of aromatic nitro compounds, *Colloidsand Surfaces A: Physicochemical and Engineering Aspects*, 196, 2-3, 247-257.

19

Prasad R., Lolakshi M.K., Bhat B. R., 2016. rGOsupported Co-Nibimetallic magnetically separable nanocatalysts for the reduction of 4-Nitrophenol, *Synthetic Metals* 219, 26-32.

Rehman S., Siddiq M., Al-Lohedan H., Sahiner N., 2015. Cationicmicrogelsembedding metal nanoparticles in thereduction of dyesandnitro-phenols, *Chemical Engineering Journal*, 265, 201–209.

Roucoux A.,Schulz J., Patin H., 2002. Reduced Transition Metal Colloids: A Novel Family of Reusable Catalysts?, *Chemical Reviews*, 102 (10), 3757–3778.

Sahiner N., 2013. Soft and flexible hydrogel templates of different sizes and various functionalities for metal nanoparticle preparation and their use in catalysis, *Progress in Polymer Science*, 38, 9, 1329-1356.

Sahiner N., Sagbas S., 2013. Tunablepoly (2-acrylamido-2-methyl-1-propan sulfonicacid) based microgels with beter catalytic performances for Co and Ni nanoparticle preparation and their use in hydrogen generation from NaBH$_4$, *International Journal of Hydrogen Energy*, 37, 18944-18951.

Sahiner N.,Yildiz S., Al-Lohedan H., 2015. There source fulness of p(4-VP) cryogels as template for in situnanoparticle preparation of various metal sand their use in H$_2$ production, nitrocompound reduction and dyedegradation, *Applied Catalysis B: Environmental*, 166–167, 145–154.

Spaldin, N. A., 2006. Magneticmaterials: Fundamentals and device applications (Repr. ed.). *Cambridge: Cambridge Univ. Press*, pp. 89–106.

Şengönül M., Durgun İ., Dökmetaş N., Kalkan H., Kaftanoğlu B., 2016. Bor Nitrür Kaplamanın, Kaynak Çapaklarının Metal Aparat Yüzeylerine Yapışma Davranışlarına Etkisi, *Makine Tasarım ve İmalat Dergisi*, Cilt 14, 1, 23-30.

Tombal D., T., Özkan G., Ş., Ünver İ., K., Osmanlıoğlu A., E., 2016. Bor bileşiklerinin özellikleri, üretimi, kullanımı ve nükleer reaktör teknolojisinde önemi, *Bor Dergisi*, 2, 85-96.

Werheit H., Filipov V., Kuhlmann U., Schwarz U., Armbrüster M., Leithe-Jasper A., Tanaka T., Higashi I., Lundström T., Gurin V.N., 2010. Raman effect in icosahedralboron-richsolids, *Science and Technology of Advanced Materials*, 11, 2, 1-27.

Xia L., Zhao H., Liu G., Hu X., Liu Y., Li J., Yang D., Wang X., 2011. Degradation of dyesusinghollow copper microspheres as catalyst, *Colloids and Surfaces A: Physico chemical and Engineering Aspects*, 384, 358– 362.

Yakıncı D. Z., Kök M., 2016. Borun Sağlık Alanında Kullanımı, *İnönü Üniversitesi Sağlık Hizmetleri Meslek Yüksek Okulu Dergisi*, Cilt 4, 1, 36-44.

Yenialaca Ç., 2009. *Bor ve Kullanım Alanları*, (Y. Lisans tezi) Gazi Üniversitesi, Gazi Eğitim Fakültesi, Fizik Eğitimi Bilim Dalı, Ankara.

Yenmez N., 2009. İstanbul Üniversitesi Edebiyat Fakültesi Coğrafya Bölümü Coğrafya Dergisi Stratejik Bor Maden Olarak Bor Minerallerin Türkiye İçin Önemi 19, 59-94.

Yıldırım, A., Şimşek, H. (2006). *Sosyal Bilimlerde Nitel Araştırma Yöntemleri*. Ankara: Seçkin Yayıncılık.

Yılmaz A., Şefik S., 2017. Sodyum Borhidrür (NaBH$_4$) Destekli Bir Hidrojen/Hava PEM Yakıt Hücresi İle Elektrik Üretiminin Deneysel Analizi, *Batman Üniversitesi Yaşam Bilimleri Dergisi* 7, 216-227.

Yiğitbaşıoğlu H., 2004. Türkiye İçin Önemli Bir Maden: Bor Ankara Üniversitesi, *Coğrafi Bilimler Dergisi*, Cilt 2, 2, 13-25.

SOME HIGHER ORDER DIFFERENCE DOUBLE SEQUENCE SPACES DEFINED BY AN ORLICZ FUNCTION

Bipul SARMA *

MC College (Gauhati University), Barpeta, Assam, INDIA, E-mail: drbsar@yahoo.co.in
ORCID ID: https://orcid.org/0000-0003-4446-6710

ABSTRACT

In this article we introduce some kth order difference operator on some double sequences operated by an Orlicz function. We introduce some sequence spaces and study different properties of these spaces like completeness, solidity, symmetricity etc. We establish some inclusion results among them.

Keywords: Orlicz function, difference space, completeness, solid space, symmetric space etc..

2010 AMS Subject Classification: 40A05; 40B05; 46E30

1. INTRODUCTION

Throughout, a double sequence is denoted by $A = <a_{ij}>$. A double sequence is a double infinite array of elements $a_{ij} \in R$ for all $i, j \in N$ and $_2w$ will denote the class of all double sequences.

The initial works on double sequences is found in Bromwich [2]. Later on it was studied by Hardy [6], Moricz [12], Moricz and Rhoades [13], Tripathy [16], Tripathy and Sarma [17], Tripathy, Choudhury and Sarma [18], Basarir and Sonalcan [1] and many others. Hardy [6] introduced the notion of regular convergence for double sequences.

The concept of paranormed sequences was studied by Nakano [14] and Simmons [15] at the initial stage. Later on it was studied by many others.

The notion of difference sequence spaces (for single sequences) was introduced by Kizmaz [8] as follows:

$$Z(\Delta) = \{ (x_k) \in w : (\Delta x_k) \in Z \}$$

for $Z = c, c_0$ and 1_∞, where $\Delta x_k = x_k - x_{k+1}$ for all $k \in N.$

The above spaces are Banach spaces, normed by

$$\| (x_k) \| = | x_1 | + \sup_{k \geq 1} | \Delta x_k |$$

The notion was further investigated by many workers on sequence spaces.

2. DEFINITIONS AND PRELIMINARIES

An *Orlicz function M* is a mapping $M : [0, \infty) \to [0, \infty)$ such that it is *continuous*, *non-decreasing* and *convex* with $M(0) = 0$, $M(x) > 0$, for $x > 0$ and $M(x) \to \infty$, as $x \to \infty$.

Lindenstrauss and Tzafriri [10] used the idea of Orlicz function to construct the sequence space

$$1^M = \left\{ (x_k) : \sum_{k=1}^{\infty} M\left(\frac{| x_k |}{\rho} \right), \quad \text{for some} \quad \rho > 0 \right\},$$

which is a Banach space normed by

$$\|(x_k)\| = \inf \left\{ \rho > 0 : \sum_{k=1}^{\infty} M\left(\frac{| x_k |}{\rho} \right) \leq 1 \right\}.$$

The space λ^M is closely related to the space λ^p, which is an Orlicz sequence space with $M(x) = |x|^p$, for $1 \leq p < \infty$.

An Orlicz function M is said to satisfy the Δ_2 -condition for all values of u, if there exists a constant $K > 0$, such that $M(2u) \leq K(Mu)$, $u \geq 0$.

Remark 1. Let $0 < \lambda < 1$, then $M(\lambda x) \leq \lambda M(x)$, for all $x \geq 0$.

Let $p = (p_k)$ be a positive sequence of real numbers. If $0 < p_k \leq \sup p_k = H$ and $D = \max (1, 2^{H-1})$, then for a_k, $b_k \in C$ for all $k \in N$, we have

$$| a_k + b_k |^{p_k} \leq D \left\{ | a_k |^{p_k} + | b_k |^{p_k} \right\}.$$

Definition 2.1. A double sequence space E is said to be *solid* if $<\alpha_{ij} a_{ij}> \in E$ whenever $<a_{ij}> \in E$ for all double sequences $<\alpha_{ij}>$ of scalars with $|\alpha_{ij}| \leq 1$ for all $i, j \in N$.

Definition 2.2. Let $K = \{(n_i, k_i) : i \in N ; n_1 < n_2 < n_3 < \dots . \text{ and } k_1 < k_2 < k_3 < \dots . \}$

$\subseteq N \times N$ and E be a double sequence space. A *K-step space* of E is a sequence space $\lambda_K^E = \{< a_{n_i k_i} > \in {}_2 w :< a_{nk} > \in E\}$.

A *canonical pre-image* of a sequence $< a_{n_i k_i} > \in E$ is a sequence $<b_{nk}> \in E$ defined as follows:

$$b_{nk} = \begin{cases} a_{nk}, & \text{if} \quad (n,k) \in K, \\ 0, & \text{otherwise.} \end{cases}$$

A *canonical pre-image of a step space* λ_K^E is a set of canonical pre-images of all elements in λ_K^E.

Definition 2.3. A double sequence space E is said to be *monotone* if it contains the canonical pre-images of all its step spaces.

22

Remark 2. From the above notions, it follows that "If a sequence space E solid then E is monotone".

Definition 2.4. A double sequence space E is said to be *symmetric* if $<a_{ij}> \in E$ implies $<a_{\pi(i)\pi(j)}> \in E$, where π is the permutation of N.

Let M be an Orlicz function and $p = <p_{ij}>$ be a double sequence of strictly positive real numbers. We introduce the following sequence spaces.

$$_2W(M, \Delta^k, p) = \left\{ <a_{ij}> \in \,_2w : \lim_{m,n} \frac{1}{mn} \sum_{i=1}^{m} \sum_{j=1}^{n} \left(M\left(\frac{|\Delta^k a_{ij} - L|}{\rho} \right) \right)^{p_{ij}} = 0, \right.$$

$$\left. \text{for some } \rho > 0 \text{ and } L. \right\}$$

$$_2W_0(M, \Delta^k, p) = \left\{ <a_{ij}> \in \,_2w : \lim_{m,n} \frac{1}{mn} \sum_{i=1}^{m} \sum_{j=1}^{n} \left(M\left(\frac{|\Delta^k a_{ij}|}{\rho} \right) \right)^{p_{ij}} = 0, \text{ for some } \rho > 0. \right\}$$

$$_2W_\infty(M, \Delta^k, p) = \left\{ <a_{ij}> \in \,_2w : \sup_{m,n} \frac{1}{mn} \sum_{i=1}^{m} \sum_{j=1}^{n} \left(M\left(\frac{|\Delta^k a_{ij}|}{\rho} \right) \right)^{p_{ij}} < \infty, \text{ for some } \rho > 0. \right\}$$

3. RESULTS

Theorem 3.1. *The sequence spaces* $_2W(M,\Delta^k, p)$, $_2W_0(M,\Delta^k, p)$ *and* $_2W_\infty(M,\Delta^k, p)$ *are paranormed sequence spaces paranormed by*

$$g(<a_{ij}>) = \inf \left\{ \rho^{\frac{p_{ij}}{J}} > 0 : \sup_{i,j} \left(M\left(\frac{|\Delta^k a_{ij}|}{\rho} \right) \right) \leq 1 \right\},$$

where $J = \max(1, H)$.

Proof. Clearly $g(0) = 0$, $g(-<a_{ij}>) = g(<a_{ij}>)$. Let $<a_{ij}>, <b_{ij}> \in \,_2W_\infty(M, \Delta^k, p)$. Then there exists some $\rho_1, \rho_2 > 0$ such that

$$\sup_{i,j} \left(M\left(\frac{|\Delta^k a_{ij}|}{\rho_1} \right) \right) \leq 1$$

and

$$\sup_{i,j} \left(M\left(\frac{|\Delta^k b_{ij}|}{\rho_2} \right) \right) \leq 1.$$

Let $\rho = \rho_1 + \rho_2$. Then we have,

$$\sup_{m,n} \left(M\left(\frac{|\Delta^k a_{ij} + \Delta^k b_{ij}|}{\rho} \right) \right) \leq \frac{\rho_1}{\rho_1 + \rho_2} \sup_{i,j} \left(M\left(\frac{|\Delta^k a_{ij}|}{\rho_2} \right) \right) + \frac{\rho_2}{\rho_1 + \rho_2} \sup_{i,j} \left(M\left(\frac{|\Delta^k b_{ij}|}{\rho_2} \right) \right) \leq 1$$

Now

$$g(<a_{ij}>+<b_{ij}>) = \inf\left\{ (\rho_1+\rho_2)^{\frac{p_{ij}}{J}} > 0 : \sup_{i,j}\left(M\left(\frac{|\Delta^k a_{ij} + \Delta^k b_{ij}|}{\rho_1+\rho_2}\right)\right) \le 1\right\}$$

$$\le \inf\left\{ \rho_1^{\frac{p_{ij}}{J}} : \sup_{i,j}\left(M\left(\frac{|\Delta^k a_{ij}|}{\rho_1}\right)\right) \le 1\right\} + \inf\left\{ \rho_2^{\frac{p_{ij}}{J}} : \sup_{m,n}\left(M\left(\frac{|\Delta^k b_{ij}|}{\rho_2}\right)\right) \le 1\right\}$$

$$= g(<a_{ij}>) + g(<b_{ij}>)$$

Let $\eta \in C$, then the continuity of the product follows from the following equality.

$$g(\eta<a_{ij}>) = \inf\left\{ \rho^{\frac{p_{ij}}{J}} : \sup_{i,j}\left(M\left(\frac{|\Delta^k \eta a_{ij}|}{\rho}\right)\right) \le 1, \ \rho > 0\right\}$$

$$= \inf\left\{ (|\eta|r)^{\frac{p_{ij}}{J}} : \sup_{m,n}\left(M\left(\frac{|\Delta^k a_{ij}|}{r}\right)\right) \le 1, \ r > 0\right\},$$

where $\dfrac{1}{r} = \dfrac{|\eta|}{\rho}$.

Proposition 3.2. (*i*) $_2W(M, \Delta^k, p) \subset {}_2W_\infty(M, \Delta^k, p)$ (*ii*) $_2W_0(M, \Delta^k, p) \subset {}_2W_\infty(M, \Delta^k, p)$. *The inclusions are strict.*

Theorem 3.3. *If* $\sup\dfrac{p_{ij}}{p_{uv}} < \infty$ *for all* $i \ge u, j \ge v$, *then* $_2W(M, \Delta^{k-1}, p) \subset {}_2W_0(M, \Delta^k, p)$. *The inclusion is strict.*

Proof. Let $<a_{ij}> \in {}_2W(M, \Delta^{k-1}, p)$. Then

$$\lim_{m,n}\frac{1}{mn}\sum_{i=1}^{m}\sum_{j=1}^{n}\left(M\left(\frac{|\Delta^{k-1}a_{ij} - L|}{\rho}\right)\right)^{p_{ij}} = 0, \ \text{for some } \rho > 0 \ \text{and } L. \quad \dots (2)$$

Since $\sup\dfrac{p_{ij}}{p_{uv}} < \infty$ so there exists $K > 0$ such that $p_{ij} < K.p_{uv}$ for all $i \ge u, j \ge v$.

Thus from (2) we have, $\quad \lim_{m,n}\dfrac{1}{mn}\sum_{i=1}^{m}\sum_{j=1}^{n}\left(M\left(\frac{|\Delta^{k-1}a_{ij} - L|}{\rho}\right)\right)^{p_{i,j+1}} = 0,$

$$\lim_{m,n}\frac{1}{mn}\sum_{i=1}^{m}\sum_{j=1}^{n}\left(M\left(\frac{|\Delta^{k-1}a_{ij} - L|}{\rho}\right)\right)^{p_{i+1,j}} = 0 \ \text{and}$$

$$\lim_{m,n}\frac{1}{mn}\sum_{i=1}^{m}\sum_{j=1}^{n}\left(M\left(\frac{|\Delta^{k-1}a_{ij} - L|}{\rho}\right)\right)^{p_{i+1,j+1}} = 0.$$

Now for $|\Delta^k a_{ij}| = |\Delta^{k-1}(a_{ij} - a_{i,j+1} - a_{i+1,j} + a_{i+1,j+1})|$

$$= |\Delta^{k-1}a_{ij} - \Delta^{k-1}a_{i,j+1} - \Delta^{k-1}a_{i+1,j} + \Delta^{k-1}a_{i+1,j+1} + L - L + L - L|$$

we have,

$$\lim_{m,n} \frac{1}{mn} \sum_{i=1}^{m} \sum_{j=1}^{n} \left(M\left(\frac{|\Delta^k a_{ij}|}{\rho} \right) \right)^{p_{ij}}$$

$$\leq \lim_{m,n} \frac{1}{mn} \sum_{i=1}^{m} \sum_{j=1}^{n} \left(M\left(\frac{|\Delta^{k-1} a_{ij} - L|}{\rho} + \frac{|\Delta^{k-1} a_{i+1,j} - L|}{\rho} + \frac{|\Delta^{k-1} a_{i,j+1} - L|}{\rho} + \frac{|\Delta^{k-1} a_{i+1,j+1} - L|}{\rho} \right) \right)^{p_{ij}}$$

$$\leq D^2 . \lim_{m,n} \frac{1}{mn} \sum_{i=1}^{m} \sum_{j=1}^{n} \left\{ \left(M\left(\frac{|\Delta^{k-1} a_{ij} - L|}{\rho} \right) \right)^{p_{ij}} + \left(M\left(\frac{|\Delta^{k-1} a_{i+1,j} - L|}{\rho} \right) \right)^{p_{ij}} \right.$$

$$\left. + \left(M\left(\frac{|\Delta^{k-1} a_{i,j+1} - L|}{\rho} \right) \right)^{p_{ij}} + \left(M\left(\frac{|\Delta^{k-1} a_{i+1,j+1} - L|}{\rho} \right) \right)^{p_{ij}} \right\} .$$

$$\leq D^2 . \lim_{m,n} \frac{1}{mn} \sum_{i=1}^{m} \sum_{j=1}^{n} \left\{ \left(M\left(\frac{|\Delta^{k-1} a_{ij} - L|}{\rho} \right) \right)^{p_{ij}} + \left(M\left(\frac{|\Delta^{k-1} a_{i+1,j} - L|}{\rho} \right) \right)^{p_{i+1,j}} \right.$$

$$\left. + \left(M\left(\frac{|\Delta^{k-1} a_{i,j+1} - L|}{\rho} \right) \right)^{p_{i,j+1}} + \left(M\left(\frac{|\Delta^{k-1} a_{i+1,j+1} - L|}{\rho} \right) \right)^{p_{i+1,j+1}} \right\}$$

.

$$= 0.$$

Thus $< a_{ij} > \, \in \, _2W_0(M, \Delta^k, p)$ and hence $_2W(M, p) \subseteq \, _2W_0(M, \Delta^k, p)$.

The inclusion is strict follows from the following example.

Theorem 3.4. (*i*) If $0 < \inf p_{ij} \leq p_{ij} < 1$, *then* $_2W(M, \Delta^k, p) \subseteq \, _2W(M, \Delta^k)$.

(*ii*) If $1 \leq p_{ij} < \sup p_{ij} < \infty$, *then* $_2W(M, \Delta^k) \subseteq \, _2W(M, \Delta^k, p)$.

Proof. The first part of the result follows from the inequality

$$\frac{1}{mn} \sum_{i=1}^{m} \sum_{j=1}^{n} \left(M\left(\frac{|\Delta^k a_{ij} - L|}{\rho} \right) \right) \leq \frac{1}{mn} \sum_{i=1}^{m} \sum_{j=1}^{n} \left(M\left(\frac{|\Delta^k a_{ij} - L|}{\rho} \right) \right)^{p_{ij}}$$

and the second part of the result follows from the inequality

$$\frac{1}{mn} \sum_{i=1}^{m} \sum_{j=1}^{n} \left(M\left(\frac{|\Delta^k a_{ij} - L|}{\rho} \right) \right)^{p_{ij}} \leq \frac{1}{mn} \sum_{i=1}^{m} \sum_{j=1}^{n} \left(M\left(\frac{|\Delta^k a_{ij} - L|}{\rho} \right) \right)$$

Theorem 3.5. *Let M_1 and M_2 be two Orlicz functions. Then*

$$_2W(M_1, \Delta^k, p) \cap \, _2W(M_2, \Delta^k, q) \subseteq \, _2W(M_1 + M_2, \Delta^k, q).$$

Proof. Let $< a_{ij} > \, \in \, _2W(M_1, \Delta^k, p) \cap \, _2W(M_2, \Delta^k, q)$. Then

$$\lim_{m,n} \frac{1}{mn} \sum_{i=1}^{m} \sum_{j=1}^{n} \left(M_1 \left(\frac{|\Delta^k a_{ij} - L|}{\rho_1} \right) \right)^{p_{ij}} = 0, \quad \text{for some } \rho_1 > 0.$$

$$\lim_{m,n} \frac{1}{mn} \sum_{i=1}^{m} \sum_{j=1}^{n} \left(M_2 \left(\frac{|\Delta^k a_{ij} - L|}{\rho_2} \right) \right)^{p_{ij}} = 0, \quad \text{for some } \rho_2 > 0.$$

Let $\rho = \max \{ \rho_1, \rho_2 \}$. The result follows from the following inequality.

$$\sum_{i=1}^{m} \sum_{j=1}^{n} \left((M_1 + M_2) \left(\frac{|\Delta^k a_{ij} - L|}{\rho} \right) \right)^{p_{ij}} \leq$$

$$D \left\{ \sum_{i=1}^{m} \sum_{j=1}^{n} \left(M_1 \left(\frac{|\Delta^k a_{ij} - L|}{\rho_1} \right) \right)^{p_{ij}} + \sum_{i=1}^{m} \sum_{j=1}^{n} \left(M_2 \left(\frac{|\Delta^k a_{ij} - L|}{\rho_2} \right) \right)^{p_{ij}} \right\}.$$

Theorem 3.6. *The sequence space* $_2W_\infty(M, \Delta^m, p)$ *is solid and hence monotone.*

Proof. Let $< a_{ij} > \in {}_2W_\infty(M, \Delta^k, p)$ and $< \alpha_{ij} >$ be a scalar sequence such that $|\alpha_{ij}| \leq 1$ for all $i, j \in N$.

Now $M \left(\frac{|\alpha_{ij}\Delta^k a_{ij}|}{\rho} \right) \leq M \left(\frac{|\Delta^k a_{ij}|}{\rho} \right)$

$$\Rightarrow \left(M \left(\frac{|\alpha_{ij}\Delta^k a_{ij}|}{\rho} \right) \right)^{p_{ij}} \leq \left(M \left(\frac{|\Delta^k a_{ij}|}{\rho} \right) \right)^{p_{ij}}$$

$$\Rightarrow \sup_{m,n} \frac{1}{mn} \sum_{i=1}^{m} \sum_{j=1}^{n} \left(M \left(\frac{|\alpha_{ij}\Delta^k a_{ij}|}{\rho} \right) \right)^{p_{ij}} \leq \sup_{m,n} \frac{1}{mn} \sum_{i=1}^{m} \sum_{j=1}^{n} \left(M \left(\frac{|\Delta^k a_{ij}|}{\rho} \right) \right)^{p_{ij}} < \infty.$$

Result 3.7. *The sequence spaces* $_2W(M, \Delta^k, p)$ *and* $_2W_0(M, \Delta^k, p)$ *are not monotone and hence are not solid.*

Proof. The result follows from the following example.

Example 3.1. Let $M(x) = x^p$, $p \geq 1$. Then the double sequence $< a_{ij} >$ defined by $a_{ij} = 1$ for all $i, j \in N$ belongs to $_2W(M, \Delta^k, p)$ and $_2W_0(M, \Delta^k, p)$. Consider its pre-image $< b_{ij} >$ defined as

$$b_{ij} = \begin{cases} a_{ij}, & \text{if } i + j \text{ is odd.} \\ 0, & \text{otherwise.} \end{cases}$$

Then $< b_{ij} >$ belongs neither to $_2W(M, \Delta^k, p)$ nor to $_2W_0(M, \Delta^k, p)$ for any k. Hence the spaces $_2W(M, \Delta^k, p)$ and $_2W_0(M, \Delta^k, p)$ are not monotone and by Remark 3 these are not solid also.

Result 3.8. *The sequence spaces* $_2W(M, \Delta^k, p)$, $_2W_0(M, \Delta^k, p)$ *and* $_2W_\infty(M, \Delta^k, p)$ *are not symmetric.*

Proof. To prove the results consider the following examples.

Example 3.2. Let $M(x) = x^2$, $k = 2$. Consider the sequence $< a_{ij} >$ defined by

$$a_{ij} = \begin{cases} 1, & \text{if } i \text{ is odd for all } j \in N. \\ -1, & \text{otherwise.} \end{cases}$$

Then $\Delta^2 a_{ij} = 0$ for all $i, j \in N$.

Let $< b_{ij} >$ be a rearrangement of the sequence $< a_{ij} >$ defined by

$$b_{ij} = \begin{cases} -1, & \text{if } i + j \text{ is even.} \\ 1, & \text{otherwise.} \end{cases}$$

Then $\quad \Delta^2 b_{ij} = \begin{cases} -16, & \text{if } i + j \text{ is even.} \\ 16, & \text{otherwise.} \end{cases}$

Here $< a_{ij} > \in {}_2W_0(M, \Delta^k, p) \subseteq {}_2W(M, \Delta^k, p)$ but $< b_{ij} > \notin {}_2W(M, \Delta^k, p)$.

Example 3.3. Let $M(x) = x^p$, $p \geq 1$, $k = 2$, $p_{ij} = 2$ for all $i, j \in N$. Consider the sequence $< a_{ij} >$ defined by

$$a_{ij} = \begin{cases} 0, & \text{if } i \text{ is even for all } j \in N. \\ i, & \text{otherwise.} \end{cases}$$

Then $\Delta a_{ij} = 0$ for all $i, j \in N$.

Let $< b_{ij} >$ be a rearrangement of the sequence $< a_{ij} >$ defined by

$$b_{ij} = \begin{cases} 0, & \text{if } i + j \text{ is odd.} \\ i, & \text{otherwise.} \end{cases}$$

Then $\quad \Delta^2 b_{ij} = \begin{cases} 8i + 8, & \text{if } i + j \text{ is even.} \\ -8i - 8, & \text{otherwise.} \end{cases}$

Here $< a_{ij} > \in {}_2W_\infty(M, \Delta^k, p)$ but $< b_{ij} > \notin {}_2W_\infty(M, \Delta^k, p)$.

REFERENCES

1. Basarir, M. and Sonalcan, O.: On some double sequence spaces; *J. Indian Acad. Math.* 21(2), (1999); 193-200.

2. Bromwich T.J.IA: *An Introduction to the Theory of Infinite Series*; MacMillan and Co. Ltd. New york (1965).

3. Esi, A.: Some new sequence spaces defined by Orlicz functions; *Bull. Inst. Math. Acad. Sinica.*; 27(1) (1999), 71-76.

4. Esi, A. and Et, M.: Some new sequence spaces defined by a sequence of Orlicz functions; *Indian J. Pure. Appl. Math.*; 31(8) (2000), 967-972.

5. Et, M.: On some new Orlicz sequence spaces; *J. Analysis*; 9 (2001), 21-28.

6. Hardy G.H.: On the convergence of certain multiple series; *Proc. Camb. Phil. Soc.*; 19 (1917).

7. Kamthan, P.K. and Gupta, M.: *Sequence Spaces and Series*: Marcel Dekker, 1980.

8. Kizmaz, H: On certain sequence spaces; *Canad. Math. Bull.*, 24 (1981), 169 –176.

9. Krasnoselkii, M.A. and Rutitsky, Y.B.: *Convex function and Orlicz Spaces*; Groningen Netherlands, 1961.

10. Lindenstrauss, J. and Tzafriri, L.: On Orlicz sequence spaces: *Israel J. Math.* 10 (1971), 379-390.

11. Maddox, I.J.: Spaces of strongly summable sequences. *Quart. Jour. Math.* (Oxford 2nd Ser), vol. 18, no.72(1976), 345-355.

12. Moricz, F: Extension of the spaces c and c_0 from single to double sequences; *Acta. Math. Hungerica.*; 57(1-2), (1991), 129 -136.

13. Moricz, F. and Rhoades B.E.: Almost convergence of double sequences and strong regularity of summability matrices; *Math. Proc. Camb. Phil. Soc.*; 104 (1988), 283-294.

14. Nakano H.: Modular sequence spaces; *Proc. Japan Acad.*; 27 (1951) , 508 – 512.

15. Simons, S.: The sequence spaces $l(p_v)$ and $m(p_v)$. *Proc. London Math. Soc.*,(3) 15 (1965), 422-436.

16. Tripathy B.C.: Generalized difference paranormed statistically convergent sequences defined by Orlicz function in a locally convex spaces; *Soochow J. Math.* 30(4)(2004), 431-446.

17. Tripathy B.C. and Sarma B.: Statistically convergent double sequence spaces defined by Orlicz functions; *Soochow J. Math.*; 32(2)(2006), 211-221.

18. Tripathy B.C., Choudhury B. and Sarma B.: Some Difference Double Sequence Spaces Defined By Orlicz Function, Kyungpook Math. J. 48(2008), 613-622.

19. Zygumd, A.: *Trigonometric Series*, vol II , Cambridge (1993) .

28

A SIMPLE MATHEMATICAL MODEL THROUGH FRACTIONAL-ORDER DIFFERENTIAL EQUATION FOR PATHOGENIC INFECTION

İlhan ÖZTÜRK & Bahatdin DAŞBAŞI** & Gizem CEBE****

*Erciyes University, Faculty of Science, TURKEY, Email: ozturki@erciyes.edu.tr
ORCID ID: https://orcid.org/0000-0002-1268-6324

**Kayseri University, Faculty of Applied Sciences, TURKEY, Email: dasbasi_bahatdin@hotmail.com,
ORCID ID: https://orcid.org/0000-0001-8201-7495

***Kangal Koç Anatolian High School, TURKEY, E-mail: cebegizem@hotmail.com,
ORCID ID: https://orcid.org/0000-0002-6373-2503

ABSTRACT

The model in this study, examined the time-dependent changes in the population sizes of pathogen-immune system, is presented mathematically by fractional-order differential equations (FODEs) system. Qualitative analysis of the model was examined according to the parameters used in the model. The proposed system has always namely free-infection equilibrium point and the positive equilibrium point exists when specific conditions dependent on parameters are met, According to the threshold parameter R_0, it is founded the stability conditions of these equilibrium points. Also, the qualitative analysis was supported by numerical simulations.

Keywords: Fractional-Order Differential Equation, Numerical Simulation, Stability Analysis

2010 AMS Subject Classification: 34D20, 92B05

1. INTRODUCTION

Transferring process of a situation or incident by using mathematical symbols is called as mathematical modeling [1]. In these kinds of modeling, the use of fractional-order differential and integral operators has increased recently [2,3]. In this sense, fractional-order calculations are widely used especially in physics, thermodynamics, viscoelasticity, electrical circuit theory, mechatronic systems, signal process, chemical mixtures, chaos theory, engineering, biological systems, economics, and many various areas [4-8]. Stability of the equilibrium point for fractional-order differential equations (FODEs) and its systems is at least as much as their integer order. Accordingly, the behavior of the system can be estimated by the stability analysis of equilibrium points of the suggested system via

mathematical modeling. The biological population modeling formed by using FODE is an ample source in terms of mathematical ideas [9-11].

The diseases induced by organisms called as pathogens such as tumor, bacteria, fungus or viruses have been considered as the main cause of fatal diseases through the human history. Basically, it is a quite complex process for both the pathogen and host. In spite of developing different treatment strategies against to diseases caused by these pathogens, main and first process of fight against these is played by the individuals immune system. Immune system is called as the system of biological structures and processes in an organism protecting host against the possible harmful organisms by recognizing and responding to the antigens of pathogens [12]. In this context, dynamics between immune system cells of host and pathogen that causes disease are important to understand the nature of disease and are tried to be explained in [13-19] in different ways.

The proposed mathematical model in form, nonlinear autonomous two-dimensional fractional-order differential equation system considered the main mechanisms of pathogen and immune system cells in host, was presented in this study.

2. PRELIMINARIES AND DEFINITIONS

Definition 2.1. *(Fractional Derivative and Integral in Caputo Sense) For $t > 0, \beta \in R^+$, fractional-order integral of the function $f(t)$ is defined as*

$$I^\beta f(t) = \int_0^t \frac{(t-s)^{\beta-1}}{\Gamma(\beta)} f(s)ds \quad (2.1)$$

and fractional-order derivative the function $f(t)$ is defined as

$$D^\alpha f(t) = I^{n-\alpha} D^n f(t), \qquad D = \frac{d}{dt} \quad (2.2)$$

for $\alpha \in (n-1, n]$ [3,20-23].

Lemma 2.1. *Stability Analysis of Equilibrium Point of Nonlinear Autonomous Two-Dimensional Fractional-Order Differential Equations System is as the followings:*

Proof. With initial conditions

$$x(0) = x_0 \text{ and } y(0) = y_0, \quad (2.3)$$

let us consider the following system

$$\begin{aligned} D^\alpha x(t) &= f_1(x, y) \\ D^\alpha y(t) &= f_2(x, y) \end{aligned} \quad (2.4)$$

for $\alpha \in (0,1]$. Also, we have supposed that equilibrium point obtained from equation system $f_1(\bar{x}, \bar{y}) = f_2(\bar{x}, \bar{y}) = 0$ is shown by $(\bar{x}, \bar{y})$. The Jacobian Matrix of system (2.4) is founded from $J = \begin{bmatrix} \frac{\partial f_1}{\partial y_1} & \frac{\partial f_1}{\partial y_2} \\ \frac{\partial f_2}{\partial y_1} & \frac{\partial f_2}{\partial y_2} \end{bmatrix}$. If the eigenvalues λ_1 and λ_2 obtained from the equation $\text{Det}\left(J_{(x,y)=(\bar{x},\bar{y})} - \lambda I_2\right) = 0$ provide the conditions

$$\left(|\arg(\lambda_1)| > \frac{\alpha\pi}{2}, \quad |\arg(\lambda_2)| > \frac{\alpha\pi}{2}\right), \quad (2.5)$$

then, the equilibrium point $(\bar{x}, \bar{y})$ is locally asymptotically stable (LAS) for system (2.4). Stability region of equilibrium point for FODE systems is larger than its integer order [24].

Conditions expressed in (2.5) can be detailed as the following. The characteristic polynomial belonging to the eigenvalues λ_1 and λ_2 obtained from $\text{Det}\left(J_{(x,y)=(\bar{x},\bar{y})} - \lambda I_2\right) = 0$ is

$$p(\lambda) = \lambda^2 + a_1\lambda + a_2 = 0. \quad (2.6)$$

When both the conditions (2.5) and the polynomial (2.6) are taken into account together; LAS conditions of the equilibrium point $(\bar{x}, \bar{y})$ are that coefficients of the polynomial (2.6) provide either Routh–Hurwitz conditions $(a_1, a_2 > 0)$ [1] or

$$a_1 < 0, 4a_2 > (a_1)^2, \left| \tan^{-1}\left(\frac{\sqrt{4a_2 - (a_1)^2}}{a_1} \right) \right| > \frac{\alpha\pi}{2}. \quad (2.7)$$

[25].

3. MATHEMATICAL MODEL

It has been identified pathogen load and level of immunity in a diseased individual. Therefore, it is presumed that the population sizes of pathogen load and immune system cells at time t denote by $P(t)$ and $I(t)$, respectively. The variable I can be denoted some accurate amount, like the density of specific B-cells or antibodies. In this context, the model in the form of FODEs system with the initial conditions $P(t_0) = P_0$ and $I(t_0) = I_0$ is

$$D^\alpha P(t) = \beta_P P(t)\left(1 - \frac{P(t)}{C_p}\right) - \mu_P P(t) - \bar{\sigma}P(t)I(t) \quad (3.1)$$
$$D^\alpha I(t) = \bar{\omega}I(t)P(t) - \mu_I I(t) + H$$

where α shows the orders of derivative and the parameters $\beta_P, C_p, \mu_P, \bar{\sigma}, \bar{\omega}, \mu_I$ and H are positive constants. In the model (3.1), the growth rate of pathogen is β_P and the carrying capacity of pathogen is C_p In this sense, it is supposed that pathogen multiply according to logistic rule. Also, the natural death rate of pathogen is μ_P, the rate at which the immune system cells destroy pathogens is $\bar{\sigma}$, the multiplying rate of immune system cells in the existence of pathogen is $\bar{\omega}$ (specific immune system cells), the natural death rate of immune system cells is μ_I and the base production density of immune system cells in fixed quantity is H (aspecific immune system cells).

Figure 2.1. Schematic demonstration of interaction between immune system cells and pathogen in the model (3.1).
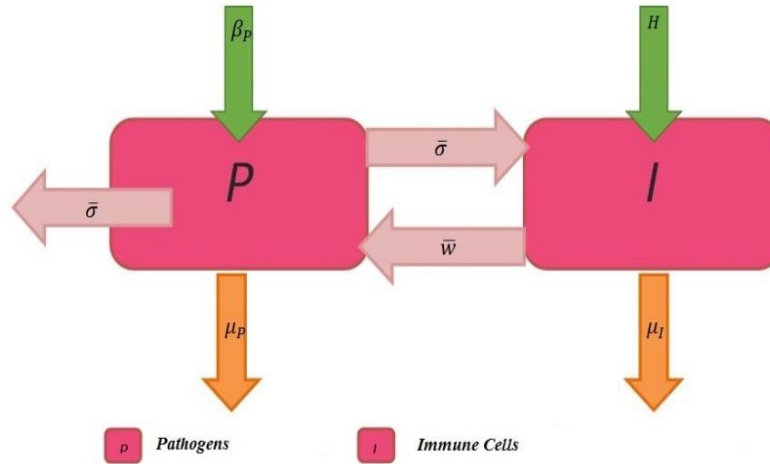
Let us consider as $P(t) = C_p p(t)$ and $I(t) = C_p i(t)$. When the parameter transformations $\overline{\sigma} C_p = \sigma, \overline{\omega} C_p = \omega$ and $h = \dfrac{H}{C_p}$ are applied to the system (3.1), it is obtained that

$$D_t^\alpha p = \beta_P p(1-p) - \mu_P p - \sigma p i$$
$$D_t^\alpha i = \omega i p - \mu_I i + h \qquad (3.2)$$
$$0 < \alpha \leq 1$$

Therefore, stability analysis of the system (3.1) can be sustained through the system (3.2).

3.1. Matrix Form of the System (3.2). FODEs system in (3.2) can be rewritten in matrix form as follows,

$$D^\alpha X(t) = AX(t) + x_1(t)BX(t) + R$$
$$X(0) = X_0 \qquad (3.3)$$

where $0 < \alpha \leq 1, t \in (0,1], n \in \mathbb{N}^+,$ $p(t) = x_1(t),$ $i(t) = x_2(t),$ $X(t) = \begin{pmatrix} x_1(t) \\ x_2(t) \end{pmatrix},$ $X_0 = \begin{pmatrix} x_1(0) \\ x_2(0) \end{pmatrix},$ $R = \begin{pmatrix} 0 \\ h \end{pmatrix},$ $A = \begin{pmatrix} \beta_P - \mu_P & 0 \\ 0 & -\mu_I \end{pmatrix}$ and $B = \begin{pmatrix} -\beta_P & -\sigma \\ 0 & \omega \end{pmatrix}.$

Definition 3.1. *For $X(t) = \big(x_1(t)\ x_2(t)\big)^T$, $C^*[0,T]$ set is a continuous set of the vector $X(t)$ at interval $[0,T]$. Norm of the vector $X(t) \in C^*[0,T]$ in (3.3) is $\|X(t)\| = \sum_{i=1}^{5} \sup_t |x_i(t)|$.*

Proposition 3.1. *Let us consider Definition 3.1. and $X(t) = (x_1(t)\ x_2(t))^T$ in $\mathbb{R}_+^2 = \{X \in R^2 : X \geq 0\}$ and $D^\alpha f(x) \in C[a,b]$ for $f(X) \in C[a,b],$ $0 < \alpha \leq 1$. According to generalized mean value theorem, it is $f(x) = f(a) + \frac{1}{\Gamma(\alpha)} D^\alpha f(\xi)(x-a)^\alpha$ for $\forall\ x \in [a,b]$ and $0 \leq \xi \leq x$. Also,*

- *When $D^\alpha f(x) > 0$ for $\forall\ x \in [a,b]$, the function $f(x)$ increases for each $x \in [a,b]$.*

- *When $D^\alpha f(x) < 0$ for $\forall\ x \in [a,b]$, the function $f(x)$ decreases for each $x \in [a,b]$.*

Also, the vector field is the points in $\mathbb{R}_+^2$, since $D^\alpha x_1(t)\big|_{x_1=x_2=0} = 0$ and $D^\alpha x_2(t)\big|_{x_1=x_2=0} = h$.

Proposition 3.2. *If $X(t) \in C^*[0, T]$, the system (3.2) has a single solution.*

Proof. We have $D^\alpha X(t) = AX(t) + x_1(t)BX(t) + R$ in (3.3). In this situation, it is $F\big(X(t)\big) \in C^*[0, T]$ for $X(t) \in C^*[0, T]$. Also, for vectors that would be like $X(t), Y(t) \in C^*[0, T]$ and $X(t) \neq Y(t)$, we have the followings

$$\left\| F\big(X(t)\big) - F\big(Y(t)\big) \right\| =$$

$$\left\| (AX(t) + x_1(t)BX(t) + R) - (AY(t) + y_1(t)BY(t) + R) \right\|$$

$$\left\| AX(t) + x_1(t)BX(t) - AY(t) - y_1(t)BY(t) \right\|$$

$$\left\| A\big(X(t) - Y(t)\big) + x_1(t)BX(t) - y_1(t)BY(t) - \left(\underbrace{x_1(t)BY(t) - x_1(t)BY(t)}_{0} \right) \right\|$$

$$\left\| A\big(X(t) - Y(t)\big) + x_1(t)B\big(X(t) - Y(t)\big) + \big(x_1(t) - y_1(t)\big)BY(t) \right\|$$

$$\leq \left(\left\| A\big(X(t) - Y(t)\big) \right\| + \left\| x_1(t)B\big(X(t) - Y(t)\big) \right\| + \left\| \big(x_1(t) - y_1(t)\big)BY(t) \right\| \right)$$

$$\leq \left(\|A\| \left\| \big(X(t) - Y(t)\big) \right\| + \|B\| |x_1(t)| \left\| \big(X(t) - Y(t)\big) \right\| + \|B\| \underbrace{\left| \big(x_1(t) - y_1(t)\big) \right|}_{\leq \left\| (X(t) - Y(t)) \right\|} \|Y(t)\| \right)$$

$$\leq \left(\|A\| + \|B\| \left(\underbrace{|x_1(t)|}_{\leq \|X(t)\|} + \|Y(t)\| \right) \right) \left\| \big(X(t) - Y(t)\big) \right\|$$

and thus it is

$$\left\| F\big(X(t)\big) - F\big(Y(t)\big) \right\| \leq L \left\| \big(X(t) - Y(t)\big) \right\|$$

where $L = \|A\| + \|B\|(M_1 + M_2) > 0$ and M_1 and M_2 are positive constants, such that $X(t), Y(t) \in C^*[0, T]$, $\|X(t)\| \leq M_1$, $\|Y(t)\| \leq M_2$. Therefore the system (3.2) has a single solution.

4. QUALITATIVE ANALYSIS OF PROPOSED MODEL

In this part, equilibrium points of model, expressed in (3.2), are found and the stability analysis of these points is made.

Definition 4.1. *In system (3.2), the parameters are redefined as*

$$A_1 = \frac{\beta_P - \mu_P}{\beta_P}, A_2 = \frac{\mu_I}{\omega}, A_3 = \frac{\sigma}{\beta_P}, A_4 = \frac{h}{\omega} \quad (4.1)$$

for ease of stability analysis. Because the parameters used in system (3.1) are positive, it is

$$A_2, A_3, A_4 > 0 \quad (4.2)$$

Therefore, the system (3.2) can be rewritten as,

$$D_t^\alpha p = f(p, i) = p \frac{1}{\beta_P} (A_1 - p - A_3 i)$$
$$D_t^\alpha i = g(p, i) = \omega(ip - A_2 i + A_4) \quad (4.3)$$
$$0 < \alpha \leq 1$$

Proposition 4.1. *The system (4.3) has always the equilibrium point $E_0 \left(0, \frac{A_4}{A_2} \right)$ namely free-infection equilibrium point. Also, when $A_1 A_2 - A_3 A_4 > 0$, the positive equilibrium point*

33

$E_1 \left(\frac{(A_1+A_2)-\sqrt{(A_1-A_2)^2+4\,A_3A_4}}{2}, \frac{(A_1-A_2)+\sqrt{(A_1-A_2)^2+4\,A_3A_4}}{2A_3} \right)$ *exists.*

Proof. Let us consider that the general expression of equilibrium points of the system (4.3) is $E_j = (\bar{p}, \bar{\imath})$ for $j = 1,2$. They can be found by solving the equation system $f(\bar{p}, \bar{\imath}) = g(\bar{p}, \bar{\imath}) = 0$ in (4.3). Thus, we have

$$\bar{p}(A_1 - \bar{p} - A_3\bar{\imath}) = 0$$
$$(\bar{\imath}\bar{p} - A_2\bar{\imath} + A_4) = 0 \quad (4.4)$$

By the first equation in (4.4), it is either $\bar{p} = 0$ or $A_1 - \bar{p} - A_3\bar{\imath} = 0$ is obtained.

- Let $\bar{p} = 0$. In this situation, $\bar{\imath} = \frac{A_4}{A_2}$ is obtained from the second equation of (4.4).

Therefore the free-infection equilibrium point is $E_0 \left(0, \frac{A_4}{A_2} \right)$.

- Consider the other situation being $A_1 - \bar{p} - A_3\bar{\imath} = 0$ that is

$$\bar{\imath} = \frac{A_1 - \bar{p}}{A_3}. \quad (4.5)$$

When this value in (4.5) is written in the second equation in (4.4), the second degree polynomial

$$\bar{p}^2 - (A_1 + A_2)\bar{p} + (A_1A_2 - A_3A_4) = 0 \quad (4.6)$$

related to $\bar{p}$ is obtained. Discriminant of (4.6) is $\Delta = (A_1 - A_2)^2 + 4\,A_3A_4$. In this sense, it is clear that $\Delta > 0$ due to (4.2). The roots $\bar{p}$ are found as,

$$\overline{p_1} = \frac{(A_1 + A_2) - \sqrt{(A_1 - A_2)^2 + 4\,A_3A_4}}{2}$$
$$\text{and} \quad (4.7)$$
$$\overline{p_2} = \frac{(A_1 + A_2) + \sqrt{(A_1 - A_2)^2 + 4\,A_3A_4}}{2}.$$

For the roots $\overline{p_1}$ and $\overline{p_2}$ are positive real number, it must be $(A_1 + A_2) \mp \sqrt{(A_1 - A_2)^2 + 4\,A_3A_4} > 0$ and so,

$$A_1A_2 - A_3A_4 > 0 \quad (4.8)$$

Thus, the values $\bar{\imath}_j$ for $j = 1,2$ that correspond to $\overline{p_1}$ and $\overline{p_2}$ can be found from (4.5) as

$$\overline{\imath_1} = \frac{(A_1 - A_2) + \sqrt{(A_1 - A_2)^2 + 4\,A_3A_4}}{2A_3}$$
$$\text{and} \quad (4.9)$$
$$\overline{\imath_2} = \frac{(A_1 - A_2) - \sqrt{(A_1 - A_2)^2 + 4\,A_3A_4}}{2A_3},$$

respectively. It is clear from (4.2) that $\overline{\imath_1}$ is always positive and $\overline{\imath_2}$ is always negative. Accordingly when (4.8) is provided, the positive equilibrium point $E_1(\overline{p_1}, \overline{\imath_1})$ is as follows; $E_1 \left(\frac{(A_1+A_2)-\sqrt{(A_1-A_2)^2+4\,A_3A_4}}{2}, \frac{(A_1-A_2)+\sqrt{(A_1-A_2)^2+4\,A_3A_4}}{2A_3} \right)$.

Thus, as a result, the following table can be given.

Table 4.1. The biological existence conditions of equilibrium points of system (4.3)

Equilibrium Points	Condition of biological existence
$E_0\left(0, \dfrac{A_4}{A_2}\right),$	Always exists
$E_1\left(\dfrac{(A_1+A_2)-\sqrt{(A_1-A_2)^2+4\,A_3A_4}}{2}, \dfrac{(A_1-A_2)+\sqrt{(A_1-A_2)^2+4\,A_3A_4}}{2A_3}A_3A_4\right),$	$A_1A_2 - A_3A_4 > 0$

Proposition 4.2. *For the system (4.3), when equilibrium points shown in Table 4.1 are considered, the stability of these points are obtained as follows:*

(i) *If $A_1A_2 - A_3A_4 < 0$, then the equilibrium point $E_0\left(0, \dfrac{A_4}{A_2}\right)$ is locally asymptotically stable (LAS).*

(ii) *We have assumed that the condition (4.8) be provided. In this situation, the positive equilibrium point E_1 is locally asymptotically stable (LAS).*

Proof.

For the stability analysis, Jacobian matrix obtained from the right side of the system (4.3) is assigned as:

$$J = \begin{pmatrix} \dfrac{1}{\beta_P}(A_1 - 2p - A_3 i\,) & -A_3 p \dfrac{1}{\beta_P} \\ \omega i & \omega(p - A_2) \end{pmatrix} \quad (4.10)$$

(i) Jacobian Matrix calculated in $E_0\left(0, \dfrac{A_4}{A_2}\right)$ is as following

$$J\left(E_0\left(0, \dfrac{A_4}{A_2}\right)\right) = \begin{pmatrix} \beta_P \dfrac{A_1A_2 - A_3A_4}{A_2} & 0 \\ \omega \dfrac{A_4}{A_2} & -\omega A_2 \end{pmatrix} \quad (4.11)$$

Here, it is clear that eigenvalues are real number. Accordingly, for the stability of this equilibrium point, it is enough to look at Routh-Hurwitz criteria. Also, the characteristic equation belonging to this matrix is of second degree, since Jacobian Matrix in (4.11) is 2x2. As a result of this criteria, for eigenvalues to be negative, and so LAS of this point, the condition $\mathrm{TrJ}(E_0) = \dfrac{\beta_B\,(A_1A_2 - A_3A_4)}{A_2} - A_2\,\omega < 0$ and $\mathrm{DetJ}(E_0) = -\omega\,\beta_B\,(A_1A_2 - A_3A_4) > 0$ must be provided. Thus, if

$$A_1A_2 - A_3A_4 < 0, \quad (4.12)$$

from aforementioned inequality with respect to $\mathrm{TrJ}(E_0)$ and $\mathrm{DetJ}(E_0)$, then $E_0\left(0, \dfrac{A_4}{A_2}\right)$ is LAS.

(ii) We have the positive equilibrium point E_1 under condition $A_1A_2 - A_3A_4 > 0$. Jacobian matrix calculated in E_1 is written as

$$J(E_1) = \begin{pmatrix} -\beta_S \bar{p} & -\sigma \bar{p} \\ \omega \bar{\imath} & -\dfrac{h}{\bar{\imath}} \end{pmatrix} \quad (4.13)$$

Characteristic equation obtained from (4.13) is as follows:

$$\lambda^2 + \left(\beta_P \bar{p} + \frac{h}{\bar{\imath}}\right)\lambda + \bar{p}\left(\omega\sigma\bar{\imath} + \beta_P \frac{h}{\bar{\imath}}\right) = 0 \quad (4.14)$$

When Lemma 2.1. is considered, as coefficients of (4.14) are positive real number. According to Routh-Hurwitz criteria, the eigenvalues λ are either negative real number or complex numbers having negative real parts. In this respect, when the positive equilibrium point E_1 biologically exists, it is also the stable equilibrium point.

Stability conditions of equilibrium points expressed in Table 4.1. are summarized in the following table.

Table 4.2. Stability conditions of equilibrium points of (4.3).

Equilibrium Point	Stability Condition
$E_0\left(0, \dfrac{A_4}{A_2}\right)$	$A_1 A_2 - A_3 A_4 < 0$
$E_1\left(\dfrac{(A_1+A_2)-\sqrt{(A_1-A_2)^2+4A_3A_4}}{2}, \dfrac{(A_1-A_2)+\sqrt{(A_1-A_2)^2+4A_3A_4}}{2A_3}A_3A_4\right).$	When It exists as biological (that is, $A_1 A_2 - A_3 A_4 > 0$)

Definition 4.2. *For (4.3) system, the threshold parameter R_0, minimum infection free parameter, has the following property:*

If $R_0 < 1$, then equilibrium point E_0 is LAS, and if $R_0 > 1$, then positive equilibrium point E_1 is LAS. Here R_0 parameter is defined as following

$$R_0 = \frac{A_1 A_2}{A_3 A_4} \quad (4.15)$$

Table 4.3. According to the parameter R_0, stability conditions of equilibrium points of (4.3).

Equilibrium Point	Stability Condition
$E_0\left(0, \dfrac{A_4}{A_2}\right)$	$R_0 < 1$
$E_1\left(\dfrac{(A_1+A_2)-\sqrt{(A_1-A_2)^2+4A_3A_4}}{2}, \dfrac{(A_1-A_2)+\sqrt{(A_1-A_2)^2+4A_3A_4}}{2A_3}A_3A_4\right).$	$R_0 > 1$

5. RESULTS

In this part, qualitative analysis of system is supported via numerical simulations by giving values to parameters used in system (3.2).

Table 5.1. For system (3.2), values and expressions of parameter values.

ParametersDescriptions		Values
β_P	Growth rate of pathogen,	0.8 day^{-1}
C_p	Carrying capacity of pathogen,	10^9 cells
μ_P	Natural death rate of pathogen,	0.312 day^{-1}
μ_I	Natural death rate of immune cells,	0.1512 day^{-1}
$\overline{\sigma}$	The rate at which the immune system cells destroy pathogens,	$3*10^{-6} \text{ cells}^{-1} \text{ days}^{-1}$
$\overline{\omega}$	Proliferation rate of immune system cells in pathogenesis,	$10\text{-}9 \text{ cells}{-}1 \text{ days}{-}1$
H	Intensity of base production of immune system cells,	106 cells
α	The orders of the derivative in the system,	0.25, 0.50, 0.75, 0.9, 0.99
$[P_0 \ I_0]$	Initial condition	[10000 1000]

In the light of data obtained from Table 5.1., it is founded as following

$$A_1 = 0.61, A_2 = 1.512, A_3 = 3750, A_4 = 0.001$$

and the equilibrium points

$$E_0(0,661375.7) \text{ and } E_1(-927316121.8,409951).$$

Because it is

$$A_1A_2 - A_3A_4 = -2.82768,$$

the positive equilibrium point E_1 is biologically meaningless and E_0 is locally asymptotically stable. This situation with different derivative orders is clearly seen in Figure 5.1 and Figure 5.2.

Figure 5.1. In case of $\alpha = 0,25, 0.50, 0.75, 0.90$ and 0.99 in system (3.2), respectively, temporal courses of pathogen obtained by using datas in the Table 5.1.
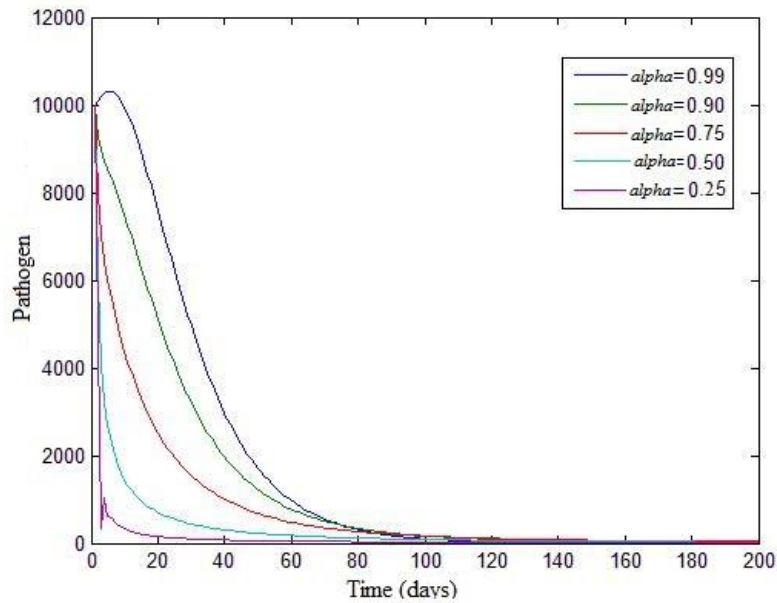
Figure 5.2. In case of $\alpha = 0,25, 0.50, 0.75, 0.90$ and 0.99 in system (3.2), respectively, temporal courses of Immune system cells obtained by using datas in the Table 5.1.
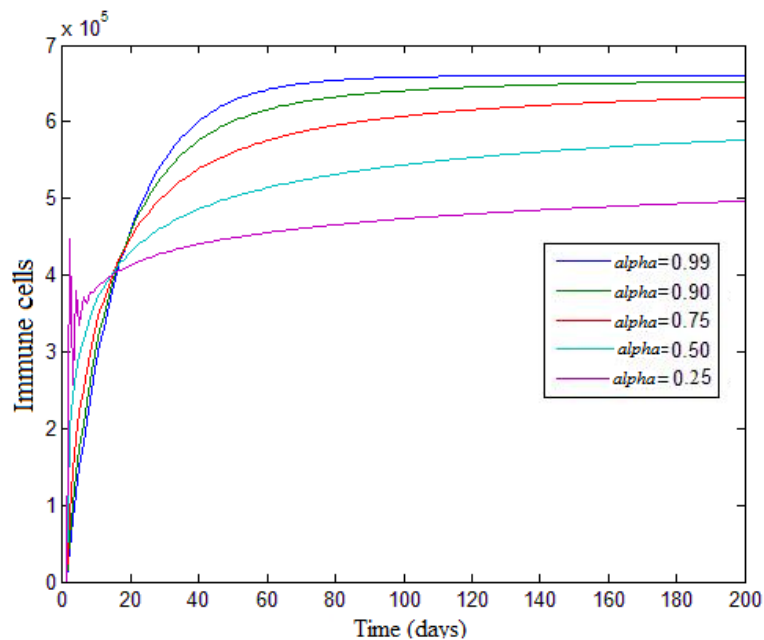
In the numerical studies in this section, the parameters obtained from the literature for mycobacterium tuberculosis were used. Within about 100 days, as can be seen from the figures above, the pathogen population disappears and the immune system cells increase.

REFERENCES

[1] L. J. S. Allen, An Introduction to Mathematical Biology., 2007, ISBN 10: 0-13-035216-0.

[2] H. El-Saka and A. El-Sayed, Fractional Order Equations and Dynamical Systems. Germany: Lambrt Academic Publishing, 2013.

[3] A. M. A. El-Sayed and F.M. Gaafar, "Fractional order differential equations with memory and fractional-order relaxation oscillation model," (PU.M.A) Pure Math. Appl., vol. 12, 2001.

[4] F. A. Rihan, "Numerical Modeling of Fractional-Order Biological Systems," Abstract and Applied Analysis, pp. 1-11, 2013.

[5] W. Deng and C. Li, "Analysis of Fractional Differential Equations with Multi-Orders," Fractals, vol. 15, no. 2, pp. 173-182, 2007.

[6] M. Axtell and E. M. Bise, "Fractional calculus applications in control systems," in Proc. of the IEEE, New York, 1990, pp. 563-566.

[7] A. M. A. El-Sayed, "Fractional differential-difference equations," J. Fract. Calc., vol. 10, pp. 101–106, 1996.

[8] Xue-Zhi Li, Chun-Lei Tang, and Xin-Hua Ji, "The Criteria for Globally Stable Equilibrium in n-Dimensional Lotka-Volterra Systems," Journal of Mathematical Analysis and Applications, vol. 240, pp. 600-606, 1999.

[9] I. Podlubny and A.M.A. El-Sayed, On Two Definitions of Fractional Calculus.: Slovak Academy of Science, Institute of Experimental Phys., 1996.

[10] A. M. A. El-Sayed, E.M. El-Mesiry, and H.A.A. El-Saka, "Numerical solution for multi-term fractional (arbitrary) orders differential equations," Comput. Appl. Math., vol. 23, no. 1, pp. 33-54, 2004.

[11] B. Daşbaşı, "The Fractional-Order mathematical modeling of bacterial resistance against multiple antibiotics in case of local bacterial infection," Sakarya University Journal of Science, vol. 251, no. 3, pp. 1-13, 2017.

[12] B. Daşbaşı, "Dynamics between Immune System-Bacterial Loads," Imperial Journal of Interdisciplinary Research, vol. 2, no. 8, pp. 526-536, 2016.

[13] B. Daşbaşı and İ. Öztürk, "Mathematical modelling of bacterial resistance to multiple antibiotics and immune system response," SpringerPlus, vol. 5, no. 408, pp. 1-17, April 2016.

[14] M. Mohtashemi and R. Levins, "Transient dynamics and early diagnosis in infectious disease," J. Math. Biol., vol. 43, pp. 446-470, 2001.

[15] B. Daşbaşı and İ. Öztürk, "The dynamics between pathogen and host with Holling type 2 response of immune system," Journal Of Graduate School of Natural and Applied Sciences, vol. 32, pp. 1-10, 2016.

[16] A. Pugliese and A. Gandolfi, "A simple model of pathogen–immune dynamics including specific and non-specific immunity," Math. Biosci., vol. 214, pp. 73–80, 2008.

39

[17] T. Kostova, "Persistence of viral infections on the population level explained by an immunoepidemiological model," Math. Biosci., vol. 206, no. 2, pp. 309-319, 2007.

[18] M. Gilchrist and A. Sasaki, "Modeling host–parasite coevolution: A nested approach based on mechanistic models," J. Theor. Biol., vol. 218, pp. 289-308, 2002.

[19] M. Merdan, Z. Bekiryazici, T. Kesemen, and T. Khaniyev, "Comparison of stochastic and random models for bacterial resistance," Advances in Difference Equations, vol. 133, pp. 1-19.

[20] R. Gorenflo and F. Mainardi, Fractional calculus: Integral and differential equations of fractional order, in: A. Carpinteri, F. Mainardi (Eds.), Fractals and Fractional Calculus in Continuum Mechanics.: Springer, Wien, 1997.

[21] E. M. El-Mesiry, A.M.A. El-Sayed, and H.A.A. El-Saka, "Numerical methods for multi-term fractional (arbitrary) orders differential equations," Appl. Math. Comput., vol. 160, no. 3, pp. 683–699, 2005.

[22] D. Matignon, "Stability results for fractional differential equations with applications to control processing," Comput. Eng. Sys. Appl. 2, vol. 963, 1996.

[23] I. Podlubny, Fractional Differential Equations. New York: Academic Press, 1999.

[24] B. Daşbaşı and T. Daşbaşı, "Mathematical Analysis of Lengyel-Epstein Chemical Reaction Model by Fractional-Order Differential Equation's System with Multi-Orders," International Journal of Science and Engineering Investigations, vol. 6, no. 70, pp. 78-83, 2017.

[25] A. M. A. El-Sayed, E. M. El-Mesiry, and H. A. A. El-Saka, "On the fractional-order logistic equation," AML, vol. 20, pp. 817-823, 2007.

DIGITALIZATION OF SOLAR ENERGY: A PERSPECTIVE

*Nevin TAŞALTIN *, ***

***Maltepe University, Department of Electrical & Electronics Eng., TURKEY,*
E-mail: nevintasaltin@maltepe.edu.tr

****Maltepe University Environment & Energy Technologies Research Center, TURKEY*
ORCID ID: https://orcid.org/0000-0001-6788-1605

ABSTRACT

The risky limits of fossil fuel reserves are increasing the importance of energy in sustainable development. High economic growth rates of developing countries increase their energy consumption. Energy policies, green energy and new technologies are emerging as priority issues in the energy market. Global energy consumption is expected to increase by 28% by 2040. The changing geographical and economic balances in energy reveal the necessity of producing long-term solutions to the changes in energy markets. Solar energy has begun a fundamental transformation from an old analogue system to a fully digital network. This paper have presented a perspective on digitalization of solar energy including the relationship and benefits of, blockchain, industry 4.0, artificial intelligence and big data.

Keywords: Digitalization, solar energy, blockchain, industry 4.0, artificial intelligence, big data.

1. INTRODUCTION

The risky limits of fossil fuel reserves are increasingly increasing the importance of energy in sustainable development. Global energy consumption is expected to increase by 28% by 2040. High economic growth rates of developing countries increase their energy consumption. The changing geographical and economic balances in energy reveal the necessity of producing long-term solutions to the changes in energy markets. Energy policies, green energy and new technologies are emerging as priority issues in the energy market. In the case of predictions, renewable energy will stand out as the fastest growing energy source in the world. Despite this increase in renewable energy sources, coal, oil and natural gas are expected to maintain their position as main energy sources by 2040 and 77% of global energy consumption will still be provided from fossil fuels in 2040. Natural gas among fossil fuels is expected to be the fastest growing energy type. 33% of global energy consumption comes from

petroleum and liquid fuels in 2017, while by 2040 this ratio is expected to decrease slightly to 31% [1-4].

It is foreseen that nuclear energy consumption worldwide will increase by 1.5 times in the period 2018- 2040. Nuclear energy is expected to be the second fastest growing energy source in the world with this projected increase. Increasing energy demand and energy-changing balances are changing the supply and demand markets. For the importer of energy and the dependence on foreign countries in this area, getting rid of energy dependency is of great importance in terms of achieving economic independence. In addition, the geopolitical uncertainty environment, the approach to the limits of sustainability in the use of fossil fuels, and the climate change that has begun to give dramatic signals make it necessary for countries to recreate their energy cycles as soon as possible. When producing solutions for climate change, it is necessary to focus not only on increasing alternative energy sources, but also on reducing energy consumption and developing solutions for energy efficiency [1-4].

Intelligent technologies, including the connection of objects to the Internet, storage of big data, cloud computing systems, artificial intelligence (AI) development, virtual reality, and other forms of advanced communication, fundamentally change the operation of businesses and societies [5-7].

When Industry 4.0 is applied to photovoltaic systems, it provides the stability and reliability needed to manage energy production more effectively. With the digitalization of the solar sector, the increase in producibility will also make the industry more competitive. With the application of digital technologies, smart panel photovoltaic systems offer opportunities to obtain more energy from less solar panel. When the data from the panel are analyzed correctly, many data about panel usage and production are obtained. The use of algorithms allows the use of algorithms to make accurate predictions and make real-time decisions that increase energy production, so that the return on investment of each solar energy increases very rapidly [5-7].

Through the monitoring technology that technology companies continue to develop, it allows photovoltaic system owners and operators to remotely view and remotely perform all details of photovoltaic systems. Each panel provides individual data about the performance of the entire array, which, when combined, provides precise information about the performance of the entire system. Energy managers can scan many photovoltaic systems in real time from any point they connect to the internet using their personal computers or smartphones, and quickly identify the causes of faults and problems. The real-time monitoring technology allows maintenance in the photovoltaic system without a problem yet, eliminating the need for unplanned, tiring, onsite testing that is costly. As a result, plant owners, operating and maintenance operators can ensure that solar panel facilities always operate at maximum efficiency. Such solutions optimize plant uptime and improve energy efficiency. Investors face a much lower failure rate, thus increasing both the return on investment and the operating costs. There is no doubt that many new technologies will be used with the further development of technology or even more costs. A technology that will provide information about the period to be cleaned and the amount of water to be used by a machine to be used for the cleaning of the panels can give information about the data to be taken from the field with the data obtained from the field, which string (panel set) yield is reduced, short circuit or need to change. The sensor technology will allow the panels to see the sun at the right angle, allowing them to control the direction to get more efficiency from the sun [5-7].

Conventional electricity transmission systems are vulnerable to attacks from anywhere in the world due to their centrist nature, as they are exposed to losses due to the transmission of electricity to remote locations. The electrical systems we need for almost all of our needs are exposed to many attacks and malfunctions in the world and cause problems in societies. In

2003, it occurred in the NorthEastern United States and Canada's also affecting power outages and Ireland, Ukraine, Switzerland, society occurring in countries such as Turkey cuts significantly influence are just a few of them [8-10].

Blockchain technology, in which we are familiar with crypto coins, has been proposed to be used in energy transmission systems as a solution to the negative aspects of the system instead of the traditional electricity transmission / distribution systems. While these losses are prevented in the non-centralized system against the losses encountered in transmission to long distances, it is foreseen that operation costs will decrease and personnel costs will decrease. Blockchain technology is a non-centralized system without a single authority, and basically all users in the system can access the data. Therefore, data encryption is used in the system [8-10].

It is thought that more efficient energy trade will be provided in the electricity transmission systems using Blockchain technology. With this system, consumer units will also be able to be included in the system as producers. Through this system, each unit can also monitor the energy produced in the other unit and the system becomes transparent. In the approach to solar energy, a house with a solar panel can be included in this market by selling more than the energy it produces to a non-centralized person (peer to peer). In this way, a local solar market can be established, income flow can be ensured and even a single panel can be included in this system [8-10]. The surplus energy produced by solar panels placed on the roofs of buildings can be sold to neighboring buildings. Although these buildings are connected to each other via the city network, they can use Blockchain systems for trading. These and many other Blockchain-based pilot projects can be implemented in all countries. This approach, which is prepared to be used in solar energy technology, allows us to keep track of the current amount of energy produced, cost, where the energy is produced, where this energy is needed. In public spaces, it can also be supported by communities producing electricity with solar panels. In this way, increase in orientation towards solar energy can be achieved and loss rates can be reduced and social contribution can be provided to energize critical areas and effective use can be increased [8-10].

In the near future, Artificial Intelligence (AI) will further automate solar industry operations and increase efficiency in the renewable energy sector. With the Big Data analytics, which is one of the leading disciplines in AI and its advancement in the digital world, sustainability parameters such as decision making and planning, status monitoring, maintenance, robotics, audits and supply chain optimization can be most effectively presented to the renewable energy world [11, 12]. With the benefits of this relationship of AI and Big Data;

- The development of robotic applications, which are widely used for remote examination, accelerates day to day.

- The decision-making mechanism of monitoring/scanning robots using a range of technologies, such as microwave and ultrasonic transmitters / receivers, which can approach the surface of the Solar Energy panels to reveal the error and failure of the materials used in solar panels, can be improved by increasing the accuracy share day to day.

- Efficient and efficient inspection of solar energy panels of autonomous drones with real-time artificial intelligence-assisted analyzes can be achieved by maximizing the efficiency of minimum human power.

- Great data to benefit from historical data and artificial intelligence, which accelerates due diligence, optimizes the energy used for planning and analysis.

- Enables the establishment of systems that can balance supply and demand with minimum margin of error in energy supply.

- Estimates such as forecasting in which months of the year the region will be cloudy and the estimation of the current system to produce effective / usable energy in a yearly average. With the assumption that production will be performed at full capacity with the exception of the low production forecast, the facilities producing energy in fossil fuels may reduce the use of fossil fuels or stop it for a short time. Thus, when different sources of renewable energy meet in the same database, fossil fuel consumption can be gradually reduced.

- Within the scope of the cause-effect relationship within these main features; In order to realize the problems in the electricity grid in advance, to reduce the network problems, and to use the AI in order to get the systems back up to speed, the research studies have started. AI will be realized in cooperation with AI and big data in order to eliminate power imbalances in electricity networks, to prevent failures and damages that may occur in the network and to be used as a help element in the faster elimination of blackouts, cyber attacks, solar burst and other reasons.

All of these relationships will feature the technology of Internet of Things, the shining star of the IT industry, to work healthy and create the Big Data infrastructure. Thus, the data of the solar energy panels rather than the interconnected system with the electrical connection in the networks will all be interconnected.

2. RESULTS AND CONCLUSIONS

The solar energy sector is considered as one of the most important investment in renewable energy resources invested together with government incentives. When the fees are taken into account, it appears to be reasonable investment as depreciation period. However, when it comes to sustainability costs and business needs in applications such as solar farms, an investment is difficult for the investor. Therefore, it is possible to minimize the sustainability costs by making use of the developing technology. With the concept of the Internet of Things (IoT), each solar system can be an object; NarrowBand IoT (NB-IoT) technology with low power consumption will allow you to observe all values such as battery, inverter, fault information, total generated energy by using the energy produced. In this way, the investor can share your monthly/weekly/yearly data with the energy you produce in the future, compare with the weather information and the energy you produce, and share this information with you if your panel needs to be cleaned. In order to facilitate our lives, the energy sector is of great importance in smart city applications prepared for use in all sectors such as transportation, energy and communication. The increasing number of electric cars and the number of devices we use each day makes the efficient use of solar energy more important. When energy distribution companies enter their data in forecasting systems, the energy needs of hours/minutes will be revealed and the systems that will be put into use in order to assist the city network will be widespread in the coming days. Solar energy technology will be transformed into sustainability, low cost and scalable systems for both countries and investors.

REFERENCES

[1] https://assets.kpmg/content/dam/kpmg/tr/pdf/2018/02/sektorel-bakis-2018-enerji.pdf

[2] https://www.mmo.org.tr/sites/default/files/EnerjiGorunumu2018_1.pdf

[3]http://www.enerji.gov.tr/File/?path=ROOT%2F1%2FDocuments%2FEnerji%20ve%20Tab ii%20Kaynaklar%20G%C3%B6r%C3%BCn%C3%BC%2FSayi_15.pdf

[4] http://www.yegm.gov.tr/document/enver_gelisim_rapor_2018.pdf

[5] STOCK, T, SELIGER, G. 2016. Opportunities of Sustainable Manufacturing in Industry 4.0. Procedia CIRP 40 536-541.

[6] KAGERMANN, H. 2014. Change Through Digitization-Value Creation in the Age of Industry 4.0. Management of Permanent Change 23-45.

[7] LISERRE, M, SAUTER, T, HUNG, J.Y. 2010. Future Energy Systems: Integrating Renewable Energy Sources into the Smart Power Grid Through Industrial Electronics. IEEE Industrial Electronics Magazine 4, 1, 18-37.

[8]ZHENG, Z, XIE, S, DAI, H.N., CHEN, X, WANG, H. 2018. Blockchain challenges and opportunities: a survey. Int. J. Web and Grid Services, 14, 4, 352-375.

[9] IMBAULT, F, SWIATEK, M, BEAUFORT, R, PLANA, R. 2017. The green blockchain: Managing decentralized energy production and consumption. IEEE Industrial and Commercial Power Systems Europe (EEEIC / I&CPS Europe), 17029854.

[10] XU, C, WANG, K, GUO, M. 2017. Intelligent Resource Management in Blockchain-Based Cloud Datacenters. IEEE Cloud Computing 4, 6, 50-59.

[11] ZHOU, K, FU, C, YANG, SHANLIN. 2016. Big data driven smart energy management: From big data to big insights. Renewable and Sustainable Energy Reviews 56, 215-225.

[12] KOLOKOTSA, D, ROVAS, D, KOSMATOPOULOS, E, KALAITZAKIS, K. 2011. A roadmap towards intelligent net zero- and positive-energy buildings. Solar Energy 85, 12, 3067-3084.

45

A RULE OF THUMB TO DETERMINE THE LOCATION OF WI-FI MODULE ON PLASTIC OR METAL CHASSIS

Alper ÖZEL & Meriç DÖNER***

**İstanbul Technical University, Faculty of Electrical Engineering, Department of Electronics and Communication Engineering, TURKEY, E-mail: alper.ozel@arcelik.com,*
ORCID ID: https://orcid.org/0000-0002-3929-1672

** İstanbul Technical University, Faculty of Electrical Engineering, Department of Electronics and Communication Engineering, TURKEY, E-mail: meric.doner@arcelik.com,
ORCID ID: https://orcid.org/0000-0002-3113-6918

ABSTRACT

In this study, a general rule of thumb was developed for an easier and more robust product configuration management containing more than one Wi-Fi modules. In the study, a television chassis is being used for two different models having different Wi-Fi modules in them. From manufacturing perspective, managing the product configuration as simple as it can improve the manufacturing costs drastically. Two Wi-Fi modules having different antenna characteristics will perform differently based on their locations on the chassis. Based on the distance of the antenna to the closest material of the chassis effects antenna characteristics of both Wi-Fi modules. We obtained a common minimum distance that does not disrupts the antenna performance of both Wi-Fi modules to out of Wi-Fi spectrum. For the particular case in this study, we obtained a safe distance which keeps the voltage standing wave ratio of the antennas of both Wi-Fi modules under two over Wi-Fi frequency spectrum.

Keywords: *Wi-Fi, Wi-Fi module positioning, Wi-Fi Antenna performance.*

1. INTRODUCTION

Wi-Fi based WLANs (Wireless Local Area Network) are widely used for Internet access. They were designed such that an Access Points (AP) serves few associated clients with symmetric uplink/downlink traffic patterns. Usage of Wi-Fi modules in televisions and in other household goods frequently experience poor performance in terms of downlink/uplink throughput, goodput and responsiveness. We study the environmental factors that are responsible for this performance degradation. We designed a Wi-Fi module for TV applications and analyze the change in antenna characteristics, antenna performance and throughput

performance of the module for various placement locations on the chassis of the television which has metal on the inside and plastic on the outside. We find that the placement location of the module in reference to the closest distance from antenna surface to plastic or metal material surface. Due to the change in the antenna characteristics, received signal strength changes and it results in performance loss. In this study, we propose a safe method to define a rule of thumb for locating the Wi-Fi modules in household goods to guarantee an acceptable performance degradation in antenna performance. We demonstrated that maximum tolerance on Wi-Fi throughput performance can be limited by this method.

2. MATERIAL AND METHODS

2.1. Importance of Antenna in Wi-Fi Systems

A Wi-Fi transceiver has several radio frequency (RF) signal paths due to many supported frequency bands. Each of these RF signal paths contain a duplex filter, a power amplifier, a low noise amplifier, and so on, resulting in various parallel paths. All this signal paths start with antenna. The receiver system starts with the antenna listening to the transmitted, attenuated and distorted signal. Overall noise of the receiver system is conformed with the noise of the antenna and with the noise addition of every element of the receiver. According to the Friis equation [1], the first block in the chain effects the SNR (Signal to Noise Ratio) most since it's noise will be transferred through each block in the chain. Therefore, in wireless systems such as Wi-Fi, the performance of antenna plays a great role in communication performance.

2.2. Parameters result in degrade in antenna Performance

Printed circuit board trace antennas and stamp antennas suffer from degradation in performance due to the presence of metal surroundings by the most [2]. However, plastics and mica surroundings are also crucial to antenna performance due to the loading effects and impedance imbalance. Plastic and mica are dielectric materials and their presence near antenna results in frequency shift in the center frequency. Moreover, some of the plastic and mica materials may have higher conductivity than usual due to the paintings on them which may contain iron oxides [3]. That results in complete characteristic change in the antenna.

48

2.3. The Instruments used in the study

Two different Wi-Fi modules are used in the tests. Their circuit board sizes are the same but one has stamp antenna and the other has PCB trace antenna. Inhouse Wi-Fi module with PCB trace antenna has transceiver architecture as Single-Band IEEE 802.11n (2x2) WLAN while the other Wi-Fi module with stamp antenna has transceiver architecture as Dual-Band IEEE 802.11n (2x2) WLAN. We designed the Wi-Fi module with the PCB trace antenna for TV applications and the other one is commercially available stamp antenna Wi-Fi. They both are to be used in the same television chassis.

Fig. 1. Single-Band IEEE 802.11n (2x2) WLAN Block Scheme
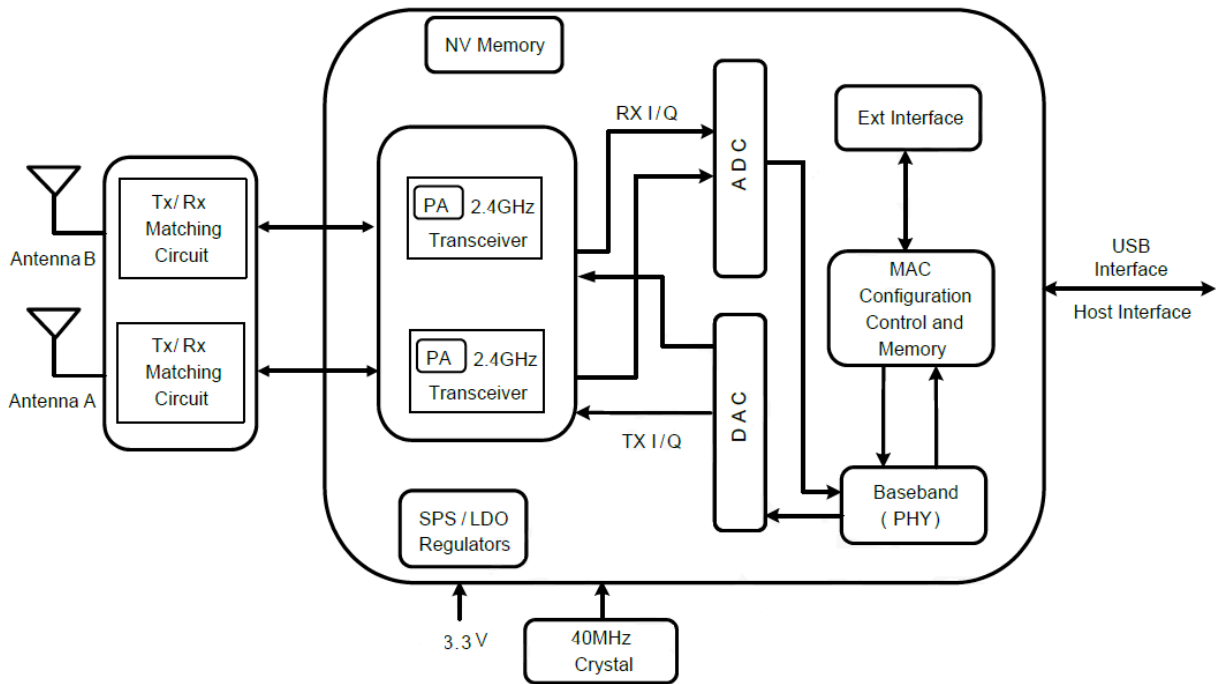
Fig. 2. Wi-Fi Module with PCB Trace Antenna

Fig. 3. Dual-Band IEEE 802.11n (2x2) WLAN Block Scheme
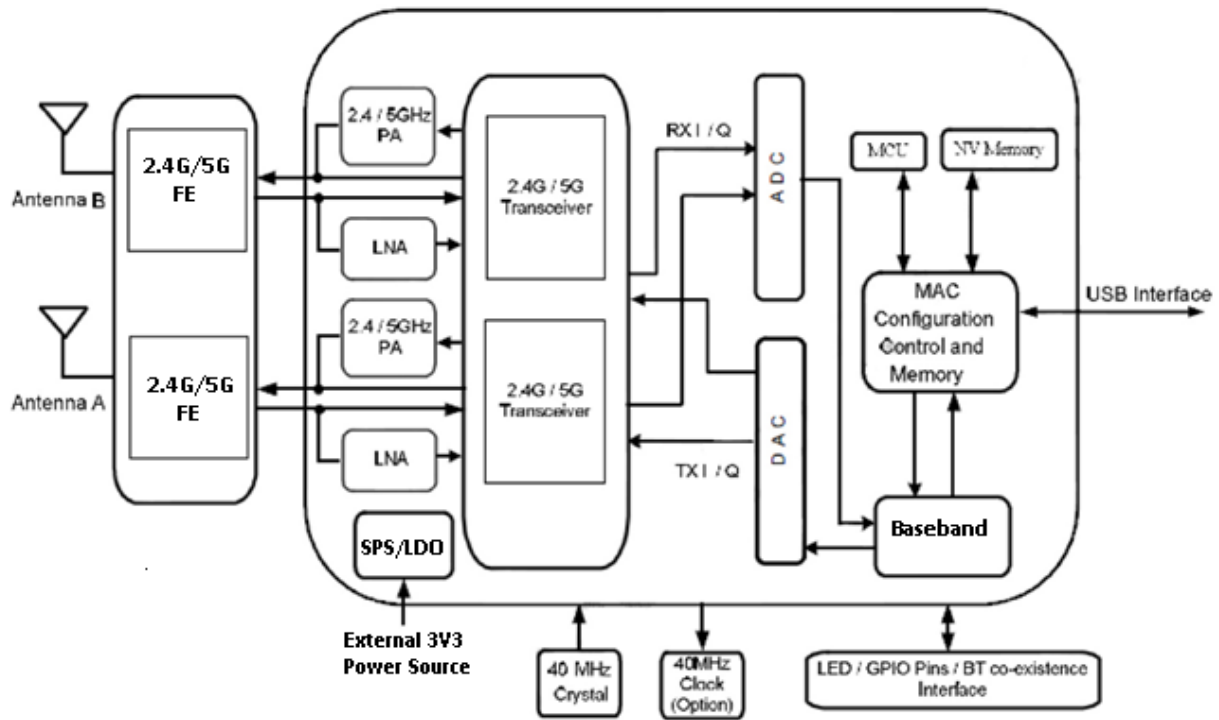
Fig. 4. Wi-Fi Module with Stamp Antenna
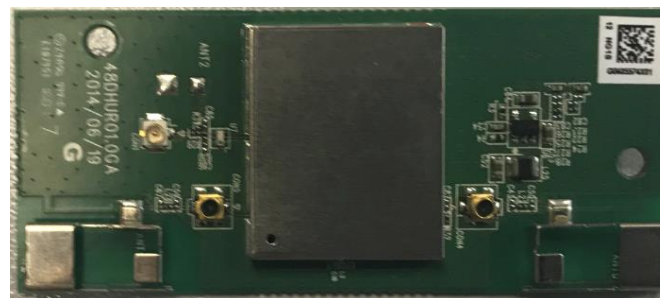
In the figures 1 and 3, system schemes of the Wi-Fi modules are demonstrated. Figure 1 shows the module which is designed by us and is a single band Wi-Fi module. Meaning it operates only in 2.4 GHz band while the other one is dual band and operates in both 2.4 GHz and 5 GHz band. As seen in the schemes, the signal is first by the antennas and then travels through the front end (FE), the first part that signal goes. This part is required to have an impedance matching regarding the signals frequency band. And for the received signals fed into a low noise amplifier (LNA) which is a special amplifier designed to amplify incoming signals with a low noise contribution. On the other hand, power amplifier (PA) is designed to amplify the outgoing signal with highest efficiency. The received signal is downconverted to the baseband and the transmitted signal is upconverted to the RF carrier frequency by the transceiver. Downconverted signal is quantized by the analog-to-digital converter (ADC) and fed into the baseband. Also, transmitted signal is dequantized by the digital-to-analog converter (DAC) and fed to the transceiver. After Media Access Control (MAC) sublayer checks if the incoming data is linked to the device and permits the data transition accordingly. Also, when the device is transmitting a package, MAC sublayer always attaches the MAC ID to the package to satisfy TCP/IP protocol.

The reference (in figure 4) and designed (in figure 2) prototypes were utilized for analyzing the influence of the proximity of antennas to different materials which are surrounding the Wi-Fi module on television (Metal and Plastic) on antenna performance. The change in antenna performance was measured with a Vector Network Analyzer (Rohde Schwarz ZNB).

For each case, each condition which has different proximity from Wi-Fi module to the material, reflection coefficient S11 and voltage standing wave ratio (VSWR) measurements are made to see direct effect of the change in the antenna performance.

2.4. Test Method

We connected the Wi-Fi modules' antenna ports to VNA (Vector Network Analyzer) via RF connectors and we measured their VSWR throughout the Wi-Fi frequency spectrum. VSWR is a function of the reflection coefficient, which describes the power reflected from the antenna. If the reflection coefficient is given by Γ, then the VSWR is defined by the following formula [4]:

$$VSWR = \frac{1 + |\Gamma|}{1 - |\Gamma|} \tag{1}$$

The VSWR is always a real and positive number for antennas. The smaller the VSWR is, the better the antenna is matched to the transmission line and the more power is delivered to the antenna. The minimum VSWR is 1.0. In this case, no power is reflected from the antenna, which is ideal. However, in many Wi-Fi applications, VSWR below 2 over the Wi-Fi band considered very good while VSWR between 2 and 3 is satisfying [5].

In the tests, firstly, VSWR characteristics of the antennas were measured in floating condition without any obstacle nearby. Then the Wi-Fi Modules are placed on metal and plastic obstacles with different distance to the obstacles and deformities in the frequency response were observed.

The test environment is shown in figures 6-8. The test method that is used to make the measurements is shown in figure 5. And the graphical outputs of the S11 measurements when the modules are in the floating conditions are shown in the figures 9-12.

Fig. 5. Illustration of the Test Method
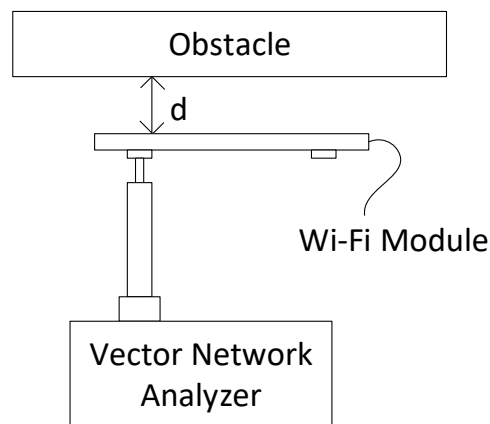
Fig. 6. Wi-Fi module in floating position.

Fig. 7. Wi-Fi module placed on Metal Surface

Fig. 8. Wi-Fi module placed on Plastic Surface

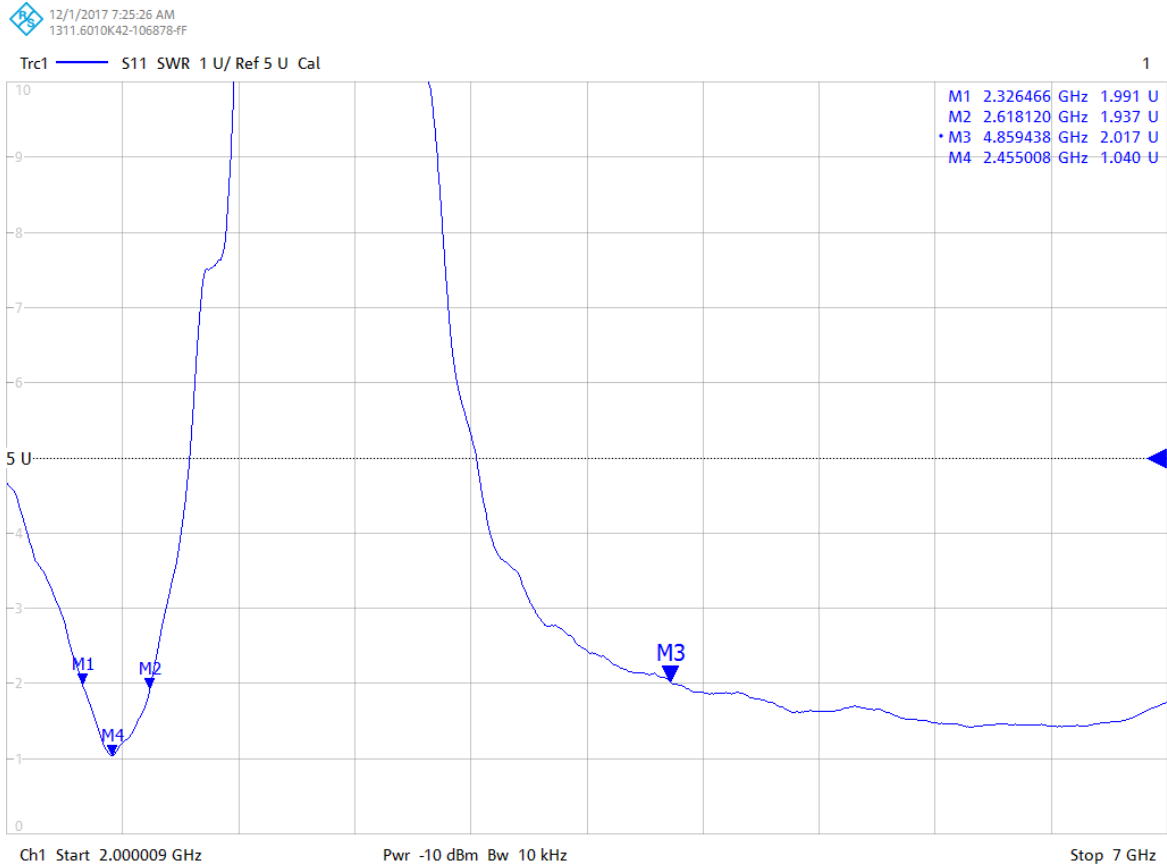**Fig. 9.** VSWR of Floating Dual Band Wi-Fi Module Antenna #1

Fig. 10. VSWR of Floating Dual Band Wi-Fi Module Antenna #2
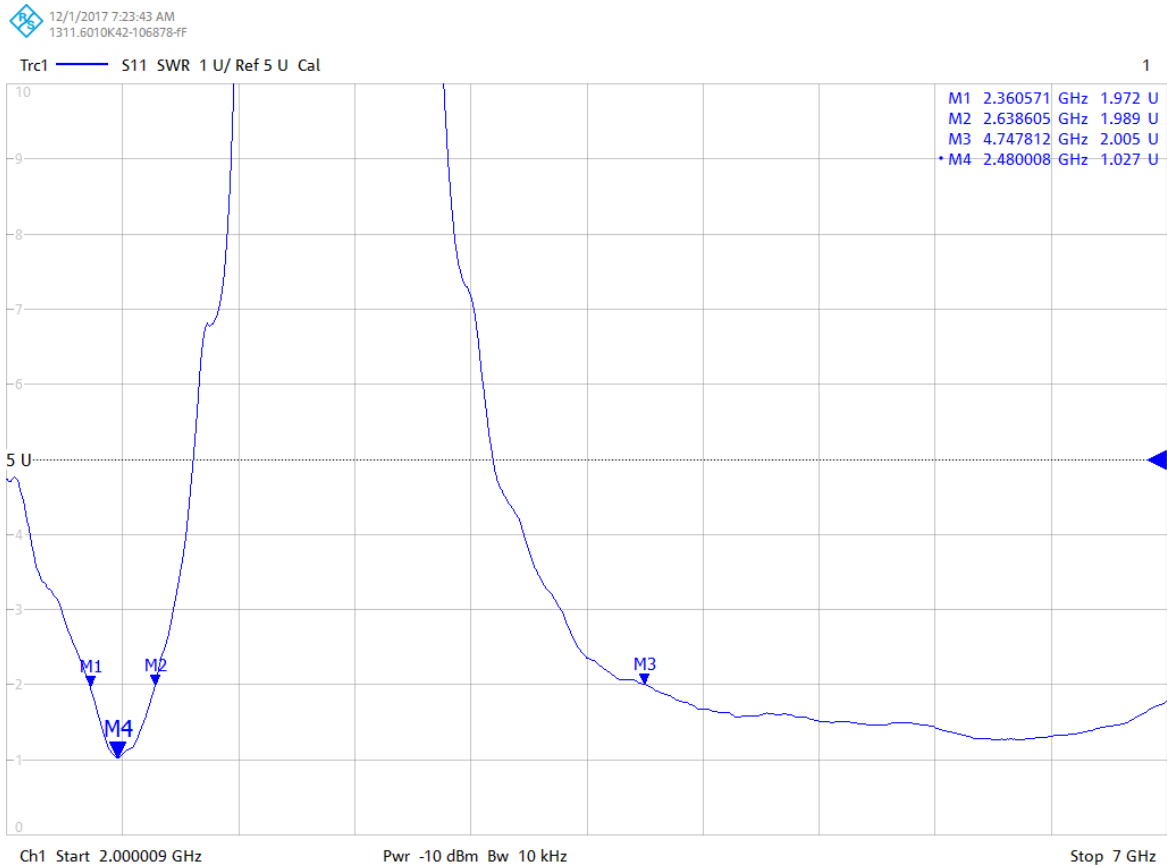
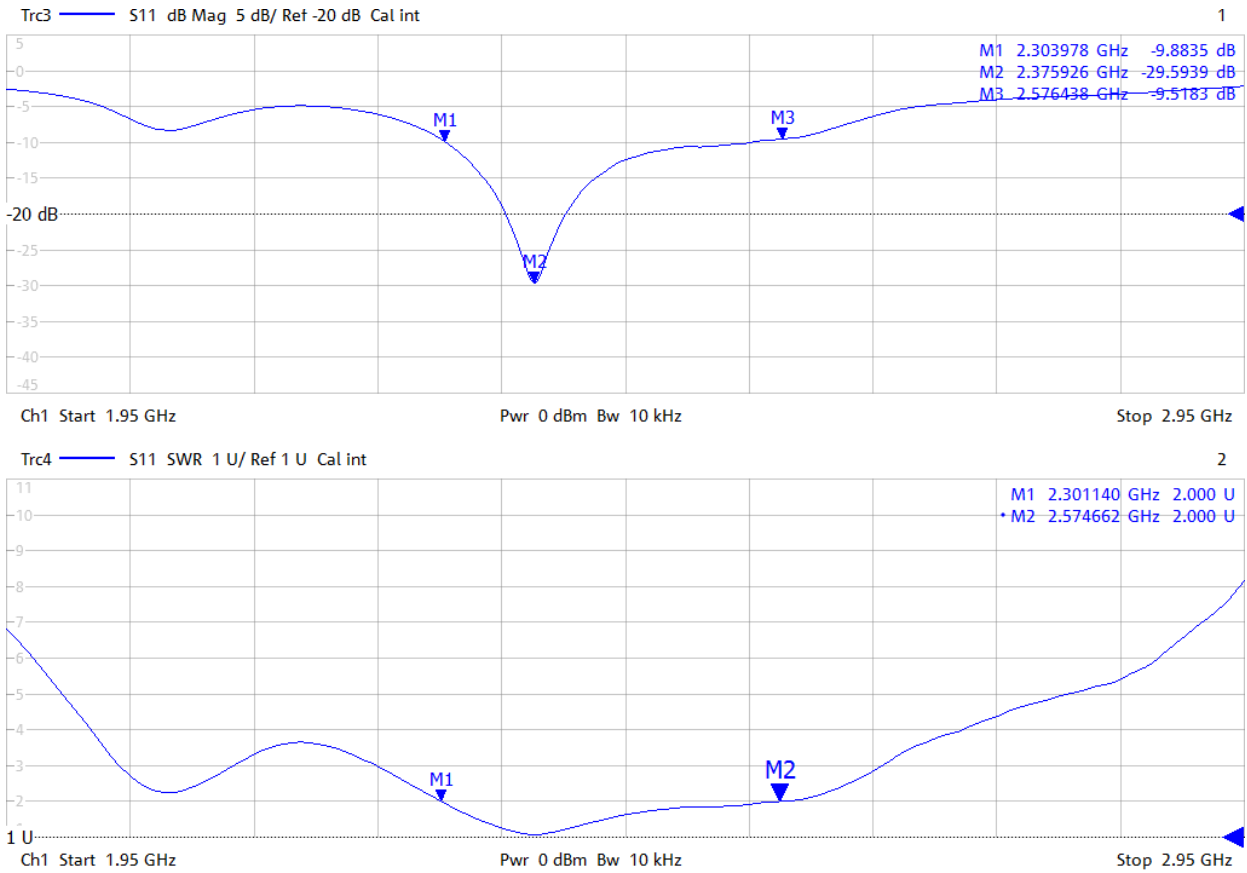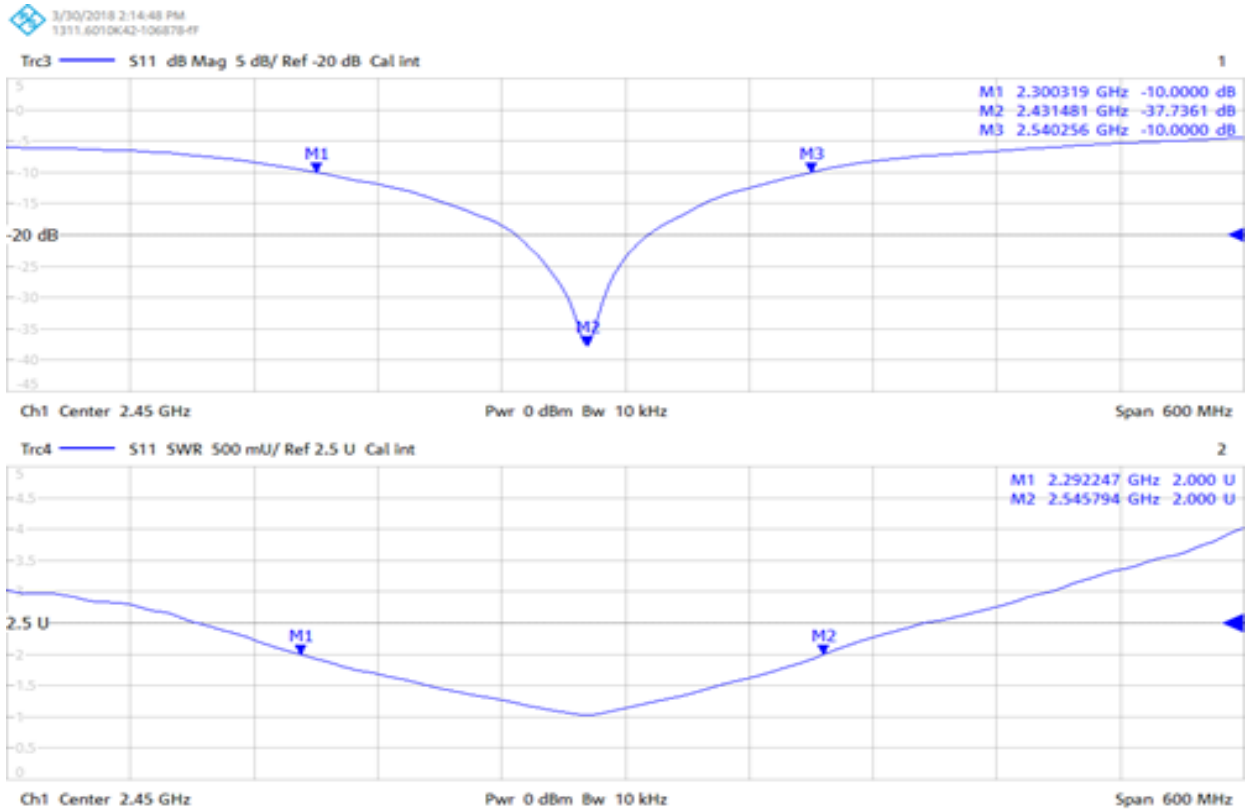**Fig. 11.** VSWR and S11 Value of Floating Single Band Wi-Fi Module Antenna #1

Fig. 12. VSWR and S11 Value of Floating Single Band Wi-Fi Module Antenna #2

2.5. Aim of the Study

In the figures 2 and 4, actual Wi-Fi modules that are used in this study are shown. In figure 2, the inhouse design Wi-Fi module is shown where in 4, the reference commercial Wi-Fi module is shown. They are two different Wi-Fi modules with the same board sizes and they both will be used in two different products with the same television chassis. To mount the Wi-Fi modules on the chassis, there must be a holder or a special slot structure on the chassis and it causes additional costs in manufacturing and allocates extra space on the chassis. Therefore, it is efficient to use both Wi-Fi modules on the same location on the chassis so there will be only one structure for Wi-Fi modules to be mounted. It will simplify the product management and the manufacturing process. However, due to the different antenna characteristics of the modules, their antenna performances on the same location will be different.

Our goal was to determine a minimum distance to TV chassis materials such as plastic and metal for Wi-Fi module positioning in television chassis so that Wi-Fi signal receptions of both modules maintain a good quality over the Wi-Fi frequency spectrum.

Fabrication of household goods requires use of same materials in many configurations for many products. For instance, in fabrication of a television, same chassis may be used for two or more different models. Also, two or more different Wi-Fi modules can be used in the same chassis for many different models. This variety in product configurations forces designers to create practical rule of thumbs for design and integration of each critical component. In this study, the case is to create a rule of thumb for locating different Wi-Fi modules in same chassis. Two different Wi-Fi modules having different antenna characteristics naturally response to the environment differently. The goal of this study is to determine a safe distance from different materials of the chassis for both Wi-Fi modules so the mechanical design can have a common location for both modules in the product without sacrificing a great received signal quality. The received signal quality is directly related to the S11 parameters, hence the VSWR of the antennas (1). Therefore, the evaluation of the measurements will be based on S11 parameters.

55

3. RESULTS AND DISCUSSION

3.1. Test Results and Comparison

We obtained two tables, table 1-2, that show the frequency value when VSWR hits to 2 first (Band Low) and after (Band High) in 2.4 GHz band regarding the type of obstacle and the distance from Wi-Fi module to the obstacle. Also, the frequency of lowest VSWR value is given as center frequency.

Measurements are made when the Wi-Fi modules were floating on air without surrounded by any material and when the modules were placed on a broad plastic or metal surface with different distances.

Table 1. Measurement results of Antenna characteristics of Dual-Band Wi-Fi module.

Wi-Fi Benchmark		2,4 GHz Band			5 GHz Band
Distance d (mm)	Obstacle	Band Low (GHz)	Center Freq (GHz)	Band High (GHz)	Band Low (GHz)
Floating Antenna 1		2,326	2,455	2,618	4,859
Floating Antenna 2		2,361	2,480	2,639	4,748
1	Plastic	2,242	2,410	2,572	4,774
2	Plastic	2,301	2,420	2,597	4,774
1	Metal	2,110	2,200	2,259	5,987
2,5	Metal	2,090	2,185	2,449	5,817
5	Metal	2,085	2,150	2,484	5,590
7,5	Metal	2,085	2,135	2,560	5,376
10	Metal	2,459	2,515	2,589	4,312
12,5	Metal	2,444	2,520	2,629	5,266
15	Metal	2,437	2,535	2,630	4,312
17,5	Metal	2,422	2,515	2,627	4,430
20	Metal	2,409	2,515	2,621	5,378
22,5	Metal	2,38	2,510	2,621	5,164

Table 2. Measurement results of Antenna characteristics of Single-Band Wi-Fi module

Single Band Wi-Fi Module		2,4 GHz Band		
Distance d (mm)	Obstacle	Band Low (GHz)	Center Freq (GHz)	Band High (GHz)
Floating Antenna 1		2,387	2,482	2,598
Floating Antenna 2		2,300	2,431	2,540
1	Plastic	2,082	2,258	2,363
2	Plastic	2,311	2,436	2,551
1	Metal	2,579	2,590	2,606
2,5	Metal	2,573	2,589	2,606
5	Metal	2,405	2,505	2,561
7,5	Metal	2,545	2,596	2,640
10	Metal	2,239	2,429	2,525
12,5	Metal	2,332	2,408	2,583
15	Metal	2,282	2,372	2,512
17,5	Metal	2,329	2,411	2,579
20	Metal	2,388	2,481	2,596
22,5	Metal	2,392	2,471	2,599

Both tables show the shift in frequency response as expected. The antennas of both Wi-Fi modules are affected by the proximity to metal and plastic surfaces due to the changes in their impedances. Their operating frequency interval which is when the VSWR is below 2 shifted drastically regarding the distance between the module and the chassis surface.

Wi-Fi single band frequency spectrum covers from 2412 MHz to 2472 MHz. The VSWR value below 2 within this frequency spectrum is an important criterion for the performance of the Wi-Fi modules. Therefore, the minimum distance to the chassis when both modules meet this criterion must be found to determine the location of the Wi-Fi module holder on the chassis.

3.2. Conclusion

The results clearly show that the two Wi-Fi modules, due to the structure of their different antenna structures, response differently to the change in distance to the plastic or metal chassis. However, the results also show that both Wi-Fi module have a good antenna performance when they have minimum 2 mm distance to plastic chassis and when they have 5 mm distance to metal chassis. In given circumstances when they have 2 mm distance to plastic chassis or when they have 5mm distance to metal chassis, they both remains good antenna performance with VSWR below 2 within Wi-Fi spectrum.

Finding these minimum distances allows using only one place, therefore, one holder structure for both Wi-Fi modules and simplifies the manufacturing process and the design leading decrease in the manufacturing costs.

REFERENCES

[1] H. T. Friis, "Noise figures of radio receivers", *Proc. IRE*, vol. 32, no. 7, pp.419–422, July, 1944
doi: 10.1109/JRPROC.1944.232049

[2] L. F. T. G. Amarai and M. S. Novo, "Effects of printed circuit board on the performance of tag antennas for passive RFID," *2017 Progress in Electromagnetics Research Symposium - Spring (PIERS)*, St. Petersburg, 2017, pp. 621-626.
doi: 10.1109/PIERS.2017.8261815

[3] M. K. Mandal and M. Kahar, "A multiband robust planar antenna for wireless handheld devices," *2016 Asia-Pacific Microwave Conference (APMC)*, New Delhi, 2016, pp. 1-4.
doi: 10.1109/APMC.2016.7931474

[4] Wang Shan, Guo Chenjiang, Zhou Yanqiu and Ding Jun, "A vector method for determining voltage standing wave ratio of radio communication," *2015 12th IEEE International Conference on Electronic Measurement & Instruments (ICEMI)*, Qingdao, 2015, pp. 656-660

[5] M. A. Al-Tarifi and D. S. Filipovic, "Multi-layer dielectric rod antenna with stable patterns over decade bandwidth," *2017 IEEE International Symposium on Antennas and Propagation & USNC/URSI National Radio Science Meeting*, San Diego, CA, 2017, pp. 505-506.
doi: 10.1109/APUSNCURSINRSM.2017.8072295

58

ORGAN DONATION AWARENESS

*Cabir ALAN * & Hasan Anıl KURT***

* Canakkale Onsekiz Mart University, Faculty of Medicine, Department of Urology. TURKEY
E-mail: cabir1@yahoo.com,ORCID ID: https://orcid.org/0000-0002-6024-4475

** Canakkale Onsekiz Mart University, Faculty of Medicine, Department of Urology, TURKEY
E-mail: doktoranil@yahoo.com, ORCID ID: https://orcid.org/0000-0001-7292-2248

ABSTRACT

Organ transplantation is a medical procedure which a healthy organ is removed from the living or cadaver donor to be transplanted into the recipient whose related organ is no more functioning properly. There are two types of organ transplantation: living-donor and cadaver-donor transplantation. After the donation, related organs are taken from the patient following the brain death in the ICU and transplanted to the recipient. Organs can be used only when the brain death is confirmed and declared in the ICU. Brain death is the irreversible state of loss in the brain functions. According to the article 14 of the law No 2238, when a patient is officially brain-dead, the organs or tissues can be taken with the consent of their spouse, children of age, mother/father, siblings in order or an acquaintance of any of them if the rest is not present. Organ donation is when an individual gives their consent by documentation, with free will, and allow their tissues and organs to be donated for the treatment of other patients after the end of their life medically. According to the law no 2238, any citizen who is mentally healthy and above 18 years of age, can donate their organs and obtain an organ donation card. Organ transplantation is a very serious medical issue in Turkey as it is in other countries and the donation rates should be increased by informing the public and getting more participation. Success in organ transplantation can be obtained by a higher number of organ donations

Keywords: Organ Transplantation, Organ Donation, Brain Death

ORGAN DONATION AWARENESS

Organ transplantation is a medical procedure which a healthy organ is removed from the living or cadaver donor to be transplanted into the recipient whose related organ is no more functioning properly. In our country, transplantation of kidney, skin, liver, heart, lungs, pancreas, small intestine is permitted. Bone, bone marrow and cornea are the tissues for transplantation. There are two types of organ transplantation: living-donor and cadaver-donor transplantation.

A living-donor transplantation is a procedure where the donor can donate one of the kidneys, a portion of liver or bone marrow providing that the blood and tissue type of the organ donor and the organ recipient match, while still alive. The donor must be the spouse of the recipient for at least two years or they must be fourth degree of relatives. The success rate of living-donor transplantation is higher compared to cadaver-donor transplantation.

After the donation, related organs are taken from the patient following the brain death in the ICU and transplanted to the recipient. These patients are called cadaver donors. Organs can be used only when the brain death is confirmed and declared in the ICU. Organs cannot be used under any other conditions of death.

Brain death is the irreversible state of loss in the brain functions. In brain death, blood circulation completely stops and the person is considered dead by medical and legal descriptions. The patient lacks reflexes such as: light reflex, cornea reflex, - oculocephalic and oculovestibular reflexes, oropharyngeal reflex as well as being unresponsive to facial nerve along with a positive apnea test.

Brain death is not a persistent vegetative state. In brain death, the patient is connected to a ventilator and has no brain function or possibility to revive in any way. However, when a patient is in a vegetative state, he/she usually still has respiration and there is still a slight possibility of reviving. The blood circulation and brain functions are still in place.

The most common causes of brain death are severe head injuries, aneurysmal subarachnoidal and intracerebral hemorrhage, cerebral edema and herniation, extended cardiac resuscitation and asphyxia.

Two physicians are required for the assessment and declaration of brain death. A Neurosurgeon or a Neurologist- an Anaesthesiologist or an Intensivist. The physicians will do physical examination, radiological and lab tests to determine whether the patient meets brain death criteria. If so, the patient is pronounced brain dead along and it is officialized with a certificate. Without the certificate, brain death is not finalized and the organs cannot be taken away. Physicians listed above, decide independently upon the declaration of brain death within the boundaries of medical possibilities.

According to the article 14 of the law No 2238, when a patient is officially brain-dead, the organs or tissues can be taken with the consent of their spouse, children of age, mother/father, siblings in order or an acquintance of any of them if the rest is not present.

Organ donation is when an individual gives their consent by documentation, with free will, and allow their tissues and organs to be donated for the treatment of other patients after the end of their life medically. After filling out an application form on E-nabiz, anyone who wishes to donate their organs can obtain their donation cards before two witnesses by applying to local health authorities, organ donation units in the hospitals, family physicians. The person who has an organ donation card must carry it with themselves at all times.

According to the law no 2238, any citizen who is mentally healthy and above 18 years of age, can donate their organs and obtain an organ donation card.

In Turkey, organ donation is often refused due to several reasons: the unclarity of people on the concept of brain death, anxiousness about the appearance of their body or physical integrity after donation, social, cultural and religious perceptions, unreliability of who the recipient will be, anger towards the hospital/staff, fear of delay or not getting the body back.

The person is not obliged to have all their organs donated. On the organ donation card, there are options to choose from regarding which organ is to be donated. In this section, the donor may tick up the ones he/she wishes to donate and no other organs can be taken under any

circumstances. If the death of the donor occurs at home, the scene of the accident or on the way, the organs cannot be taken. Only the organs of those who are medically declared as brain dead in the hospital can be taken.

If one wishes, they can change their mind just by ripping up the donation card or informing their family regardless of whether they have the card or not. The donation card is never sufficient on its own in any case. The organs cannot be taken without the consent of the family or acquaintances. Therefore, if one wishes to donate their organs, they must inform and let their family know about their decision.

The donated organs cannot be given to anyone with the purpose of any interest or benefits. According to the law no 2238, giving away one's organs in exchange for profit/interest is prohibited.

The recipients are determined primarily according to their compatibleness of blood and tissue groups and medical urgency by National Coordination System of Organ and Tissue Transplantation. There is no discrimination of gender, race, economical status. The organ is transplanted to the recipient who is the most available in terms of distance.

Organ transplantation surgery is done meticulously by surgical teams in operating conditions with the skin covered by blind stitch so that the body integrity is preserved upon delivery to the family.

The waiting lists are made according to the types of transplant patients applied to organ transplantation centers in the framework of the formats presented by the Ministry following the suggestions of Scientific Council Institution. Organ and tissue transplantation centers make the transplant waiting list and inform the Regional Coordination Center (RCC) and National Coordination Center (NCC) in cases of urgent organ and tissue needs. A committee, which was established by RCC, an agency of Ministry of health and its agency NCC, decides upon each kidney transplant recipient by the standards of organ sharing criteria.

According to the decision no. 396, dated 6.3.1980 by Turkish High Board of Religious Affairs (under the Turkish Presidency of Religious Affairs), the organ transplantation is approved (as long as there is no material benefit or payment). The same institution also describes the organ donation as "the biggest favor one can do to the other".

Statistically, the total number of patients declared brain dead in 2017 was 1969 while the number of cadaver donors was 472. In 2018, 472 patients were declared brain dead with the number of 479 donated cadavers within the same year.

If we happen to answer the question of "Why do we need to increase organ donation?" with the number of patients waiting for organs: among the total of more than 60 thousand patients with chronic renal failure, there are 22062 waiting on the kidney transplant list, 2236 on the liver list, 729 on the heart list, 272 on the pancreas list and 2628 waiting on the cornea list. Approximately 6000-7000 patients die while waiting for an organ transplantation annually.

In our country, the number cadaver donors is much lower than living-donor transplantation compared to that in other countries. For instance, %80 of the organs in England is obtained from cadaver donors while %70 of the total is obtained from living-donor transplantation in our country.

Organ transplantation is a very serious medical issue in Turkey as it is in other countries and the donation rates should be increased by informing the public and getting more participation. Success in organ transplantation can be obtained by a higher number of organ donations. In our country, the living-donor transplantations are at a very high rate due to "traditional close-knit family relations" while cadaver donors are much fewer in comparison

with other countries. Healthcare professionals bear great responsibilities and duties on this issue. The awareness of the public should be raised strategically by detecting the factors negatively affecting organ donations and clarifying any questions in people's minds to change the negative attitudes towards it.

This study was presented at the 2nd International Awareness Congress on 13-15 December 2018.

RESOURCES

1. T.C. Saglik Bakanligi, https://www.saglik.gov.tr/, https://organ.saglik.gov.tr/

2. Turkiye Organ Nakli Dernegi, http://www.tond.org.tr/tr/

BIODIVERSITY AND DIET OF COCCINELLIDAE ON CITRUS IN METIDJA (ALGERIA)*

*Nabila BOUBEKKA * & Samia HACINI*

* *Akli Mohand oulhadj –Bouira (Algeria) University Higher National Agricultural School, ALGERIA,*
E-mail: boubekkanabila@hotmail.fr

ABSTRACT

Biological control is a viable alternative to the use of chemical pesticides that are harmful to the environment. From this perspective, this work aims to make an inventory of Coccinellidae and to classify them according to their diet. Sampling by yellow sticky plates is carried out each week from 23 April to 24 July 2014 at the Eastern Metidja very important citrus region in Algeria. A total of 16 ladybug species are sampled in four citrus species, orange, lemon, clementine and pomelo. It is the Coccidiphagous that are the richest with a total of 7 species, followed by the aphidophagous with 5 species and mycophagous with the two species. Finally found the aleurodiphagous and acariphagous, with a single species for each group. With regard to relative abundance, a total of 467 individuals coccinellidae were captured, of which the species Clitostethus arcuatus (ladybug aleurodiphagous) alone counted 285 individuals, that is 61.29%.

Keywords: *Biodiversity, Coccinellidae, Diet, Citrus, Mitidja.*

INTRODUCTION

Given the human, economic and agricultural importance of citrus growing in Algeria, it is important to ensure the best productivity and to conduct it in good conditions. The enemies that can cause significant damage to citrus, both on the plant itself and on the crop, are extremely varied and numerous. Among these enemies is a whole host of pathogens and pests, more than 120 pests are arthropods (AUBERT, 1992), include aphids, cochineal and whitefly. These pests are fought mainly by pesticides, but the use of chemicals is harmful to human health and the environment. This is why, with a view to sustainable development, this control method is increasingly being replaced by biological control. Auxiliary fauna is one of the major limiting factors for pests. Among this fauna, ladybugs. In the same optics, this study is conducted to provide some data on their biodiversity and diet in Mitidja, citrus growing area by excellence (MOSTEFAOUI and *al.*, 2011), it accounts for 44% of Algerian citrus production (BICHE, 2012).

1. MATERIAL AND METHODS

1.1 Choice of the study station

The study was conducted in the Orangeraie of the Horticultural Station of the National Agronomic School of El Harrach, a group of small experimental orchards. The study plot is a mixture of different citrus species grown in organic agriculture without recourse to the use of pesticides.

1.2 Sampling methods

The sampling of coccinelidae is carried on citrus: orange, lemon, clementine and pomelo for 12 weeks, going from April 23 to July 24 of 2014, at the Horticultural station of the National Agronomic School of El Harrach, we chose the yellow plates stuck, this kind of trap can catch a very large number of insects including hemiptera, Diptera, hymenoptera and some beetles like ladybugs. It is not a selective trap. It is effective in quantifying a population of pests or beneficials (FRANCK, 2013).

1.3 Treatment of results

In order to evaluate the biodiversity and the diet of ladybugs, we have opted for the use of total wealth and relative abundance.

2. RÉSULTS AND DISCUSSION

2.1-Biodiversity of sampled ladybugs

The different species of ladybugs listed on orange, lemon, clementine and pomelo are listed in the following table

Table 1: Biodiversity of ladybug species recorded on citrus

Sub-Families	Tribes	Species
Chilocorinae	Chilocorini	*Chilocorus bipunctatus* (Linné, 1758)
		Brumus quadrimaculatus (Linné, 1758)
Coccidulinae	Coccidulini	*Rhyzobius lophantae* (Blaisdell, 1892)
	Noviini	*Rodolia (Novius)cardinalis* (Mulsant, 1850)
Scymninae	Scymnini	*Clitostethus arcuatus* (Rossi, 1794)
		Nephus peyerimhoffi (Sicard, 1923)
		Nephus quadrimaculatus (Herbest, 1783)
		Pullus subvillosus (Goeze, 1777)
		Scymnus (Scymnus)interruptus (Goeze, 1777)
		Scymnus (Scymnus) pallipediformis (Gunther, 1958)
		Stethorus punctillum (Welse, 1801)
Coccinellinae	Coccinellini	*Adalia (Adalia) bipunctata* (Linné, 1758)
		Adalia (Adalia) decimpunctata (Linné, 1758)
	Tytthaspidini	*Tytthaspis (Tytthaspis) phalerata (*Costa, 1849)
	Psylloborini	*Psyllobora vigintiduopunctata* (Linné, 1758)
Sticholotidinae	Sticholotidini	*Phoroscymnus setulosus* (Chevrolat, 1861)

A total of 16 ladybug species are sampled in four citrus species, orange, lemon, clementine and pomelo. Seven of them belong to the tribe of Scymnini, while the tribes of

Chilocorini and Coccinellini have only two species for each. The least represented are the tribes of Coccidulini, Noviini, Tytthaspidini, Psylloborini and Sticholotidini, with one species for each tribe. Similarly SAHARAOUI and HEMPTINNE (2009), studying population dynamics of citrus ladybirds in eastern Mitidja, found that the tribe of Scymnini is the most represented withe 8 species, followed by tribes of Chilocorini and Coccinellini represented with three species each. SAHARAOUI and GOURREAU (2000), noted in a study of ladybugs in Algeria, that the Scymnini tribe is the most diversified with 14 species followed by the tribe of Coccinellini with 9 species.

2.1 Deit of sampled ladybugs

The diet of species of ladybugs listed on orange, lemon, clementine and pomelo are listed in the following table

Table 2: Diet of ladybug species recorded on citrus

Species	Clementine		Lemon		Orange		Pomelo		Total
	N	F	N	F	N	F	N	F	
Chilocorus bipunctatus	10	11,90	12	6,38	15	10	3	6,67	40
Brumus quadrimaculatus	0	0,00	0	0,00	1	0,67	0	0,00	1
Rhyzobius lophantae	0	0,00	3	1,60	0	0	4	8,89	7
Rodolia (Novius)cardinalis	3	3,57	20	10,64	19	12,67	6	13,33	48
Nephus peyerimhoffi	5	5,95	13	6,91	4	2,67	0	0,00	22
Nephus quadrimaculatus	0	0,00	3	1,60	0	0,00	0	0,00	3
Phoroscymnus setulosus	0	0,00	1	0,53	0	0,00	0	0,00	1
Total of Coccidiphagous	18	21,43	52	27,66	39	26,00	13	28,89	122
Pullus (Pullus) subvillosus	5	5,95	11	5,85	14	9,33	3	6,67	33
Scymnus (Scymnus)interruptus	2	2,38	0	0,00	0	0,00	0	0,00	2
Scymnus (Scymnus)pallipediformis	2	2,38	1	0,53	1	0,67	1	2,22	5
Adalia (Adalia) bipunctata	0	0,00	1	0,53	0	0,00	0	0,00	1
Adalia (Adalia) decimpunctata	0	0,00	0	0,00	1	0,67	0	0,00	1
Total of Aphidiphagous	9	10,71	13	6,91	16	10,67	4	8,89	42
Tytthaspis (Tytthaspis) phalerata	0	0,00	0	0,00	1	0,67	0	0,00	1
Psyllobora vigintiduopunctata	2	2,38	4	2,13	0	0,00	4	8,89	10
Total of mycophagous	2	2,38	4	2,13	1	0,67	4	8,89	11
Clitostethus arcuatus	53	63,10	117	62,23	93	62,00	22	48,89	285
Total of Aleurodiphagous	53	63,10	117	62,23	93	62,00	22	48,89	285
Stethorus punctillum	2	2,38	2	1,06	1	0,67	2	4,44	7
Total of Acariphagous	2	2,38	2	1,06	1	0,67	2	4,44	7
Total	84	100,00	188	100,00	150	100	45	100,00	467

A total of 467 individuals belonging to the family Coccinellidae are captured by the yellow sticky plates of which the species Clitostethus arcuatus (Whitebug Ladybug) alone counted 285 individuals or 61.29%. With regard to the importance of Aphidiphagous ladybirds in relation to all Coccinellidae, this group is represented by 42 individuals divided among 5 species, 9 individuals representing 10.71% of the total clementine population, 13 individuals

(6, 91%) on lemon tree, 16 individuals (10.67%) on orange trees and 4 individuals (8.89%) on pomelo. As a result, Aphidiphages are in third place after Aleurodiphage and Coccidiphages. SAHARAOUI and HEMPTINNE (2009) noted that the Aphidiphagous are in second position after the Coccidiphagous, while the Aleurodiphagous, the latter are represented by a single species *Clitostethus arcuatus*.

Regarding the biodiversity, the coccidiphagous are the richest with a total of 7 species, followed by the aphidiphagous with 5 species either *Pullus (Pullus) subvillosus*, *Scymnus (Scymnus) interruptus*, *Scymnus (Scymnus) pallipediformis*, *Adalia (Adalia) bipunctata* and *Adalia (Adalia) decimpunctata*, Mycophagous with 2 species, *Tytthaspis phalerata*, *Psyllobora vigintiduopunctata*, and lastly, the aleurodiphagous and the acariphagous, with only one species for each group. It is on lemon tree that we have recorded the highest total richness with 12 species, 6 coccidiphagous species, 3 aphidiphagous species and a single species for the mycophagous, white-blooded and acariphagous species. On clementine and orange tree we have identified 9 species for each citrus, of which three species are aphidiphagous. On pomelo, 8 species of lady beetles are sampled, two of them are aphidiphagous.

CONCLUSION AND PERSPECTIVES

A total of 467 individuals shared between sixteen ladybug species belonging to the family Coccinellidae are sampled from four citrus species, orange, lemon, clementine and pomelo. Seven of them belong to the tribe of Scymnini. Regarding the biodiversity, the coccidiphagous are the richest with a total of 7 species, followed by the aphidiphagous with 5 species. With regard to the diet, Aleurodiphagous are the most numerous with the species *Clitostethus arcuatus* who counted 285 individuals, followed by the Coccidiphagous and Aphidiphagous. In perspective we plan to make a comprehensive inventory of the Coccinellidae of fruit trees in general and that of the entire guild entomophagous,

66

REFERENCES

− AUBERT B., 1992 – Le programme agrume du CIRAD – IRFA. Rev. Fruits, Vol. 47, numéro spécial Agrumes : 99 – 102.

− BICHE M., 2012 - Les principaux insectes ravageurs des agrumes en Algérie et leurs ennemis naturels. Ed. I. N. P. V., Alger, 36 p.

− FRANK A., 2013- Capture, conditionnement, expédition et mise en collection des insectes et acariens en vue de leur identification. Ed Cirad, Montpellier, 50 p.

− MOSTEFAOUI H., DJAZOULI Z. and ALLAL-BENFEKIH L., 2011- Effet de la poussée de sève sur interactions Agrumes-Pucerons. Sém. Internati. Prot. Vég., du 18-21 avril. Dép. Zool. agri. For., Inst. nati. agro., El Harrach, p. 81.

− SAHARAOUI and GOURREAU (2000).,- Arboriculture — Fruits transformés, Bulletin de santé du végétal, N°17, 5 p 4.

− SAHARAOUI and HEMPTINNE (2009) – Dynamique des communautés des coccinelles (Coléoptera : Coccinellidae) sur agrumes et interactions avec leur proies dans la région de Rouïba (Mitidja orientale) Algérie. Ann. Soc. Entomol. Fr (n.s.), 45(2) : 245-259.

68

RARE AND ENDEMIC TAXA OF LAMIACEAE IN TURKEY AND THEIR THREAT CATEGORIES*

Gül KUŞAKSIZ *

* *Assoc. Prof. Dr., Bursa Uludağ University, Faculty of Science and Arts Department of Biology, TURKEY, E-mail: gult@uludag.edu.tr,*
ORCID ID: https://orcid.org/0000-0001-2345-6789

ABSTRACT

Lamiaceae (Labiatae) is the third largest family in Turkey. It is represented by 48 genera and 782 taxa (603 species, 179 subspecies and varieties) in the country, 346 taxa (271 species, 75 subspecies and varieties) of which are endemic. Endemism ratio is ca. % 44. The largest genera in the country based on the taxon number are Stachys L.(118 taxa), Salvia L.(107 taxa), Sideritis L.(54 taxa), Phlomis L.(53 taxa), Teucrium L. (49 taxa), Thymus L.(47 taxa). Endangered genera according to IUCN criteria; Salvia L.(43 taxa), Stachys L.(19 taxa) Thymus L. (16 taxa), Sideritis L.(14 taxa), Teucrium L. (10 taxa), Lamium L.(8 taxa), Phlomis L. and Scutellaria L. (7 taxa), Micromeria Bentham and Nepeta L. (6 taxa), Ajuga L.and Origanum L. (5 taxa), Marrubium L..(4 taxa), Acinos Miller, Satureja L. and Calamintha Miller (2 taxa), Ballota L., Dorystaechas Boiss. & Heldr. ex Bentham, Cyclotrichium (Boiss.) Manden. & Scheng. and Lopanthus Adans. (1 taxon). Lamiaceae has 160 taxa endangered in Turkey of which are categories; 43 taxa critically endangered, 59 taxa endangered and 58 taxa vulnerable. Phytogeographic distribution of rare and endemic Turkish Lamiaceae taxa are 79 taxa in the Mediterranean, 63 taxa in the Irano-Turanien, 5 taxa in the Euro-Siberian phytogeographic region, and 11 taxa in unknown or multiregional phytogeographical elements.This study was carried out to draw attention to the endangered and vulnerable taxa in Lamiaceae family and to indicate which phytogeographic regions these taxa are more widely distributed.

Keywords: *Lamiaceae, Threat categories, Turkey.*

1. INTRODUCTION

Turkey is among the richest countries in the World in terms of plant diversity. With around 11.707 flowering plant species, the flora is the richest of any country in Europe, North Africa and Middle East. (Davis 1982, Davis et al. 1988, Güner et al. 2000, Güner 2012).

Wild Flowering Plants in Turkey (Güner 2012)

| Family	Genera	Species	Subspecies	Varietes	Total infrageneric taxa
167	1320	9996	1989	867	11707

The main reasons for this wealth are as follow;

-A variety of climates

-Topographical diversity with marked changes in ecological factors over short distance

-Geological and geomorphic variation

-A range of aquatic environments such as seas,lakes and rivers

- Altitude variations from sea level to 5000 (Ekim and Güner 2000).

The situation of the country at the junction of three major phytogeographical regions:

-Mediterranean

 -Irano-Turanian

-Euro-Siberian

There are the number of major mountain ranges in Anatolia which constitute effective barriers and these have further encouraged a greater diversity of species. Additionally, during many historical periods, Anatolia has served as a passege way between the continents of Europe, Asia and Africa, resulting in dispersal of a wide variety of plants and animals (Anonim 1996). All these factors combined have provided many opportunities for the plants to evolve and differentiate creating the present wealth of species now estimated to be over 11.707 taxa, about one third of which are endemic (3649 taxa) (Güner 2012). Lamiaceae is the third largest family in Turkey. The family has 48 genera and 782 taxa, 346 taxa of which are endemic (ca. 44 %) in the country (Celep and Dirmenci 2017).

Figure 1. Phytogeographic regions of Turkey (Davis, 1965; modified byAvcı, 1996).
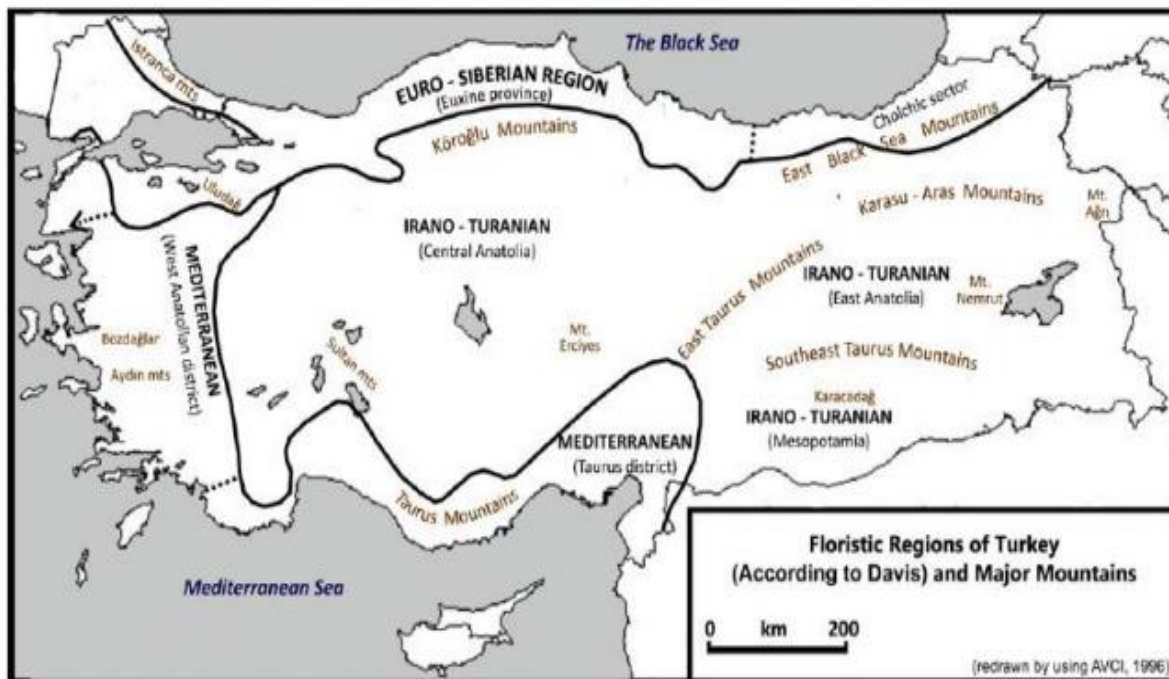
The purpose of this study are to obtain the threatened category of endemic and rare taxa of Lamiaceae family in Turkey and to indicate which phytogeographic regions these taxa are more widely distributed.

2. MATERIAL AND METHODS

Data were obtained by scanning Flora of Turkey, Red Data Books, The List of Turkey Plants (Vascular Plants), check-lists, publications and observations (Davis 1982, Davis et al. 1988, Güner et al. 2000, Tarımcılar 1998, Aytaç and Aksoy 2000, Ekim et al. 2000, Dönmez 2001, Dirmenci 2003, Akçiçek and Vural 2007, Alan 2009, Ekim 2009, Fırat and Dirmenci 2009, Bacherpour 2010, Torlak et al. 2010, Bulut and Yılmaz 2010, Celep and Doğan 2010, İpek and Gürbüz 2010, Yılmaz et al. 2010, Bacherpour et al. 2011, Çiçek and Ketenoğlu 2011, Güner 2012, Tel 2012, Özçelik 2012, Çiçek and Yaprak 2013, Celep et al. 2015, Dinç and Doğu 2016, Özuslu and Öztekin 2008, Dirmenci et al. 2010, Dirmenci et al. 2011, Öztürk et al. 2011, Güner and Akçiçek 2014, Vural et al. 2015, Akçiçek et al. 2016, Celep 2017, Celep and Dirmenci 2017, Özhatay et al. 2017, Yurteri et al. 2017).

3. RESULTS AND DISCUSSION

There are 782 Lamiaceae taxa in Turkey, 346 which are endemic (44.2 % endemic ratio). According to species number, there are 603 Lamiaceae species, 179 subspecies and varietes in Turkey. The largest genera in the country based on the taxon number are *Stachys* L.(118 taxa), *Salvia* L.(107 taxa), *Sideritis* L.(54 taxa), *Phlomis* L.(53 taxa*), Teucrium* L. (49 taxa), *Thymus* L.(47 taxa*)*. The largest 15 genera based on taxon number in Turkey are given in Table 1 (Celep and Dirmenci 2017).

Table 1. The largest 15 genera based on taxon number in Turkish Lamiaceae

Genera	Taxon number	Species number	Endemic taxa end. ra.%	Endemic species end. ra.%
Stachys	118	90	53 (45%)	43 (48%)
Salvia	107	100	58 (54%)	53 (53%)
Sideritis	54	45	40 (74%)	36 (80 %)
Phlomis	53	33	30 (57%)	16 (48%)
Teucrium	49	36	17 (35%)	15 (42%)
Thymus	47	42	20 (43%)	20 (48%)
Nepeta	46	39	20 (43%)	17 (44%)
Scutellaria	39	17	17 (44%)	6 (35%)
Origanum	31	27	18 (58%)	18 (67%)
Marrubium	27	21	17 (63%)	11 (52%)
Lamium	26	15	5 (19%)	4 (27%)
Clinopodium	25	16	7 (24%)	3 (19%)
Ajuga	23	13	7 (30%)	6 (46%)
Ballota	18	12	11 (61%)	8 (67%)
Satureja	17	16	6 (35%)	5 (31%)

Sideritis Drymosiphon, Marrubium, Ballota, *Origanum*, *Phlomis*, *Salvia* have a large number endemic taxa and species. Their endemism ratio is over 54 % in Turkey. There are two monotypic genera in Turkey as *Dorystaechas* (endemic) ve *Pentapleura* (non-endemic). *Lophantus* has also only one species in Turkey, it is not monotypic genus. Fifteen genera with the highest endemism ratio are given in Table 2 (Celep and Dirmenci 2017).

Table 2. Fifteen genera with the highest endemism ratio in Lamiaceae in Turkey

	Genera	Endemism ratio based on taxa number%	Endemism ratio based on species number %
1	*Dorystaechas*	100	100
2	*Lophantus*	100	100
3	*Sideritis*	74	80
4	*Drymosiphon*	67	75
5	*Marrubium*	63	52
6	*Ballota*	61	67
7	*Origanum*	58	67
8	*Phlomis*	57	48
9	*Salvia*	54	53
10	*Stachys*	45	48
11	*Scutellaria*	44	35
12	*Thymus*	43	48
13	*Nepeta*	43	44
14	*Teucrium*	35	42
15	*Satureja*	35	31

Result of endangered family of Lamiaceae according to IUCN threat categories are 20 genera in Turkey. These genera; *Salvia* L.(43 taxa*), Stachys* L.(19 taxa), *Thymus* L. (16 taxa), *Sideritis* L.(14 taxa), *Teucrium* L. (10 taxa), *Lamium* L.(8 taxa), *Phlomis* L. ve *Scutellaria* L. (7 taxa), *Micromeria* Bentham ve *Nepeta* L. (6 taxa), *Ajuga* L. ve *Origanum* L. (5 taxa), *Marrubium* L. (4 taxa), *Acinos* Miller, *Satureja* L. ve *Calamintha* Miller (2 taxa), *Ballota* L., *Dorystaechas* Boiss. & Heldr. ex Bentham*, Cyclotrichium* (Boiss.)Manden. & Scheng. ve *Lopanthus* Adans.(1 taxon) (Table 3).

Table 3. Endangered Lamiaceae genera according to IUCN threat categories in Turkey

Genera	CR (critically endangered)	EN (endangered)	VU (vulnerable)
Salvia (43 taxa)	13	15	15
Stachys (19 taxa)	3	10	6
Thymus (16 taxa)	7	4	5
Sideritis (14 taxa)	2	3	9
Teucrium (10 taxa)	4	3	3
Lamium (8 taxa)	2	3	3
Phlomis (7 taxa)	1	2	4
Scutellaria (7 taxa)	1	3	3
Micromeria (6 taxa)	2	2	2
Nepeta (6 taxa)	3	2	1
Ajuga (5 taxa)	-	4	1
Origanum (5 taxa)	1	3	2
Marrubium (4 taxa)	1	2	1
Acinos (2 taxa)	-	2	-
Satureja (2 taxa)	2	-	-
Calamintha (2 taxa)	-	1	1
Ballota (1 taxa)	-	-	1
Dorystaechas (1 taxa)	-	-	1
Cylotrichium (1 taxa)	-	-	1
Lopanthus (1 taxa)	1	-	-

73

Endangered and vulnerable family of Lamiaceae according to IUCN threat categories are 160 taxa in country (Appendix, Table 1).

CR (critically endangered) 43 (42 endemic / 1 non-endemic)

EN (endangered) 59 (57 endemic / 2 non-endemic)

VU (vulnerable) 58 (52 endemic / 6 non-endemic)

Threat categories of the largest five genera in the country based on the taxon number are;

Salvia (43 taxa) / 13 CR (critically endangered) / 15 EN (endangered)) / 15 VU (vulnerable)

Stachys (19 taxa) / 3 CR (critically endangered) / 10 EN (endangered)) / 6 VU (vulnerable)

Thymus (16 taxa) / 7 CR (critically endangered) / 4 EN (endangered)) / 5 VU (vulnerable)

Sideritis (14 taxa) / 2 CR (critically endangered) / 3 EN (endangered)) / 9 VU (vulnerable)

Teucrium (10 taxa) / 4 CR (critically endangered) / 3 EN (endangered)) / 3 VU (vulnerable)

Figure 2. A. *Salvia aytachii* Vural&Adıgüzel
B. *Salvia kronenburgii* Rech. fil. (Nasip Demirkuş)
C. *Salvia fruticosa* Mill. (Ester Inbar)
D. *Stachys distans* Bentham var. *cilicica* Bhattacharjee & Hub.-Mor.
E. *Stachys bayburtensis* Bhattacharjee & Hub.-Mor.
F. *Thymus cariensis* Hub.-Mor. & Jalas
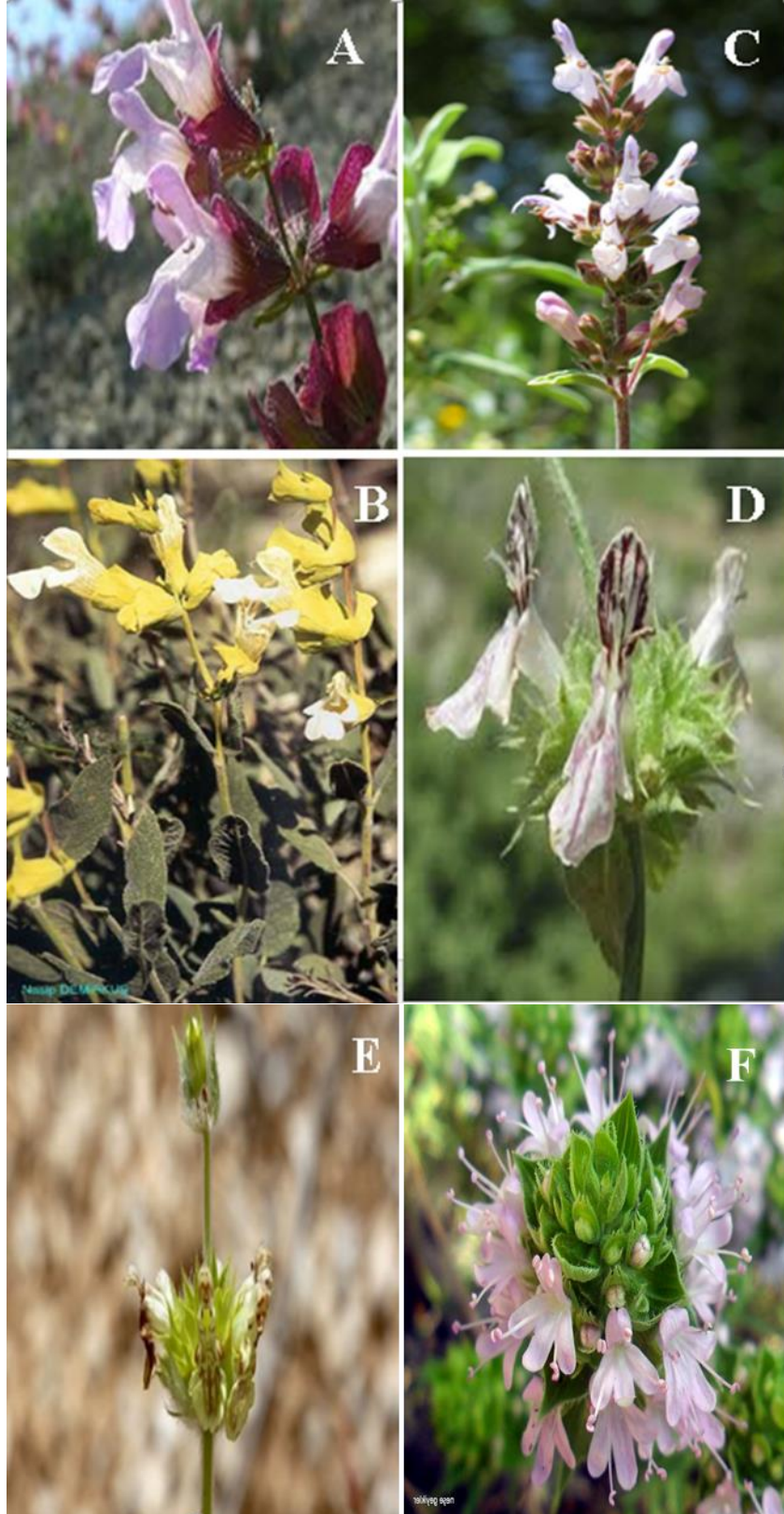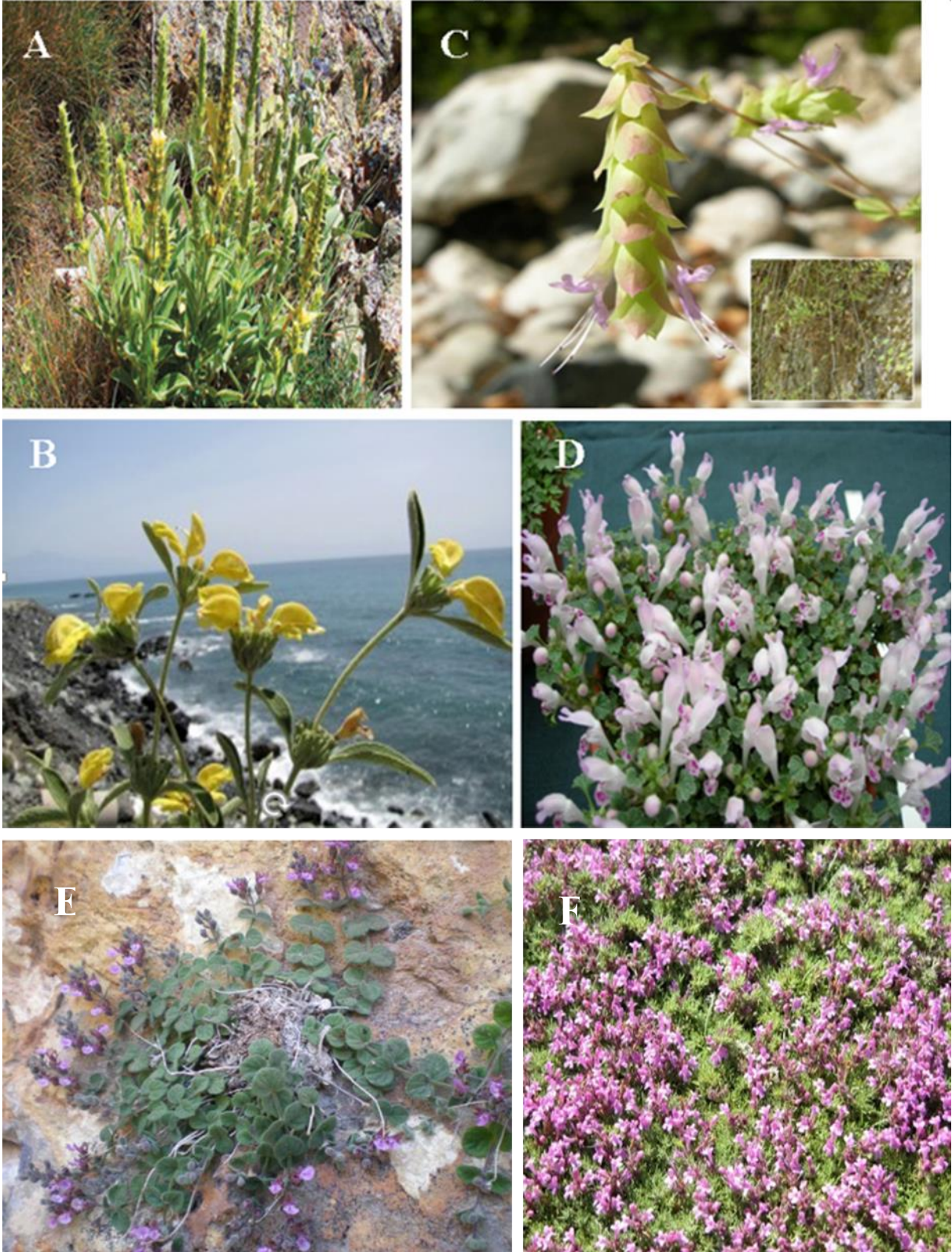

74

Figure 3. A. *Sideritis akmanii* Z. Aytaç, M. Ekici & A. Dönmez
B. *Phlomis amanica* Vierh.
C. *Origanum solymicum* P.H. Davis
D. *Lamium microphyllum* Boiss.
E. *Teucrium cavernarum* P.H. Davis
F. *Thymus pulvinatus* Celak.

Phytogeographic distribution of Turkish Lamiaceae taxa are 293 taxa in the Mediterranean (% 37.4), 267 taxa in the Irano-Turanian (%36.7), 90 taxa in the Euro-Siberian (% 11.5) phytogeographic region, and 112 taxa in Unknown or Multiregional (%14.3) phytogeographical elements (Celep and Dirmenci 2017) .

Endangered endemic and rare taxa of Lamiaceae genera are phytogeographic region in Turkey (Table 4).

Mediterranean elements 79 taxa, 74 endemic / 5 non-endemic

İrano-Turanian elements 63 taxa, 58 endemic /5 non-endemic

Euro-Siberian elements 6 taxa, 5 endemic / 1 non-endemic

Unknown or Multiregional elements 11 taxa, 11 endemic

Table 4. Phytogeographic distribution of endangered Lamiaceae genera based on taxon number and Endemism status

Genera (Taxon number)	Irano-Turanian el.	Mediterranean el.	Euro-Siberian el.	Unknown or Multiregional	Endemic
Salvia (43)	18	19	1	5	37
Stachys (19)	10	7	-	2	18
Thymus (16)	6	6	-	4	14
Sideritis (14)	2	12	-	-	14
Teucrium (10)	3	7	-	-	9
Lamium (8)	1	4	3	-	7
Phlomis (7)	4	3	-	-	7
Scutellaria (7)	4	3	-	-	7
Micromeria (6)	1	4	1	-	6
Nepeta (6)	2	4	-	-	6
Ajuga (5)	3	2	-	-	5
Origanum (5)	1	4	-	-	5
Marrubium (4)	2	1	1	-	4
Acinos (2)	-	2	-	-	2
Satureja (2)	1	1	-	-	2
Calamintha (2)	1	1	-	-	2
Ballota (1)	1	-	-	-	1
Dorystaechas (1)	-	1	-	-	1
Cylotrichium (1)	1	-	-	-	1
Lopanthus (1)	1	-	-	-	1

76

In conclusion, according to IUCN threat categories, 160 endemic and rare taxa of Lamiaceae are endangered in Turkey. 43 taxa (26.87%) are critically endangered (CR) and 59 taxa (36.87%) endangered (EN). Total 102 taxa (63.75%) are endangered and critically

endangered. 58 taxa (36.25%) are vulnerable. Phytogeographic distribution of endemic and rare Turkish Lamiaceae taxa are 79 taxa (49.37 %), in the Mediterranean, 63 taxa (39.37 %) in the Irano-Turanien, 5 taxa (3.12%) in the Euro-Siberian phytogeographic region, and 11 taxa (6.8%) in unknown or multiregional phytogeographical elements.

REFERENCES

AKÇİÇEK E., VURAL M., 2007, Kumular Dağı (Afyonkarahisar)' nın Endemik ve Nadir Bitkileri, Balıkesir Üniversitesi Fen Bilimleri Dergisi, 9 (2), 78-86.

AKÇİÇEK E., FIRAT M., GÜNER Ö., 2016, *Stachys hakkariensis* (Lamiaceae), A New Species from Eastern Anatolia (Turkey) Belonging to *Stachys* sect. *Olisia,* Phytotaxa, 257 (2), 167-173.

ALAN S., OCAK A., 2009, Taxomical and Morphological Studies on The Genus *Calamintha* Miller (Lamiaceae) in Turkey, Biodicon, 2 (2), 125-143.

ANONİM 1996, Türkiye Bitki Genetik Çeşitliliğinin Yerinde (Insitu) Korunması Ulusal Planı, Çevre Bakanlığı, Tarım ve Köy İşleri Bakanlığı, Orman Bakanlığı, Ankara.

AYTAÇ Z., AKSOY A., 2000, A New *Sideritis* Species (Labiatae) from Turkey, Flora Mediterranea, 10, 181-184.

BACHERPOUR S., 2010, Taxonomic Studies on The Genus *Salvia* L. (Labiatae) in Central Anatolia, Turkey, Doktora Tezi, Middle East Techinacal University The Graduate School of Natural and Applied Sciencis.

BACHERPOUR S., CELEP F., KAHRAMAN A., DOĞAN M., 2011, *Salvia brachyantha* subs. *tankutiana* (Lamiaceae), A New Subspecies from Central Anatolia, Turkish Journal of Botany, 35, 343-350.

BULUT Z., YILMAZ H., 2010, The Current Situation of Threatened Endemic Flora in Turkey: Kemaliye (Erzincan) Case, Pak. Journal of Botany, 42 (2); 711-719.

CELEP F., DOĞAN M., 2010, *Salvia ekimiana* (Lamiaceae), A New Species from Turkey, Ann. Bot. Fennici, 47, 63-66.

CELEP F., DİRMENCİ T., GÜNER Ö., 2015, *Salvia hasankeyfence* (Lamiaceae), A New Species from Hasankeyf (Batman, South-eastern Turkey), Phtytotaxa, 227 (3), 289-294.

CELEP F., 2017, *Lamium bilgilii* (Lamiaceae), A New Species from South-western Turkey (Burdur-Muğla), Phytotaxa, 312 (2), 263-270.

CELEP F., DİRMENCİ T., 2017, Systematic and Biogeographic Overview of Lamiaceae in Turkey, Naturel Volatiles & Essential Oils, 4 (4), 14-27.

ÇİÇEK M., KETENOĞLU O., 2011, *Scutellaria anatolica* A New Species from Turkey, Ann. Bot. Fennici, 48, 276-279.

ÇİÇEK M., YAPRAK A. E., 2013, *Scutellaria yildirimlii* (Lamiaceae), A New Species from Turkey, Phytotaxa, 138 (1), 53-58.

DAVIS P.H., 1982, Flora of Turkey and The East Aegean Islands, Vol. 7., Edinburg at the University Press, UK., 0- 85224- 396 -0.

DAVIS P.H., MILL R.R., TAN K., 1988, Flora of Turkey and The East Aegean Islands, Vol. 10.,(Supplement 1), Edinburg at the University Press, UK., 0- 85224- 559- 9.

DİNÇ M., DOĞU S., 2016, *Teucrium pruniosum* var. *aksarayense* var. nov. (Lamiacaea) from Central Anatolia, Modern Phytomorphology, 9, 13-17.

DİRMENCİ T., 2003, Türkiye'de Yetişen *Nepeta* L. (Lamiaceae) Türleri Üzerinde Taksonomik Araştırmalar, Doktora Tezi, Balıkesir Üniversitesi Fen Bilimleri Enstitüsü Biyoloji Eğitimi Anabilim Dalı.

DİRMENCİ T., YILDIZ B., HEDGE I. C., FIRAT M., 2010, *Lophanthus* (Lamiaceae) in Turkey: A new Generic Record and A new Species, Turkish Journal Of Botany, 34, 123-129.

DİRMENCİ T., YILDIZ B., AKÇİÇEK E., MARTİN E., DÜNDAR E., 2011, *Stachys vura*lii (Lamiaceae), A New Species from North Anatolia, Turkey, Ann. Bot. Fennici, 48, 401-408.

DÖNMEZ A.A., 2001, A New Turkish Species of *Salvia* L. (Lamiaceae), Botanical Journal of Linnean Society, 137, 413-416.

EKİM T., GÜNER A., 2000, The Floristic Richness of Turkey, Bentham-Moxon Trust, Blackwell Publishers, Oxford, UK., Malden, USA.

EKİM T., KOYUNCU M.,VURAL M., DUMAN H., AYTAÇ Z., ADIGÜZEL N., 2000, Türkiye Bitkileri Kırmızı Kitabı, Türkiye Tabiatını Koruma Derneği, Van Yüzüncü Yıl Üniversitesi, Barışcan Ofset, Ankara, Türkiye, 975- 93611- 0- 8.

EKİM T., 2009, Türkiye'nin Nadir Endemikleri, Türkiye İş Bankası Kültür Yayınları, Sertifika no 11213, Özgün Ofset, İstanbul, Türkiye, 978-9944-88-648-2.

FIRAT M., DİRMENCİ T., 2009, *Clinopodium hakkaricum* (Lamiaceae), A New Species from Turkey, Ann. Bot. Fennici, 46, 451-455.

GÜNER A., ÖZHATAY N., EKİM T., BAŞER K.H.C., 2000, Flora of Turkey and The East Aegean Islands, Vol. 11. (Supplement 2), Edinburg at the University Press,UK.,0- 0 - 7486- 1409- 5.

GÜNER A., 2012, Türkiye Bitkileri Listesi (Damarlı Bitkiler), Flora Araştırmaları Derneği, Nezahat Gökyiğit Botanik Bahçesi Yayınları Flora Dizisi 1, Namaş Matbaacılık, İstanbul, Türkiye, 978-605-60425-7-7.

GÜNER Ö., AKÇİÇEK E., 2014, Ulus Dağı' nın (Balıkesir-Türkiye) Endemik ve Nadir Bitkileri, Bağ Bahçe Bilim Dergisi, 1 (3), 32-38.

İPEK A., GÜRBÜZ B., 2010, Türkiye Florasında Bulunan *Salvia* Türleri ve Tehlike Durumları, Tarla Bitkileri Merkez Araştırma Enstitüsü Dergisi, 19 (1-2), 30-35.

ÖZÇELİK H.,2012, The Endemic Plant Taxa of The Köprülü Kanyon National Park and Its Surroundings (Antalya-Isparta), 16 (3), 279-296.

ÖZHATAY N., KÜLTÜR Ş., GÜRDAL B., 2017, Check- list of Additional Taxa to the Supplement Flora of Turkey VIII, 2017, İstanbul Journal of Pharmacy, 47 (1), 30-44.

ÖZTÜRK M., UYSAL İ., KARABACAK E., ÇELİK S., 2011, Plant Species Microendemism, Rarity and Conservation ofPseudo-alpine Zone of Kazdağı (Mt. Ida) National Park-Turkey, Procedia Social and Behavioral Science, 19, 778-786.

ÖZUSLU E., ÖZTEKİN M., 2008, A New Localization for *Teucrium paederotoides* Boiss. et Hausskn. (Lamiaceae), Biodicon, 1(2), 86-90.

TARIMCILAR G., 1998, Karadeniz' de Yayılışı olan Mentha L. Türleri Üzerinde Korolojik, Morfolojik, Anatomik, Sitolojik, Ekolojik ve Kimyasal Araştırmalar, Doktora Tezi, Uludağ Üniversitesi Fen Bilimleri Enstitüsü, Biyoloji Anabilim Dalı, Bursa.

TEL A. Z., 2012, Bazı Endemik Bitkilerin Kütahya'daki (Türkiye) Yayılış Alanları ve Yeni IUCN Tehlike Kategorilerine Göre Yeniden Değerlendirilmesi, Artvin Çoruh Üniversitesi Orman Fakültesi Dergisi, 13 (1), 88-108

79

TORLAK H., VURAL M., AYTAÇ Z., 2010, Endemic Plants of Turkey, Ministry of Culture and Tourism, Pelin Ofset, Ankara, Türkiye, 978-975-17-3595-9.

VURAL M., DUMAN H., DİRMENCİ T., ÖZCAN T., 2015, A New Species of *Teucrium* sect. *Stachyobotrys* (Lamiaceae) from the South of Turkey, Turkish Journal of Botany, 39, 318-324.

YILMAZ Ö., DAŞKIN R., KAYNAK G., 2010, *Stachys pseudobombycina* sp. nov. (Lamiaceae) from South Anatolia, Turkey, Nordic Journal of Botany, 28, 341-343.

YURTERİ E., ÖZCAN A., SEYİS F., KEVSEROĞLU K., 2017, Characterization of some Lamiaceae Species Distributed in The Rize Province, Turkey, International Journal of Plant Breeding and Crop Science, 4 (3), 300-307.

Appendix I.

Table 1. Endangered Lamiaceae taxa according to IUCN threat categories in Turkey and Endemism status

Taxa	Endemism	Threat categories
Acinos troodi (Post) Leblebici subsp. *grandiflorus* Hartvig & Strid	E	EN
Acinos troodi (Post) Leblebici subsp. *vardaranus* Leblebici	E	EN
*Ajuga davisi*ana Kit Tan & Yıldız	E	EN
Ajuga postii Briq.	E	VU
Ajuga relicta P.H. Davis	E	EN
Ajuga vestita Boiss.	E	EN
Ajuga xylorrhiza Kit Tan	E	EN
Ballota macrodonta Boiss. & Bal.	E	VU
Calamintha caroli-benricana Kit Tan & Sorger	E	EN
Calamintha tauricola P.H. Davis	E	VU
Cyclotrichium niveum (Boiss.) Manden & Scheng.	E	VU
Dorystaechas hastataBoiss. & Heldr. ex Bentham	E	VU
Lamium armenum Boiss. subsp. *sintenisii* R. Mill	E	VU
Lamium bilgilii Celep	E	CR
Lamium demirizii A. Khohhr.	E	EN
Lamium microphyllum Boiss.	E	VU
Lamium purpureum L. var. *aznavourii* Gand. Ex Aznav.	E	CR
Lamium sandrasicum P.H. Davis	E	EN
Lamium verronicifolium Bentham	E	VU
Lamium violaceo-velutinum A. Khohhr.	_	EN
Lopanthus turcicus Dirmenci, Yıldız & Hedge (B9)	E	CR
Marrubium bourgaei Boiss. subsp. *caricum* P.H. Davis	E	CR
Marrubium cephalanthus Boiss. & Noe subsp. *montanum* Akgül&Ketenoğlu	E	EN
Marrubium vanense Hub.-Mor.	E	EN
Marrubium vulcanicum Hub.-Mor.	E	VU
Micromeria carica P.H. Davis	E	EN
Micromeria cilicica Hausskn. ex P.H. Davis	E	EN
Micromeria cristata (Hampe) Griseb. subsp. *carminea* (P.H. Davis) P.H. Davis	E	VU
Micromeria cymuligera Boiss. & Hausskn.	E	VU
Micromeria dolichodonta P.H. Davis	E	CR
Micromeria fruticosa (L.) Druce subsp. *giresunica* P.H. Davis	E	CR
Nepeta baytopii Hedge & Lamond	E	EN
Nepeta conferta Hedge & Lamond	E	CR
Nepeta crinita Montbret & Aucher ex Bentham	E	EN
Nepeta nuda L. subsp. *glandulifera* Hub.-Mor. & Davis	E	CR
Nepeta phyllochlamys P.H. Davis	E	VU

Nepeta tumeriana B. Yıldız & T. Dirmenci	E	CR
Origanum boissieri Ietswaart	E	CR
Origanum husnucan-baseri H. Duman, Z. Aytaç & A. Duran	E	EN
Origanum micranthum Vogel	E	VU
Origanum munzurense Kit Tan & Sorger	E	EN
Origanum solymicum P.H. Davis	E	EN
Phlomis amanica Vierh.	E	EN
Phlomis angustissima Hub.-Mor.	E	VU
Phlomis brunneogaleata Hub.-Mor.	E	EN
Phlomis grandiflora H.S. Thompson var. *fimbrilligera* (Hub.-Mor.) Hub.-Mor.	E	VU
Phlomis integrifolia Hub.-Mor.	E	CR
Phlomis physocalyx Hub.-Mor.	E	VU
Phlomis sintenisii Rech. fil.	E	VU
Salvia adenocaulon P.H. Davis	E	VU
Salvia adenophylla Hedge & Hub.-Mor.	E	EN
Salvia albimaculata Hedge & Hub.-Mor.	E	EN
Salvia anatolica Hamzaoğlu & A. Duran	E	CR
Salvia aramiensis Rech. f.	-	VU
Salvia aucheri Bentham var. *aucheri*	E	VU
Salvia aucheri Bentham var. *canescens* Boiss. & Heldr.	E	VU
Salvia aytachii M. Vural & N. Adıgüzel	E	EN
Salvia ballsiana (Rech. f.) Hedge	E	CR
Salvia brachyanth (Bordz.) Pobed subsp. *tankutiana* Bagherpour,Celep, Kahraman & Doğa	E	EN
Salvia cassia G. Samuelsson ex Rech. f.	E	VU
Salvia cedronella Boiss.	E	EN
Salvia cerino-pruinosa Rech. var. *elazigensis* A. Karaman, F. Celep & Dogan	E	EN
Salvia chionantha Boiss	E	VU
Salvia chrysophylla Stapf	E	VU
Salvia cilicica Boiss. & Kotschy	E	EN
Salvia ekimiana F. Celep & Doğan	E	EN
Salvia eriophora Boiss. & Kotschy ex Boiss.	E	EN
Salvia freyniana Bornm.	E	CR
Salvia fruticosa Mill	-	VU
Salvia halophila Hedge	E	EN
Salvia hasankeyfense Dirmenci, Celep & Ö. Güner	E	CR
Salvia hedgeana Dönmez	E	CR
Salvia heldreichiana Boiss. ex DC.	E	VU
Salvia kronenburgii Rech. fil.	E	EN
Salvia kurdica Boiss. & Hohen. Ex Benth.	-	VU
Salvia marashica A. İlçim, F. Celep & Doğan	E	CR
Salvia modesta Boiss.	E	EN
Salvia nutans L.	-	VU

82

Salvia nydeggeri Hub.-Mor.	E	EN
Salvia odontochlamys Hedge	E	CR
Salvia pilifera Montbr. & Auch.	E	VU
Salvia pisidica Boiss. & Hohen. Ex Benth.	E	VU
Salvia pomifera L.	-	VU
Salvia potentillifolia Boiss. & Hohen. Ex Benth.	E	VU
Salvia pseudeuphratica Rech.	E	CR
Salvia quezelii Hedge & Afzal-Rafii	E	CR
Salvia sericeo-tomentosa Rech. fil. var. *sericeo-tomentosa*	E	CR
Salvia sericeo-tomentosa Rech. fil. var. *hatayica* F. Celep & Doğan	E	CR
Salvia smyrnaea Boiss.	E	EN
Salvia tigrina Hedge & Hub.-Mor.	E	CR
Salvia tobeyi Hedge	E	EN
Salvia vermifolia Hedge & Hub.-Mor.	E	CR
Satureja aintabensis P.H. Davis	E	CR
Satureja amani P.H. Davis	E	CR
Scutellaria glaphyrostachys Rech. fil.	E	VU
Scutellaria orientalis L. subsp. *carica* Edmondson	E	EN
Scutellaria orientalis L. subsp. *porphyrostegia* Edmondson	E	VU
Scutellaria orientalis L. subsp. *sintenisii (*Hasskn. Ex Bornm.) Edmondson	E	VU
Scutellaria orientalis L. subsp. *tortumensis* Kit Tan & Sorger	E	EN
Scutellaria rubicunda Hornem. subsp. *pannosula* (Rech. fil.) Edmondson	E	CR
Scutellaria uzundereensis A. Khohhr.	E	EN
Sideritis akmanii Z. Aytaç, M. Ekici & A. Dönmez	E	VU
Sideritis bilgerana P.H. Davis	E	VU
Sideritis brevibracteata P.H. Davis	E	VU
Sideritis brevidens P.H. Davis	E	VU
Sideritis cilicica Boiss. & Bal.	E	EN
Sideritis erythrantha Boiss. & Heldr. apud Bentham var. *cedratorum* P.H. Davis	E	VU
Sideritis gulendamii H. Duman & F.A. Karavelioğulları	E	EN
Sideritis huber-morathii Greuter & Burdet	E	VU
Sideritis lycica Boiss. & Heldr. apud Bentham	E	VU
Sideritis ozturkii Aytaç & Aksoy	E	EN
Sideritis serratifolia Hub.-Mor.	E	VU
Sideritis trojana Bornm.	E	CR
Sideritis vulcanica Hub.-Mor.	E	VU
Sideritis vuralii H. Duman & Başer	E	VU
Stachys anamurensis H. Sümbül	E	EN
Stachys antalyensis Y. Ayaşlıgil & P.H. Davis	E	VU
Stachys bayburtensis Bhattacharjee & Hub.-Mor.	E	CR
Stachys baytopiorum Kit Tan & Yıldız	-	EN
Stachys buttleri R. Mill	E	EN

Stachys cataonica Bhattacharjee & Hub.-Mor.	E	VU
Stachys chasmosericea Ayaşlıgil & P.H. Davis	E	CR
Stachys choruhensis Kit Tan & Sorger	E	EN
Stachys distans Bentham var. *cilicica* Bhattacharjee & Hub.-Mor.	E	EN
Stachys hakkariensis Akçiçek & Fırat	E	EN
Stachys huber-morathii Bhattacharjee	E	VU
Stachys inanis Hausskn. & Bornm.	E	VU
Stachys munzurdagensis Bhattacharjee	E	EN
Stachys pseudobombycina Kaynak, Daşkın & Yılmaz	E	CR
Stachys pseudopinardii Bhattacharjee & Hub.-Mor.	E	VU
Stachys sivasica Kit Tan & Yıldız	E	EN
Stachys subnuda Montbret & Aucher ex Bentham	E	VU
Stachys tundjeliensis Kit Tan & Sorger	E	EN
Stachys willemsei Kit Tan & Hedge	E	EN
Teucrium aladagense Vural & H. Duman	E	EN
Teucrium antitauricum T. Ekim	E	VU
Teucrium cavernarum P.H. Davis	E	VU
Teucrium ekimii H. Duman	E	CR
Teucrium leuchophyllum Montbret & Aucher ex Bentham	E	CR
Teucrium montbretii Bentham subsp. *pamphylicum* P.H. Davis	E	VU
Teucrium odontites Boiss. & Bal.	E	EN
Teucrium paederotoides Boiss. & Hausskn.	E	EN
Teucrium pruinosum Boiss. var. *aksarayense* M. Dinç & S. Doğu	E	EN
Teucrium sirnakense Özcan & Dirmenci	-	CR
Thymus aznavourii Velen.	E	CR
Thymus bornmuelleri Velen.	E	VU
Thymus canoviridis Jalas	E	EN
Thymus cappadocicus Boiss. var. *globifer* Jalas	E	VU
Thymus cappadocicus Boiss. var. *pruinosus* (Boiss.) Boiss.	E	VU
Thymus cariensis Hub.-Mor. & Jalas	E	CR
Thymus cherlioides Vis. var. *isauricus* Jalas	-	EN
Thymus cherlioides Vis. var. *oxyodon* Jalas	E	CR
Thymus convolutus Klokov	E	EN
Thymus leucostomus Hausskn. & Velen. var. *argillaceus* Jalas	E	VU
Thymus leucostomus Hausskn. & Velen. var. *gypsaceus* Jalas	E	CR
Thymus pectinatus Fisch. & Mey. var. *pallasicus* (Hayek & Velen.) Jalas	E	CR
Thymus praecox Opiz subsp. *praecox* var. *laniger* (Borbas) Jalas	E	CR
Thymus pulvinatus Celak.	E	CR
Thymus revolutus Celak.	E	VU
Thymus spathulifolius Hausskn. & Velen.	E	EN