



INTERNATIONAL JOINT CONFERENCE ON SCIENCE AND TECHNOLOGY

SCIENCE, TECHNOLOGY, INNOVATION, AND CULTURE FOR SUSTAINABLE DEVELOPMENT: CHALLENGE FOR GREEN INDUSTRY



POLITEKNIK NEGERI BALI



UNESA
Universitas Negeri Surabaya



ISBN 978-602-99806-3-9

IJCST 2017 PROCEEDING

Main Theme:

Science, Technology, Innovation, and Culture for Sustainable
Development: Challenge for Green Industry

PROCEEDING

AYODYA RESORT NUSA DUA BALI, INDONESIA, 27-28 SEPTEMBER 2017

Sponsored by:



PEMERINTAH KOTA
DENPASAR



POLITEKNIK NEGERI
JEMBER

Published by:

Pusat Penelitian dan Pengabdian kepada Masyarakat (P3M) Politeknik Negeri Bali
Jalan Kampus Bukit Jimbaran, Kuta Selatan, Kabupaten Badung,
Bali – 80364, Indonesia

Proceedings
of The 2nd International Joint Conference on Science and technology (IJCSST)
2017
Theme:
“Science, Technology, Innovation, and Culture for Sustainable Development:
Challenge for Green Industry”

ISBN 978-602-99806-3-9



CONFERENCE CHAIR

- Dr. Ir. Lilik Sudiajeng, M.Erg

STEERING COMMITTEE

- Prof. A. P. Bayuseno, Drer Nat, B.Eng, M.SC (UNDIP Semarang, Mechanical Engineering)
- Jamari, B.Eng, M.Eng, Dr. (UNDIP Semarang, Mechanical Engineering)
- Prof. Renanto Handogo, M.Sc, Ph.D. (ITS Surabaya, Chemical Engineering)

PERSON IN CHARGE

- Director Of Bali State Polytechnic (BSP) Ir. Made Mudhina, MT
- Dean Faculty Of Engineering, University Of Trunojoyo Madura (UTM) Dr. Rachmad Hidayat, MT
- Dean Faculty Of Social Science And Law, Universitas Negeri Surabaya (UNESA) Prof. Dr. Sarmini, M.Hum
- Dean Faculty Of Mathematics And Natural Sciences, Universitas Negeri Surabaya (UNESA) Prof. Dr. Suyono, M.Pd
- Dean Faculty Of Engineering, University Of Pembangunan Nasional “Veteran” Jawa Timur (UPNVJT) Ir. Sutyono, MT

ADVISORY

- Assistant Director Of Accademic Affairs, Bali State Polytechnic (BSP) I Putu Mertha Astawa, SE, MM
- Assistant Director Of Cooperation And International Relationship, Bali State Polytechnic (Bsp) Ir. I Gede Made Oka Aryawan, MT
- Vice Dean For Academic Affairs, University Of Trunojoyo Madura (UTM) Ari Basuki, ST., MT
- Vice Dean I Faculty Of Social Science And Law, Universitas Negeri Surabaya (UNESA) Dr. Agus Suprijono, M.Si
- Vice Dean I Faculty Of Mathematics And Natural Sciences Universitas Negeri Surabaya (UNESA) Prof. Dr. Madlazim, M.Si
- Vice Dean I Faculty Of Engineering, University Of Pembangunan Nasional “Veteran” Jawa Timur (UPNVJT) Dr. Ir. Ni Ketut Sari, MT

Main Reviewers:

No	Name	Institution	Email
1	Prof Bayuseno	Diponegoro University ,Indonesia http://www.undip.ac.id	apbayuseno@gmail.com
2	Prof. Dr. Zakaria Hossain	Department of Environmental Science and Technology, Mie University, JAPAN	zakaria@bio.mie-u.ac.jp
3	Dr. Yusri Yusof	Faculty of Mechanical and Manufacturing Engineering at the Universiti Tun Hussein Onn Malaysia (UTHM)	yusri@uthm.edu.my
4	Dr Jamari	Diponegoro University, Indonesia, http://www.undip.ac.id	j.jamari@gmail.com
5	Dr Erma Suryani	Sepuluh Nopember Institute of Technology, Indonesia https://www.its.ac.id/	erma@is.its.ac.id
6	Prof Renanto Handogo	Sepuluh Nopember Institute of Technology, Indonesia https://www.its.ac.id/	renanto@chem-eng.its.ac.id
7	I Dewa Made Cipta Santosa, PhD	Politeknik Negeri Bali , Indonesia https://www.pnb.ac.id	idmcsantosa@pnb.ac.id

Editors:

I Dewa M C Santosa, ST, M.Sc, PhD

I Made Sudina, SST.Par

Cokorda Gde Candra Hadiputra, A.Md

Published by:

Pusat Penelitian dan Pengabdian kepada Masyarakat (P3M) Politeknik Negeri Bali
Jalan Kampus Bukit Jimbaran, Kuta Selatan, Kabupaten Badung,
Bali – 80364, Indonesia

Conference website: www.bali-ijcst.org

Preface

Ladies and Gentlemen,

It is my great pleasure to welcome you all to The 2nd International Joint Conference on Science and technology –IJCST 2017 in Nusa Dua Bali-Indonesia 27-28 September 2017. This conference is multidisciplinary including engineering and social science and hope can dedicate a positive contribution to science and technology development. Hosted by Bali State Polytechnic (PNB) and other established university partner including UPNV Jatim, FMIPA-UNISA, FISH-UNESA, and UTM, this conference are attended by more than four hundreds participants who present their best research results.

Papers have been reviewed by peer reviewers and already presented orally in the conference. Some selected paper are already submitted to be published in the **Journal of Physics: Conference Series** (<http://jpcs.iop.org>) and The International Journal of GEOMATE and automatically others are published in The IJCSST 2017 proceeding. With high confidence, depend on the paper topic and quality will can reach aim and topic of the conference **“As an international platform for scholars, researchers, practitioners, and government to discuss interdisciplinary research and practices that focuses in the theme of “Science, Technology, Innovation, and Culture for Sustainable Development: Challenge for Green Industry”**.

We would like to extend our warm and sincere thanks to authors for great contribution in this conference, and thank God so this proceeding can be completed and finished as planning. Hopefully all participants and authors can extend to build a networking each other in order to improve the research quality in future.

Sincerely yours,

IJCST 2017 Committee

Remark from Conference Chair

The honourable Minister of Tourism Republic of Indonesia
Distinguish guest and participants of IJCST 2017
Welcome to Bali – a wonderful Indonesia



The past few years has witnessed the idea of “Green Economy” flowing out from its realm of environmental economics. It is now omnipresent in mainstream policy discourse, our popular culture, industries, and development of disruptive technologies. It has successfully won the headspace and commitments of the world leaders as reflected in the Paris Agreement, the United Nations Sustainable Development Goals, G20 communiques.

The time to debate about whether we should transition to a green economy has now ended. It has been agreed upon to be the only way forward. However; shifting from the traditional 20th century model to a new green society requires massive investment and transformative disruptions. Delivering this ambitious global project requires strong public-private-partnerships and cross-sector collaborations. The 2nd International Joint Conference on Science and Technology (IJCST) 2017 aims to advance both by providing a multi-stakeholder platform for concerted action, research, and sharing of best practices under the theme “Science, Technology, Innovation, and Culture for sustainable development: Challenge for Green Industry”

I would like to welcome all of you to the IJCST 2017 and express my gratitude for the expertise you bring to our gathering. You are truly our greatest asset today and I encourage you to stay engaged, keep us proactive, and help the world shape the future of green economy.

I wish you a great conference and wonderful time in Bali.

Sincerely yours,
Conference chair
Dr. Ir. Lilik Sudiajeng, M.Erg

Welcoming Addressed by Director of Bali State Polytechnic

You're Excellency Minister of Tourism Republic of Indonesia
Distinguish guest and participants of IJCST 2017

Good morning



It is my pleasure welcoming you in Bali-the wonderful Indonesia, to attend the International Joint Conference on Science and Technology (IJCST) 2017.

This is the 2nd IJCST, which is held by Bali State Polytechnic, in collaboration with University of Pembangunan Nasional Veteran-East Java; University of Trunojoyo Madura-East Java; State University of Surabaya-East Java; and National Cheng Kung University Taiwan.

The conference is to aim an international platform for scholars, researchers, practitioners, and government to discuss interdisciplinary research and practices under the theme of "Science, Technology, Innovation, and Culture for Sustainable Development: Challenge for Green Industry". This theme is raised as a manifestation of the academic community's sensitivity towards global environmental issues that are now shifting from the issue of global warming to green economics.

It is an honor for me to convey that over 350 participants attended this conference from 14 countries. I give highly appreciation for your attendance. Your presence at this conference is very important to help the world in formulating green industry that leads to green economy.

Finally, wishing you a great conference and enjoy Bali, the wonderful Indonesia.

Bali State Polytechnic
Director,

Ir. Made Mudhina, MT.

Speech by Minister of Tourism



OPENING SPEECH

MINISTER OF TOURISM, REPUBLIC OF INDONESIA

*International Joint Conference on Science and Technology (IJCST),
Nusa Dua Bali, 27 September, 2017*



First of all I would like to extend my appreciation and gratitude to the committee of International Joint Conference on Science and Technology (IJCST) for exposing the theme of the conference on Science, Technology, Innovation, and Culture for Sustainable Development: Challenge for Green Industry. The theme is strongly intersected with global tourism development, since tourism is an integrated economic development involving high technology, innovation, culture and natural sphere.

The theme has clearly revealed that sustainable tourism, as part of sustainable development, is a joint effort among stakeholders. Multi-disciplinary research has to be constantly and mutually done to create green tourism economy, where tourism can be a catalyst of natural and cultural preservation, at the same time improving people's quality of life. Tourism development requires advanced technology, in transportation, information, and communication sector to ease tourist movement in accessing main attractions. Culture and nature are the main attractions for tourism, the question is how are they utilised to generate foreign exchange earnings but at the same time managing its sustainability.

It is imperatively expected that this scientific gathering will bring about new ideas and solutions as well as mutual commitment among practitioners and academicians to make tourism more sustainable and responsible, as mandated by UNWTO. Sustainable development is dealing with present and future generations welfare. Sustainable tourism is actually defined by the resonance of its sustainable development, benefiting present and future tourists and communities and viable within indefinite time, maximizing its economic gains.

Indonesia's tourism is mainly based on culture and nature as its main portfolio products. Resources related with the portfolio products has to be carefully and responsibly managed to ensure its sustainability. Research in new technological inventions and innovations have to be continuously developed to promote better tourism for our present and future generations. We cannot avoid using technology especially for the connectivity and digital marketing of our tourism, but we have to manage it to maximize its economic, cultural and natural benefit. I do hope that this conference will provide a great opportunity for the participants to share and understand both local and global issues of tourism development.

Wishing you all a very fruitful and rewarding conference.

Greetings from **Wonderful Indonesia**

Jakarta 18 September, 2017

Dr. Ir. Arief Yahya, M. Sc.
Minister of Tourism, Republic of Indonesia

Speech by Rector of Trunojoyo University Madura

Guest of Honour, Dr. Ir. Arief Yahya, M.Sc.
Minister for Tourism, Republic of Indonesia.
Mayor of Denpasar City,
Ida Bagus Rai Dharmajaya Mantra, SE., M.Si.
Distinguished speakers,
Researchers and Colleagues,
Assalamu'alaikum Warrohmatullahi Wabarokaatuh.



Praise goes to the most merciful God Allah SWT for the blessings of life and knowledge for us to gather on this meaningful occasion.

To start with we would like to warmly welcome the eminent speakers and delegates who have come from all over the world. We are indeed honoured to have you here with us, making this conference a truly international one.

Ladies and gentlemen,

The university of Trunojoyo Madura is located on Madura island as a part of East Java province area, and currently, it is on 16 years old. This university has committed to escalating its educational process and research activity. It is because those processes play a pivotal role to aim the vision of University of Trunojoyo Madura for a period 2014 – 2018. One of main strategies to achieve the University's vision is by implementing a cluster approach in order to increase the University of Trunojoyo Madura's competitive advantage. This approach is carried out by strengthening our research based on six potential sectors. These sectors are (1) salt and tobacco sectors, (2) food commodities sector (corn, cassava, cane, cattle, and sea commodities), (3) energy sector (oil and gas, renewable energy), (4) educational sector (formal and informal education), (5) social sector (worker and women studies), and (6) tourism and creative economic. All of these sectors are regarded to Madura resources.

Ladies and gentlemen

We do realise that the process of strengthening our research cannot be accomplished by ourself. It would be hard for the University of Trunojoyo Madura if only relaying it on our internal resources. A mutualism collaboration is needed, a collaboration which involves other external parties including universities, governments, businesses, and any other parties. Therefore, on this occasion, Faculty of Engineering, University of Trunojoyo Madura runs an International Conference for the second time called ICOSE (International Conference on Science and Engineering). The ICOSE is held in collaborating with several big universities namely Bali State Polytechnic, University of Pembangunan National Veteran of Surabaya, State University of Surabaya on one event named IJCST (International Joint Conference on Science and Technology) 2017. We hope that this conference will generate an advantageous knowledge sharing about previous research results and bright outlooks. Henceforward, University of Trunojoyo Madura wishes could achieve its vision with a better result.

In closing, we encourage delegates to participate actively in interesting discussions over the seminar periods. I wish everyone has a successful and fruitful conference.

Thank you very much

Wassalamu'alaikum Warrahmatullohi Wabarokaatuh

Speech by Rector of State University of Surabaya

It is with great pleasure that I extend my warmest welcome and best wished to all keynote speakers, presenters, and participants of the 2017 International Joint Conference on Science and Technology (IJCST), “Science, Technology, Innovation, and Culture for Sustainable Development: Challenge on Green Industry.”



IJCST has worked with partners from higher education institutions and polytechnic from Indonesia and People’s Republic of China, namely UPN Jawa Timur, Universitas Negeri Surabaya, Universitas Trunojoyo, Politeknik Negeri Bali, Politeknik Negeri Jember, and National Cheng Kung University. Each institution contributes largely to the success of the 2017 IJCST by gathering academics and professionals across the country and overseas with aims at sharing recent investigations of the theme and hoping they would fruitful to stakeholders in resolving challenges on green industry.

With regards to challenges that Indonesia and countries at the global level encounter particularly demographic plus in 2020 and a surge of primary needs including clean environment as well as increased international mobility of people from various cultures, the 2017 IJCST plays a crucial role in offering innovations and resolutions of those challenges. By so doing, proposals and recommendations withdrawn from the present conference will then serve as the basis for relevant stakeholders in policymaking.

I have always believed that IJCST has been an insightful platform for intellectuals and practitioners to continuously create breakthroughs in support of achieving sustainable development. My best wishes for a fruitful and productive conference.

With regards,

Prof. Dr. Warsono, M.S.
Rektor

Speech by Rector of University of Pembangunan Nasional Surabaya

Assalamualaikum Wr. Wb. , Good Morning

Honorable Guests:

Ministry of Tourism of Republic of Indonesia, “Ir. Arief Yahya, M.Sc”

Governor of Bali, “Made Mangku Pastika”

Directorate General of Research and Development, “Dr. Muhamad Dimiyati, M.Sc.”

Director of Bali State Polytechnic, “Ir. Made Mudhina, M.T.”

Honorable Keynote Speakers :

Mayor of Denpasar City, “Ida Bagus Rai Dharmawijaya Mantra, SE, M.Si”

Head of Badung Regency, “Nyoman Giri Prasta, S.Sos”

Attache of Educational Affairs – Embassy of France in Indonesia, “Prof. Dr. Emilienne Baneth Nouailhetas”

Prof. Dr. Zakaria Hossain, Prof. Moonyong Lee, Prof. Jyh-Ming Ting, Dr. Yusri Yusof, Reviewers, and Last but not least beloved participants,

Thank God for granting us with blessings, that we could gather here today in this very special moment, “International Joint Conference on Science and Technology 2017” organized by UPN “Veteran” Jawa Timur, Bali State Polytechnic, National Cheng Kung University, University of Trunojoyo, Surabaya State University, and Jember State Polytechnic.

Ladies and Gentlemen,

Environmental problems has been a very significant issue for many parties, especially for business actors. Either help the environment and hurt your business, or irreparably harm your business while protecting the earth. With such problems, it might be wise for us to focus on the promotion of several environmental-friendly steps, some to mention are low-carbon paths to industrial development; efficient use of non-energy raw materials; adoption of relevant products and technologies to meet environmental standards; adoption of environmental and related management systems with a view to entry into global value chains; and creation of businesses that can offer services in these areas.

The theme chosen is concerning with the current problem, Green Industry which is related to the increasingly polluted environment as well as the increasingly expensive energy problems that needs finding ways of savings. It is gratifying to note that the agenda of the seminar covering a wide range of very interesting items relating to the theme.

We believe this seminar is a great opportunity for all delegates to discuss the existing problems concerning science, technology, innovation, and culture for sustainable development in answering challenges for green industry.

Distinguished guests,

I wish this moment not only could enrich a broader knowledge, but also make new friends, and build net working in creating better future.

At last but not least, I would like to express my greatest appreciation to everyone who has supported and brought this seminar into success, and we truly apologize for any inconveniences may arise during the seminar.

Thank you

Wassalamualaikum Wr. Wb.



Denpasar, September 27, 2017
Rector of UPN “Veteran” Jawa Timur
Prof. Dr. Ir. H. Teguh Soedarto, MP

Sponsor or funding acknowledgements

We are delighted to acknowledge the financial support received from Bali state Polytechnic- Ministry of Research , Technology and Higher Education- Indonesian Government and also the excellent support received from Mayor of Denpasar City, Governoor of Bali Province, Rector of Trunojoyo University Madura, Rector of State University of Surabaya, Rector of University of Pembangunan Nasional Surabaya.

List of Content

Cover	i
Verso	ii
Preface	iv
Remark from Conference Chair	v
Welcoming Addressed by Director of Bali State Polytechnic	vi
Speech by Minister of Tourism	vii
Speech by Rector of Trunojoyo University Madura	viii
Speech by Rector of State University of Surabaya	ix
Speech by Rector of University of Pembangunan Nasional Surabaya	x
Sponsor or funding acknowledgements	xi
List of Content	xii

List of Papers

No/ID	Paper's Title	Page Number
PROC_IJCST_001	Creative Economy for Sustainable Tourism <i>Rai Dharmawijaya Mantra</i>	1
PROC_IJCST_002	Environment friendly ground improvement technique using waste shell husk <i>Z Hossain¹, S H Rachmawati¹ and A S M A Awa²</i>	2
PROC_IJCST_003	Process Optimization, Integration, and Intensification: Main Route for Green and Sustainable Chemical Process <i>Moonyong Lee^a</i>	3
PROC_IJCST_004	Malaysia in Context IR4.0; Challenges and opportunities <i>Yusri Yusof</i>	4
PROC_IJCST_005	Consuming the world: the paradoxes of Tourism <i>Emilienne Baneth</i>	5
PROC_IJCST_006	Philippine IPs Culture for Sustainable Development: A Paradigm for Green Industry <i>Esmeralda F. Sanchez, PhD</i>	6
PROC_IJCST_007	MoS2 Nanostructures and Its Composites for Supercapacitors <i>Jyh-Ming Ting</i>	7
PROC_IJCST_008	A Conceptual Model of Internet of Things (IoT) for E-Participation <i>Muhammad Yusuf, Devie Rosa Anamisa, Ach Khozaimi</i>	8 - 15
PROC_IJCST_009	Audit Energy and Developing Photovoltaic (PV) Model for Refrigeration Laboratory Building Application <i>IGAB Wirajati, Ni Kadek Muliati, I DM C Santosa</i>	16 - 22
PROC_IJCST_010	Effects of concrete ages and reinforcement at the measurement of ultrasonic pulse velocity (UPV) <i>I Made Suardana Kader and Fajar Surya Herlambang</i>	23-27

PROC_IJCST_011	An Increase In Literate Statistics, (Statistical Reasoning And Statistical Thinking Through The Development Of Teaching Materials And Assessments Based E-Learning <i>I Wayan Putrana and Ni Made Kariati</i>	28 - 35
PROC_IJCST_014	Web based information system for job training activities using Personal Extreme Programming (PXP) <i>Sri Andriati Asri, I Gusti Agung Made Sunaya, Elina Rudiastari</i>	36 - 42
PROC_IJCST_015	Determining net single premium for credit life insurance at civil servants cooperative of State Polytechnic of Bali <i>Tri Tanami Sukraini, Ketut Vini Elfarosa</i>	43 - 50
PROC_IJCST_016	Analysis of seaweed cultivation business in Ped village, Nusa Penida district, Klungkung regency <i>Ni Nyoman Supiatni, A A A Mirah Kencanawati, Sagung Mas Suryaniadi</i>	51 - 54
PROC_IJCST_017	Development of quality of educational service model based on student satisfaction inventory (a case study at Bali State Polytechnic) <i>I Wayan Siwantara, I Komang Sugiarta</i>	55 - 61
PROC_IJCST_018	Influence of variation fluid flow towards the performance of cooling tower type induced draft counterflow cooling tower <i>Sudirman, I Putu Darmawa</i>	62 - 67
PROC_IJCST_019	The perception of tourists toward the Festival of Kuta Majelangu Market as a community-based tourism attraction <i>Made Ruki, Ni Gst Nym Suci Murni, Ida Ayu Elistyawati</i>	68 - 72
PROC_IJCST_021	A Web-based Automatic Meter Reading for Electric Power Monitoring <i>I G A Made Sunaya, I N K Wardana, I N Sukarma</i>	73 - 77
PROC_IJCST_022	Procurement Clean Water by Using Groundwater (Case Studi in Bukit Asah Bugbug Village Karangasem Bali) <i>Ni Ketut Masih and I Nengah Simpen</i>	78 - 84
PROC_IJCST_023	Implementation of supply chain management through collaboration strategy to improve logistic capability and performance <i>Cokorda Gede Putra Yudistira, I Wayan Edi Arsawan, Ni Wayan Sumetri, I Wayan Wirga</i>	85 - 96
PROC_IJCST_024	The integrated practice learning model to improve the competency of waiter/s occupation on hospitality study program of Bali State Polytechnic (BSP) <i>I Ketut Sadia, I Made Darma Oka, I Wayan Pugra</i>	97 - 102
PROC_IJCST_025	A Management Model for Sustainable Tourism for Tegenungan Waterfall Tourism Object in Gianyar <i>Ni Made Sudarmini, Cokorda Istri Sri Widhari, Ni Wayan Sukartini</i>	103 - 111
PROC_IJCST_026	Analysis of the effect of temperature on tire's durability on engkel truck vehicle <i>I Wayan Suastawa, Ida Bagus Putu Sukadana</i>	112 - 116
PROC_IJCST_027	The Development of Teaching Material for Automotive Electrical and Electronics Laboratorium Based on Automotive-	117 - 123

	SKKNI to Improve the Achievement of Standar Competencies of Polytechnic Students <i>I Komang Rusmariadi, I Putu Darmawa</i>	
PROC_IJCST_028	The yajna-based ashram learning model in the formation of character <i>Ketut Nurhayanti, and Putu Adi Suprpto</i>	124 - 131
PROC_IJCST_029	Analysis and design of web-based management information system for garments manufacturing process <i>I K Suwintana, I G A Oka Sudiadnyani</i>	132 - 137
PROC_IJCST_030	The influence of spreadsheet based modules implementation on statistics course achievement of Accounting Department students, Politeknik Negeri Bali <i>I Made Wijana, Anak Agung Putri Suardani</i>	138 - 143
PROC_IJCST_031	Community based village management model in Blimbingsari tourism village, Melaya, Jembrana, Bali <i>I Nyoman Meirejeki, Luh Mei Wahyuni, Cok Istri Sri Widhari, and I Made Widiantara</i>	144 - 148
PROC_IJCST_032	Formulation of creative tourism products in the area nature tourism Pandawa beach Badung Bali <i>I Dewa Gede Ari Pemayun, Luh Linna Sagitarini, and A. Agung Putu Swabawa</i>	149 - 155
PROC_IJCST_033	Development of Evaluation Instrument Context, Input, Process, Product (CIPP) Learning Program in Politeknik Negeri Bali Environment <i>I Nyoman Gunung, I Ketut Darma</i>	156 - 161
PROC_IJCST_034	The effect of administration system and tax reports on line on service quality and restaurant's tax-payer compliance in Badung Regency <i>Nyoman Sentosa Hardika, I Ketut Sukayasa, and Ni Nyoman Yintayani</i>	162 - 168
PROC_IJCST_035	Analysis of sales budget and actual sales at CV Sumberjaya <i>Made Dana Saputra, Made Agus Putrayasa</i>	169 - 174
PROC_IJCST_036	The study of development of marine eco-tourism as an alternative of livelihood of community of Tulamben and Amed of Karangasem Regency of Bali Province <i>I Gede Made Subagiana, Sagung Mas Suryaniadi, Ni Luh Made Wijayati</i>	175 - 186
PROC_IJCST_037	Development of Computer – Based Student Working Practice Information System <i>I Made Sura Ambara Jaya, I Made Ariana</i>	187 - 192
PROC_IJCST_038	Development of Accounting Model for Chicken Farming Business According to Financial Accounting Standard <i>Ni Ketut Sukasih, Ni Luh Nyoman Ayu Suda Susilawati</i>	193 - 197
PROC_IJCST_039	Spreadsheet-based accounting application with transaction cycle approach for manufacturing company <i>Ni Luh Nyoman Ayu Suda Susilawati, Ni Ketut Sukasih, I Made Ariana</i>	198 - 204

PROC_IJCST_040	The Analysis of Operation and Maintenance Costs of Retention Basin in Besakih Based on the Characteristics of River and Local Social Cultural Religious Condition <i>Ida Bagus Putu Bintana, I Made Suardana Kader</i>	205 - 212
PROC_IJCST_041	Cash flow optimal analysis on NPV risk based on break event point of various types of housing in housing development projects <i>I Gusti Agung Istri Mas Pertiwi, I Wayan Suasira, Wayan Sri Kristinayanti, Evin Yudhi Setyono, Ketut Wiwin Andayani</i>	213 - 222
PROC_IJCST_042	The Influence of the Growth of Earning Assets, Third Party Funds, Loan to Deposit Ratio, and Non Performing Loan to Rentability of Rural Bank <i>Ni Putu Rita Sintadevi, I Ketut Sudiarta and I Made Wijana</i>	223 - 227
PROC_IJCST_043	Flood handling system of Pucak Terate Bang Temple <i>IGAG Surya Negara, I Wayan Wiraga, I Wayan Arya</i>	228 - 235
PROC_IJCST_044	Sustainable management of Mati River <i>I Gst. Lanang Made Parwita, I Gede Sastra Wibawa</i>	236 - 246
PROC_IJCST_045	Foreign language interference in science writing of Politeknik Negeri Bali students <i>I N Mandia and I B A Adnyana</i>	247 - 253
PROC_IJCST_046	Investigation of solar collector for developping dewvaporation system in Bali <i>IDG Agustriputra, K Bangse</i>	254 - 257
PROC_IJCST_047	Marketing information system design based on local community tourism destinations <i>I G P Fajar Pranadi Sudhana and I Made Suarta</i>	258 - 265
PROC_IJCST_048	The Degree of Subjective Complaints of Students Practice on Mechanical Technology Laboratories <i>I Ketut Widana</i>	266 - 271
PROC_IJCST_049	Improvement of work posture to decrease musculoskeletal disorder and increase work productivity jewelry worker in bali <i>M Yusuf, M Santiana, W D Lokantara</i>	272 - 277
PROC_IJCST_050	Characterized Temperature and Humidity for Classroom Comfort Zone in Bali <i>L P I Midiani, I W A Subagia, and I B G Widiartara</i>	278 - 281
PROC_IJCST_051	Development of Simulation Control Two Water Supply Pump Using Relay Change Over and Floatless Level Switch <i>I Nyoman Gede Baliarta , I Made Sudana</i>	282-290
PROC_IJCST_052	Development of Special-Interest Marine Tourism in Serangan Village Denpasar <i>I Ketut Suarta, A. Agung Putu Swabawa, I Putu Budiarta</i>	291-295
PROC_IJCST_054	Preferred Pricing Technique Used in Tourism Small and Medium Enterprises In Badung, Bali, Indonesia <i>Ni Luh Eka Armoni, Nyoman Mastiani Nadra, I Ketut Suarta</i>	296-301
PROC_IJCST_055	Physical and Electrical Parameters Measurement Module in Solar Panel Physics Laboratory Politeknik Negeri Bali <i>I Made Aryasa Wiryawan, I Nyoman Sugiarta, I Wayan Teresna</i>	302-306

PROC_IJCST_056	The Effect of The Angular Change and The Rotation of The Blade on The Thickness of Incision on The Cocoa Skin Machine <i>Achmad Wibolo, I Gede Nyoman Suta Waisnawa</i>	307-314
PROC_IJCST_056a	Conversion of Compressive Strength of Concrete Cement Using Adhesive Pozolan on Age Variation of Concrete <i>I Wayan Intara*, I Wayan Sudiasa, I Made Jaya, I Wayan Dana Ardika</i>	315-319
PROC_IJCST_057	The Effect of Gel Coat Layer Composition on Bending Strength of Kenaf Fiber Reinforced Polymer <i>Ahmad Haya and Mardiana Amir</i>	320-325
PROC_IJCST_058	On The Classical Aspects of Electrons Tunnelling Through A Quantum Dot Via a Driven Lattice Gas Model in One Dimension <i>Hammada*, Muh. Yamin, Yusran, Nur Wahyuni</i>	326-333
PROC_IJCST_059	Strenght and Fatigue Testing of Orthotropic Metal Added Sic Using Stir Casting Method <i>Hammada*, Muh. Yamin, Yusran, Nur Wahyuni</i>	334-340
PROC_IJCST_060	Adsorption Of Manganese (MnII) from Aqueous Solutions by Using Modified Kaoline-Surfactan as Adsorben <i>A Putra, B Arifin, Marwan, Suhendrayatna, Syafruddin</i>	341-347
PROC_IJCST_061	Analysis of The Effect of Initial Moisture Content on Organic Waste Characteristics Using Biodrying Process <i>G A Kristanto, R P Shofriyah</i>	348-356
PROC_IJCST_062	Effect of Cellulase Addition on Leachate Recirculation for Leachate Qualities Using Bioreactor Landfill Method <i>G A Kristanto, R P Sari</i>	357-367
PROC_IJCST_063	Pomelo Peels Extract as Green Corrosion Inhibitor for Mild Steel in Hydrochloric Acid 1 M <i>Iwan Nurdin, Elwina, J S Maulana</i>	368-373
PROC_IJCST_065	Exploring Students Perceptions on Using Blogs for Learning Mathematics Course at State Polytechnics Manufacture of Bangka Belitung <i>Parulian Silalahi</i>	374-379
PROC_IJCST_066	The Use Of Waste Bone of Skipjack Fish (Katsuwonus Pelamis L) to be Gelatin in North Sulawesi Province <i>Hens Onibala, Engel Pandey, Agnes Agustin and Febri Triani Singkuku</i>	380-387
PROC_IJCST_067	Mix Design Stabilization of Concrete Paving Block (CPB) with Hydraulic Pressing Technology <i>Erno Widayanto, Agoes Soehardjono, Wisnumurti, . Achfas Zacoeb</i>	338-398
PROC_IJCST_068	Handling Technique Development of Live Carp, Cyprinus Carpio, in Cold Dry Styrofoam Box <i>I Ketut Suwetja, Netty Salindeho, I Gede Prabawa Suwetja</i>	399-403
PROC_IJCST_069	Critical success factors to improving safety culture on construction project in Indonesia <i>Rossy Armyn Machfudianto, Yusuf Latief, Robert, and Dadang Iskandar</i>	404-411

PROC_IJCST_070	Test Vibration in Treatment of Agave Fiber and Bamboo Fiber to Variation of Fake Direction <i>Muh. Yamin*, Hammada, Ilyas, Moh. Adnan, Nur wahyuni</i>	412-420
PROC_IJCST_071	Image of Javanese Women in Patriarchal Culture Represented by Aisyah, A Character in Umar Kayam's Para Priyayi <i>Sri Warsidah Rahmi</i>	421-427
PROC_IJCST_074	Strengthening of Fishermen Bargaining Position in Marketing of Capture Fishery Catch <i>I Ketut Setia Sapta, I Nengah Landra, I Nengah Sudja</i>	428-433
PROC_IJCST_077	Determining Blewah Fruit Maturity Based On Skin Color Texture Using Feature Extraction <i>Chrystia Aji Putra and Budi Nugroho</i>	434-439
PROC_IJCST_079	Cobit Maturity Level At PT Kai DAOP 8 Surabaya <i>Siti Mukaromah*, Agung Brastama P</i>	490-447
PROC_IJCST_080	Analysis Of Soybean Production To Achieve Soybean Self-Sufficiency Using System Dynamics Approach <i>Agung Brastama Putra, Siti Mukaromah, Nur Cahyo Wibowo</i>	448-454
PROC_IJCST_081	IT Balanced Scorecard Method For Performance Measurement Of Information System Technology Unit In Regional Water Company Of Surabaya City <i>Faisal Muttaqin, Firza Prima Aditiawan, Fetty Tri Anggraeny and Try Khurniawati</i>	455-463
PROC_IJCST_082	Measurement maturity level of business alignment and it (case study: University of Kartini Surabaya) <i>Mohammad Idhom, Akhmad Fauzi</i>	464-469
PROC_IJCST_083	Marketplace Technology To Reduce Intervention Of The Horticulture Trader In East Java <i>Sugiarto, Endang Yektiningsih, Kasirah</i>	470-473
PROC_IJCST_084	Growth And Production Plant Chili Pepper (Capsicum Annum) As A Result Of The Existence Pruning Leaves <i>Widiwurjani Amir Tjokrosmarto and Djarwatiningsih Pongki Soedjarwo</i>	474-484
PROC_IJCST_085	Text Based Maximally Stable Extremal Regions To Detect Vehicle Plate Location <i>Hendra Maulana, Darlis Herumurti and Anny Yuniarti</i>	485-490
PROC_IJCST_086	The Open Group Architecture Framework: Design Of Information Technology Architecture (Case Study: Faculty Of Economics, XYZ University) <i>Ronggo Alit, Eva Y Puspaningrum, Firza Prima A</i>	491-496
PROC_IJCST_087	Normal Leaf Knowledge On Soybean Plant Based On Threshold <i>M.Syahrul Munir, Fetty Tri Anggraeny</i>	497-501
PROC_IJCST_088	Local Pixel Analysis In Color Constancy To Improve Feature Extraction Process <i>Wahyu S J Saputra and C Aji Putra</i>	502-508
PROC_IJCST_089	Determination of Chromium Content in Various Foodstuffs <i>*Rudiana Agustini and I Gusti Made Sanjaya</i>	509-514

PROC_IJCST_090	The development of teaching material of concept maps based on inquiry as an effort to trained high-order thinking skills of chemistry education students <i>Ismono, Sri Poedjiastoeti, Suyatno</i>	515-524
PROC_IJCST_091	A conceptual system for supply chain management: agricultural products distribution in Indonesia <i>Syurfah Ayu Ithriah, Rizka Hadiwiyanti, Doddy Ridwandono</i>	525-530
PROC_IJCST_092	Automatic ontology construction from short text: a proposal <i>Prisa Marga Kusumantara, Yesi Novia, Doddy Ridwandono</i>	531-535
PROC_IJCST_093	Decision support systems: transportation mode selection for agricultural product distribution <i>Rizka Hadiwiyanti*, Doddy Ridwandono, Syurfah Ayu I, Rendra Irwanto</i>	536-539
PROC_IJCST_095	Classification of broiler chicken eggs using support vector machine (svm) and feature selection algorithm <i>Intan Y. Purbasari, Fetty T. Anggraeny and Nikolaus R. Harianto</i>	540-546
PROC_IJCST_096	Why indonesian users visiting youtube an exploration of uses and gratification theory <i>Tri Lathif Mardi Suryanto, Nur Cahyo Wibowo, Syurfah Ayu Ithriah, Asif Faroqi, Deny Fatkhur</i>	547-553
PROC_IJCST_097	Modeled early detection of pregnancy risk based on Poedji Rochjati score card using relief and neural network <i>Fetty Tri Anggraeny*, Faisal Muttaqin and M. Syahrul Munir</i>	554-560
PROC_IJCST_098	Frequency Estimation Using Top-Hat Transforms <i>IGNA Dwijaya Saputra, IGNB Catur Bawa</i>	561-571
PROC_IJCST_099	Community information systems for agriculture with analytical features <i>Mohamad Irwan Afandi, Eka Dyar Wahyuni, Achmad Nuruddin and Dwatra Apriandi</i>	572-577

Determination of chromium content in various foodstuffs

Rudiana Agustini and I Gusti Made Sanjaya
Department of Chemistry, Faculty of Mathematics and science, Surabaya State
University, Indonesia
E-mail is rudianaagustini@unesa.ac.id

Abstract. Research has been conducted to identify the content of chromium in foodstuffs, including broccoli, celery, snake grass, green mustard greens, tomatoes, carrots, beans, green beans, cauliflower, chicory, cassava, potatoes, black rice, white rice, brown rice, black sticky rice, yeast (bakery yeast) and yeast extract commercial. The determination of chromium was carried out using voltammetry method, which the results were processed using OriginPro program. The data were then analyzed descriptively. The results showed that the foodstuffs containing the highest Cr^{3+} is cauliflower that is $280 \times 10^{-4}\%$, but the Cr^{6+} content is $83 \times 10^{-4}\%$. The foodstuffs containing Cr^{6+} in small quantities are cassava, nuts and commercial yeast, which is about $8 \times 10^{-4}\%$ to $9 \times 10^{-4}\%$, but Cr^{3+} content is also not very high that is about $18 \times 10^{-4}\%$ to $21 \times 10^{-4}\%$.

Keywords: Chromium content, Foodstuffs, Chromium in foodstuffs, chromium determination

1. INTRODUCTION

Chromium is one of the seven most abundant elements in the Earth's crust and at low concentrations is an essential element for living organisms naturally. Chromium is present in various forms of compounds. In addition to being Cr metal, the chromium is found as Cr^{2+} , Cr^{3+} (trivalent chromium), and Cr^{6+} or chromium hexavalent. Cr^{3+} is known to be non-toxic, while Cr^{6+} is toxic to the human body. Cr chemicals are persistent, bio-accumulative, toxic and not readily degradable in the environment, thus accumulating in the human body through the food chain. Cr from for example the soil environment is entering the food chain through the plant. According to the World Health Organization, Cr^{6+} concentrations in soil should not be more than 0.05 mg/L or 50 ppb [1]. Cr^{6+} compounds also have genotoxic, mutagenic, and carcinogenic properties [2]. The toxicity brought by this metal can harm vital organs such as liver, kidneys, cause lung cancer, acute poisoning, chronic, irritation to the respiratory system, and irritation to the human skin [3].

Various natural ingredients including foodstuffs are known to contain chromium, both Cr^{3+} and Cr^{6+} ions. Several studies have revealed that consumption of chromium can decrease type 2 diabetes mellitus (DM). Chromium is an essential mineral that the body needs for carbohydrate and fat metabolism [4]. Diabetes mellitus type 2 (T2DM) is the most common form of diabetes found worldwide [5] [6] [7]. This is characterized by abnormalities in pancreatic insulin secretion or actions that cause hyperglycemia due to impaired metabolism of carbohydrates, fats and lipids [5][7]. T2DM prevalence worldwide is increasing and more than 366 million people are expected to be affected by 2030 [5][7]. T2DM is continuing to be a public health concern, and many people are using alternative medicine using chromium. Chromium is a common supplement used by many T2DM patients for the purpose of improving glucose regulation and in 2002 sales of chromium supplements were estimated at \$85 million [8].

According to the National Institute of Health: Dietary Supplement Office, adequate intake of Cr for men and women is 35 and 25 $\mu\text{g}/\text{day}$, respectively [5][9][10]. Chromium chloride is a natural

trivalent chromium variety found in common foodstuffs sources such as: whole grains, broccoli, mushrooms and green beans. In contrast, Cr picolinate is the synthetic family of Cr chloride. Additional forms of Cr supplements can also come from Cr's yeast and brewer's yeast. Chromium is an important micronutrient associated with the regulation of many processes in the human body including glucose homeostasis. Chromium helps regulate glucose homeostasis by activating insulin receptors through chromodulin oligopeptide thus increasing insulin signal transduction and sensitivity. Cr deficiency can lead to glucose intolerance, high circulating insulin, hyperglycemia at the time of fasting, and even disruption of growth [5][11].

Chromium can be obtained from foodstuffs and is available in very small quantities (1-2 micrograms or less). Chromium in the foodstuffs has a form of chromium (III) (indicating the amount of oxidation). Trivalent chromium or chromium (III) or Cr^{3+} is the most stable chromium and most secure, including one of the least toxic. Cr^{3+} is relatively harmless and has a role in the body's metabolism, while Cr^{6+} has a potential of 100-1000 times more toxic than Cr^{3+} because it has a high oxidation potential.

The following is a list of foods rich in chromium: broccoli (18.55 mcg/1 cup), barley (8.16 mcg/0.33 cup), oats (5.38 mcg/0.25 cup), beans (2.04 mcg/1 cup), tomatoes (1.26 mcg/1 cup). Chromium has proven its involvement in the mechanism of treatment of type 2 diabetes in several ways, including by increasing glucose tolerance. Chromium supplements increase glucose tolerance in humans with type 2 of diabetes [12]. Cr supplementation with brewery yeast may provide a marginal benefit in lowering blood glucose levels in patients with T2DM compared with placebo but no effect on glycated hemoglobin [5].

It is generally accepted that chromium is an essential element for humans. Chromium deficiency has been described in both humans and animals, but a clear quantitative definition of the daily requirement of chromium in human nutrition has not been arrived at estimates that the daily minimum population mean intake likely to meet normal requirements for chromium might be approximately $33\mu\text{g}/\text{person}$ [1]. Results of panels related to the Food Supplement and Nutrition Source, Cr^{3+} added to food and food aimed at the general population (including dietary supplements), concluded that after oral administration, trivalent chromium is poorly absorbed. The result of in vitro bacterial mutagenic test consistently is negative. The panel concluded that in very large quantities, certain trivalent chromium compounds have been shown to be cytotoxic and cause chromosomal damage. The panel also evaluated long-term toxicity and carcinogenicity data for Cr^{3+} . Based on the facts, it is known: 1) a maximum intake level of up to $250\mu\text{g}/\text{day}$ for additional intake, 2) that in vitro, at high levels of concentration, Cr^{3+} can cause DNA damage, 3) that DNA damage is not reflected in the in vivo genotoxicity test, 4) that Cr^{3+} is not carcinogenic, 5) that it is safe for a daily intake of $250\mu\text{g}/\text{day}$, equivalent to $4.1\mu\text{g}/\text{kg}$ body weight/day for people 60 kg [13]. Although chromium is an essential trace element for humans because it helps us to use glucose. However, it is poisonous in excess.

Daily chromium intake according to US dietary guidelines is 50-200 mg for adults, 30-35 mg for adult males and 20-25 mg for adult women [14][1]. About 2% of Cr^{3+} or trivalent chromium can be absorbed and the rest is excreted in the stool. Amino acids, vitamin C and niacin can increase the absorption of chromium by channels of the intestine. These minerals further accumulate in the liver, bone, and spleen. Trivalent chromium is found in a variety of foodstuffs, including wheat products, processed meats, cereals, coffee, beans, green beans, broccoli, spices, and some brands of wine and beer. Most fruits and vegetables and dairy products contain only low amounts.

2. METHODOLOGY

2.1 Preparation of materials

Foodstuffs identified about their chromium content are broccoli, celery, snake grass, green mustard, lettuce, tomatoes, carrots, beans, green beans, cauliflower, chicory, cassava, and potatoes, black sticky rice, white rice, brown rice, black rice, yeast (bakery yeast) and yeast commercial extract. The foodstuffs cut into small pieces, then weighed each 5 grams. The next step of each

foodstuff is heated in a furnace at a temperature of 700°C for 7 hours to obtain ash. The obtained ash is dissolved in 1 ml of the concentrated HNO₃ and 1 ml of the concentrated HCl. Each solution is ready to determine its chromium content.

2.2 Determination of chromium content

Determination of chromium content is done by using voltammetry method. Instrument used is Voltammeter. The chromium to be determined is Cr³⁺ and Cr⁶⁺. The first step taken on the determination of this chromium content is to make a standard solution. The standard solution used was prepared by dissolving K₂Cr₂O₇ and CrCl₃.6H₂O in variations of 5, 10, 20, 40 and 80 ppm. Measurements were made using Silica Carbon Electrode with scan rate of 50mV/sec [15]. Measurement of standard solution using voltammeter produces voltammogram, which then processed using Origin-Pro program and made standard curve between concentration versus current, so obtained linear regression equation $y = a + bx$. Then measured each sample solution or foodstuff, the result is incorporated into the equation.

3. RESULT AND DISCUSSION

Figures-1 and -2 show the standard curves of Cr³⁺ and Cr⁶⁺ in variations of concentrations of 5, 10, 20, 40, and 80 ppm. The regression equation obtained from the standard measurement of Cr³⁺ is $Y = 3.370798x + 0.004378$ and the regression equation obtained from the standard measurement of Cr⁶⁺ is $Y = 3.139306x + 0.008648$.

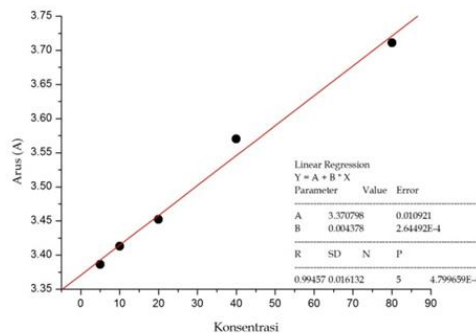


Figure-1 Standard Curve of Cr³⁺

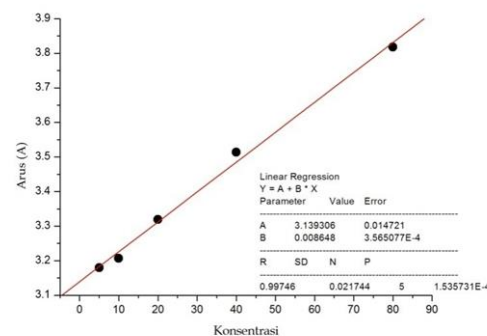


Figure-2 Standard Curve of Cr⁶⁺

By entering the data from the current strength obtained from each sample or foodstuff tested using voltammeter into the equation $Y = 3.370798x + 0.004378$ for the determination of Cr³⁺ and $Y = 3.139306x + 0.008648$ for the determination of Cr⁶⁺ then the data obtained as shown in Table-1 and -2.

Table 1 Content of Cr³⁺ Determined from Various Foodstuffs.

Groups	Name of foodstuffs	Cr ³⁺ (10 ⁻⁴ %)	
Vegetable group	Broccoli	Brassica oleraceavaritalica	116
	Celery	Apiumgraveolens L	96
	Snake grass	<i>Clinacanthusnutanslindau</i>	82
	green mustard	Brassica rapavarparachinensis	96
	lettuce	Lactuca sativa	136
	Cauliflower	Brassica oleraceavarBotrytis	280
	Chinese cabbage	Brassica juncea	176
Group of fruit	Tomatoes	Licopersicumesculentum	141
	Carrots	Daucuscarota	110
	Long beans	Vignasinensis	20
	Chili	Capsicum frutescens	70
Group of rice /cereals	black rice	Oryza sativa L	20
	Black sticky rice	Oryza sativa varglutinosa	21
	Brown rice	Oryzapunctata	19
	Green beans	Oryza sativa	18
	White rice	Phaseolusaureus	20
	Red beans	Vignaangularis	18
Group of tubers	Potatoes	Solanumtuberosum L	83
	Cassava	Manihotutilissima	41
Group of yeast	Yeast (bakery's yeast)	Saccharomyces cerevisiae	16
	Yeast extract commercial sample	Saccharomyces cerevisiae	18

Table 2 Content of Cr⁶⁺ Determined from Various Foodstuffs.

Groups	Name of foodstuffs	Cr ⁶⁺ (10 ⁻⁴ %)	
Vegetable group	Broccoli	Brassica oleraceavaritalica	54
	Celery	Apiumgraveolens L	45
	Snake grass	<i>Clinacanthusnutanslindau</i>	39
	green mustard	Brassica rapavarparachinensis	45
	lettuce	Lactuca sativa	64
	Cauliflower	Brassica oleraceavarBotrytis	83
	Chinese cabbage	Brassica juncea	39
Group of fruit	Tomatoes	Licopersicumesculentum	66
	Carrots	Daucuscarota	132
	Long beans	Vignasinensis	52
	Chili	Capsicum frutescens	33
Group of rice /cereals	black rice	Oryza sativa L	9
	Black sticky rice	Oryza sativa varglutinosa	10
	Brown rice	Oryzapunctata	9
	Green beans	Oryza sativa	9

	White rice	Phaseolusaureus	9
	Red beans	Vignaangularis	9
Group of tubers	Potatoes	Solanumtuberosum L	19
	Cassava	Manihotutilissima	8
Group of yeast	Yeast (bakery's yeast)	Saccharomyces cerevisiae	8
	Yeast extract commercial sample	Saccharomyces cerevisiae	9

Based on the data in Tables-1, and Table-2, it appears that for the vegetable group Cr^{3+} content ranges from $82 \times 10^{-4}\%$ to $280 \times 10^{-4}\%$. Cauliflower has the highest Cr^{3+} content, which is $280 \times 10^{-4}\%$. While snake grass, has the smallest content, which is $82 \times 10^{-4}\%$. Snake grass is a local crop that is believed to be useful for treating diabetes mellitus. Groups of fruits contain Cr^{3+} ranging from $20 \times 10^{-4}\%$ to $141 \times 10^{-4}\%$. Tomato fruit has the highest Cr^{3+} content, which is $141 \times 10^{-4}\%$. While the long bean, has the smallest content, which is $20 \times 10^{-4}\%$. The black rice has the highest Cr^{3+} content, which is $21 \times 10^{-4}\%$. While green beans and red beans, has the smallest content, which is $18 \times 10^{-4}\%$. Tuber groups contain Cr^{3+} ranging from $41 \times 10^{-4}\%$ to $83 \times 10^{-4}\%$. Potatoes have the highest Cr^{3+} content, which is $83 \times 10^{-4}\%$. While cassava has the smallest content, which amount to $41 \times 10^{-4}\%$. The yeast group has Cr^{3+} content ranging from $16 \times 10^{-4}\%$ to $18 \times 10^{-4}\%$. The commercial yeast extract which is thought to be made of brewery yeast has the highest Cr^{3+} content, which is $18 \times 10^{-4}\%$. While yeast (bakery yeast/yeast bread), has the smallest content, which is $18 \times 10^{-4}\%$. Based on the findings in this study, it can be concluded that the vegetable group has the highest Cr^{3+} levels among the foodstuffs tested, especially cauliflower.

Based on the data in Table -2, it can be seen that for the vegetable group Cr^{6+} content ranges from $39 \times 10^{-4}\%$ to $83 \times 10^{-4}\%$. Cauliflower has the highest Cr^{6+} content, which is $83 \times 10^{-4}\%$ while the chicory and snake grass have the smallest content, which is $39 \times 10^{-4}\%$. The fruit group contained Cr^{6+} ranging from $33 \times 10^{-4}\%$ to $132 \times 10^{-4}\%$. Carrot fruit has the highest Cr^{6+} content, which is $132 \times 10^{-4}\%$ while chili has the smallest content, which is equal to $33 \times 10^{-4}\%$. The rice/cereals group contained Cr^{6+} ranging from $9 \times 10^{-4}\%$ to $10 \times 10^{-4}\%$. Black rice has the highest Cr^{6+} content, which is $10 \times 10^{-4}\%$ whereas white rice, brown rice, black sticky rice, green beans and red beans contain $9 \times 10^{-4}\%$. Tuber groups contain Cr^{6+} ranging from $8 \times 10^{-4}\%$ to $19 \times 10^{-4}\%$. Potatoes have the highest Cr^{6+} content, which is $8 \times 10^{-4}\%$ while cassava has a content of $19 \times 10^{-4}\%$. The yeast group has a Cr^{6+} content ranging from $8 \times 10^{-4}\%$ to $9 \times 10^{-4}\%$. Commercial yeast extract has the highest Cr^{6+} content, which is $9 \times 10^{-4}\%$ while yeast (bakery yeast/baker yeast) is $8 \times 10^{-4}\%$. Based on the findings in this study, it can be concluded that carrots have the highest Cr^{6+} content among the foodstuffs tested.

4. CONCLUSION

The results showed that foodstuffs containing the highest Cr^{3+} were cauliflower having $280 \times 10^{-4}\%$, but Cr^{6+} was $83 \times 10^{-4}\%$. Foodstuffs that have a small Cr^{6+} content are cassava, nuts and commercial yeast, which range from $8 \times 10^{-4}\%$ to $9 \times 10^{-4}\%$ but Cr^{3+} content is not very high, ranging from $18 \times 10^{-4}\%$ to $20 \times 10^{-4}\%$.

5. REFERENCES

- [1] World Health Organization, Trace elements in human nutrition and health. Geneva, 1996..
- [2] Ertürün KEH, Yilmaz M, Kilic E., Constrution of an anion selective electrode: Dichromate-selective electrode. Sensors and ActuatorsB, 127, 2007, pp. 497-504
- [3] Slamet et al..Pengolahan limbah organik (fenol) dan logamberat (Cr VI atau Pt VI) secara simultan dengan fotokatalis TiO_2 , $ZNO-TiO_2$, dan $CDS-TiO_2$. Makasra Teknol, 9,2005, pp. 66-71.
- [4] Wilson BE, Gondy A., Effects of chromium supplementation on fasting insulin levels and

- lipid parameters in healthy, non-obese young subjects. *Diabetes Research and Clinical Practice*, 1995.
- [5] Yin, R.V. and Phung, O.J., Effect of chromium supplementation on glycated hemoglobin and fasting plasma glucose in patients with diabetes mellitus. *Nutrition Journal* 14, 14, 2015.
 - [6] Yeghiazaryan K, Schild HH, Golubnitschaja O., Chromium-picolinate therapy in diabetes care: individual outcomes require new guidelines and navigation by predictive diagnostics. *Infect Disord Drug Targets* vol.12, issue 5, 2012, pp. 332–9.
 - [7] Wild S, Roglic G, Green A, Sicree R, King H. Global prevalence of diabetes: estimates for the year 2000 and projections for 2030. *Diabetes Care* 27, 2004, pp. 1047–53.
 - [8] *Nutrition Business Journal*, NBJ's Supplement Business Report. San Diego, CA: Penton Media Inc., 2003.
 - [9] Rabinovitz H, Friedensohn A, Leibovitz A, Gabay G, Rocas C, Habet B., Effect of chromium supplementation on blood glucose and lipid levels in type 2 diabetes mellitus elderly patients. *Int J Vitam Nutr Res.*, Vol. 74, Issue 3, 2004, pp. 178–82.
 - [10] National Institute of Health, Chromium: Dietary supplement fact sheet, 2013 .
 - [11] Vincent J.B., Elucidating a biological role for chromium at a molecular level, *AccChem Res.*, Vol. 33, Issue 7, 2000, pp. 503–10.
 - [12] Evans GW., The effect of chromium picolinate on insulin controlled parameters in humans. *Int J Biosocial Med Res.*, 11, 1989, pp. 163-80.
 - [13] EFSA Panel, Scientific Opinion on the safety of trivalent chromium as a nutrient added for nutritional purposes to foodstuffs for particular nutritional uses and foods intended for the general population (including food supplements. EFSA Panel on Food Additives and Nutrient Sources, DOI: 10.2903/j.efsa.2010.1882, 2010.
 - [14] Trumbo, P. et al., Dietary reference intakes : Vitamin A, Vitamin K, Arsenic, boron, chromium, copper, iodine, iron, manganese, molybdenum, nickel, silicon, vanadium and zinc. *Journal of the American Dietetic Association*, 2001.
 - [15] Yulianto, E. and Setiarso, P., Making of Chitosan Modified Carbon Paste Electrode for Cr (VI) Metallic Analysis With Ion Interfering Fe (II) and Zn (II) By Cyclic Stripping Voltammetry. Surabaya: Chemistry , Surabaya State University, 2014.