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Alexandru Mihai Grumezescu

Department of Science and Engineering of Oxide Materials and Nanomaterials, Faculty of Applied Chemistry and Materials Science, Politehnica University of Bucharest, Romania

Scopus (https://www.scopus.com/authid/detail.uri?authorId=36503987100)

Research interests: nano and biomaterials, drug delivery and targeting, antimicrobial thin coatings, antimicrobial nanoparticles.

Managing Editor

Adelina Niculescu

Faculty of Engineering in Foreign Languages, University Politehnica of Bucharest, Romania

Research interests: synthesis of organic nanoparticles; drug delivery and targeting.

Associate Editors

Ephraïm Suhir,

Portland State University, Depts. of Mech. and Mat., and Elect. and Comp. Engineering, Portland, OR, USA | Technical University, Dept. of Applied Electronic Materials, Inst. of Sensors and Actuators, Vienna, Austria

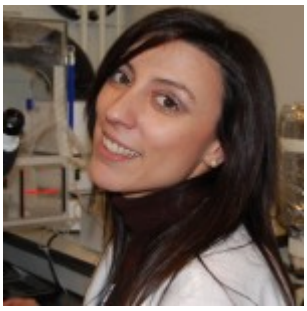
Scopus (https://www.scopus.com/authid/detail.uri?authorId=57206232654)

Research interests: Applied Mathematics and Mechanics, Applied and Mathematical Physics; Materials Science and Engineering; Analytical (Mathematical) Modeling in Applied Science and Engineering;

Monica Cartelle Gestal

Department microbiology and immunology, Gratis Associate Professor Pediatrics LSU Health Science, Shreveport Shreveport, Louisiana USA

Scopus (https://www.scopus.com/authid/detail.uri?authorId=56037430000)



Research interests: antibiotic resistance, its relationship to quorum sensing (virulence and pathogenesis) and to discover new targets; development of nanotechnology coated medical devices and antibiotic shuttle systems;

Advisory Board

Mariana Carmen Chifiriuc

Department of Microbiology, Faculty of Biology, Universtity of Bucharest, Romania

Scopus (https://www.scopus.com/authid/detail.uri?authorId=16309032500)

Research interests: investigation of antibiotic resistance at phenotypic, molecular and epidemiological level; phenotypic and genotypic investigation of bacterial virulence; investigation of host-infectious agents relationships by *in vitro* and experimental pathology assays; assessment of novel chemical structures for their antimicrobial activity); nanotechnology in microbiology;

Dan Eduard Mihaiescu

Department of Organic Chemistry, Faculty of Applied Chemistry and Materials Science, Politehnica University of Bucharest, Romania

Scopus (https://www.scopus.com/authid/detail.uri?authorId=6602674733)

Research interests: thin coatings, laser ablation, nanomaterials, drug delivery;

Keng-Shiang Huang

The School of Chinese Medicine for Post-Baccalaureate, I-Shou University, Taiwan

Scopus (https://www.scopus.com/authid/detail.uri?authorId=7403187825)

Research interests: microfluidic controlling; microdroplet; microfluidici chip fabrication; antimicrobial polymers; pulsatile delivery;

Editorial Board

Marcello Iriti

Department of Agricultural and Environmental Sciences, Faculty of Agricultural and Food Sciences, Milan State University, Italy

Scopus (http://www.scopus.com/inward/authorDetails.url?authorID=6506548774&partnerID=MN8TOARS)

Research interests: Bioactive phytochemicals, foods and medicinal plants.

Goutam Rath

Department of Pharmaceutics, ISF College of Pharmacy, GT Road (NH-95), Ghal Kalan, India

Scopus (https://www.scopus.com/authid/detail.uri?authorId=35732275200)

Research interests: Development and characterization of novel carriers for wound healing; Enzymatic debridement, a wound feedback loop for improved outcomes;

Gassan Hodaifa Meri

Pablo de Olavide University, Experimental Sciences Faculty, Molecular Biology and Biochemical Engineering Department, Spain

Scopus (https://www.scopus.com/authid/detail.uri?authorId=35326899000)

Research interests: Microorganism growth; Biotechnology of Microalgae; Biomass; Kinetic growth; Biochemical composition of the biomass; Enzymes technology; Advanced oxidation processes; Wastewater treatment; Pesticides removal; Nematode growth; Chemical Engineering; Food Engineering.

Li Zhou

Key Laboratory of New Processing Technology for Nonferrous Metal and Materials (Ministry of Education), College of Materials Science and Engineering, Guilin University of Technology, China

Scopus (https://www.scopus.com/authid/detail.uri?authorId=57164679600)

Research interests: Functional inorganic and polymer nanomaterials for biological and environmental applications.

Subhash C. Mandal

Department of Pharmaceutical Technology, Division of Pharmacognosy, Pharmacognosy and Phytotherapy Research Laboratory, Jadavpur University, India

Scopus (https://www.scopus.com/authid/detail.uri?authorId=7202228971)

Research interests: Pharmacognosy and Phytotherapy Research , Traditional Medicines & Drug Discovery;

Nima Rezaei

Children's Medical Center Hospital, Dr. Qarib St, Keshavarz Blvd, Iran

Scopus (https://www.scopus.com/authid/detail.uri?authorId=57204849465)

Research interests: Paediatric Immunology and Infectious Diseases; genetics & heredity; immunology; primary immunodeficiency disorders; Cancer Immunology;

Pradeep K Sengupta

Department of Biophysics Molecular Biology and Bioinformatics, University of Calcutta, 92 Acharya Prafulla Chandra Road, India

Scopus (https://www.scopus.com/authid/detail.uri?authorId=7103155174)

Research interests: Bio and nano materials; Pharmacologically active phytochemicals , and their binding to biomolecular targets, and their inclusion in nano-vehicles for drug delivery, explored via spectroscopic and computational tools.

Hrudayanath Thatoi

Department of Biotechnology, College of Engineering and Technology, Biju Patnaik University of Technology, India

Scopus (https://www.scopus.com/authid/detail.uri?authorId=18134726400)

Research interests: Fermentation technology, Enzyme purification and characterisation; DNA and plasmid isolation, PCR Amplification; Metal-microbe interaction and bioremediation study; DNA fingerprinting, RFLP, RAPD analysis, Metagenomic analysis;

Hazizan bin Md Akil

School of Materials and Mineral Resources Engineering, Engineering Campus, Universiti Sains Malaysia, Malaysia

Scopus (https://www.scopus.com/authid/detail.uri?authorId=7102836574)

Research Interests: Polymer Composites, 3D printing of polymers and Hydrogels

Shakeel Ahmed

Department of Chemistry, Government Degree College Mendhar, Mendhar, India

Scopus (https://www.scopus.com/authid/detail.uri?authorId=36659088500)

Research interests: Green Nanomaterials; Nanocomposites; Advanced Green Materials

Deliyanni A. Eleni

Department of Chemistry, University of Thessaloniki, Greece

Scopus (https://www.scopus.com/authid/detail.uri?authorId=6602894786)

Research interests: Adsorption/separation processes in environmental applications; Materials Chemistry; Synthesis and surface characterization of new adsorbent materials; Modification/impregnation of materials; Carbon materials as adsorbents; Graphite oxide based/polymer nanocomposite adsorbents; Deep desulfurization of fuels; Biomass conversion to activated carbon; Advanced oxidation processes/Catalytic oxidation;

Badal Kumar Mandal

Department of Chemistry, School of Advanced Sciences, VIT University, India

Scopus (https://www.scopus.com/authid/detail.uri?authorId=7102080708)

Research interests: interaction between metal nanoparticles and toxic heavy metals, remediation of toxic heavy metals using metal nanoparticles and toxic effects of nanomaterials;

Ren-Cun Jin

College of Life and Environmental Sciences, Hangzhou Normal University, China

Scopus (https://www.scopus.com/authid/detail.uri?authorId=10142829600)

Research interests: water pollution control and environmental biotechnology, which includes biological nitrogen removal technology (i.e., anaerobic ammonium oxidation) development, high-efficient bioreactor design, and optimization of wastewater treatment system for energy-saving and pollutant-reduction;

Monica Cristina Sakizlian

Department of Physical Education and Sport, University of Bucharest, Romania

Research interests: Human Motricity Sciences, Quality of Life

Rania Mohammed Hafez Mohammed Hathou

Department of Pharmaceutics and Industrial Pharmacy, Faculty of Pharmacy, Ain Shams University, Egypt

Scopus (https://www.scopus.com/authid/detail.uri?authorId=15730942800)

Research interests: preparation of different drug and gene delivery carriers such as vesicles and colloidal nanoparticles whether polymeric or lipid using different methods and studying the different physico-chemical factors influencing the morphology, particle size and stability of these drug carrier; computer-assisted dosage form design is my novel approach to drug delivery involving several bio and cheminformatics tools;

Kailas L. Wasewar

Department of Chemical Engineering, Visvesvaraya National Institute of Technology (VNIT), India

Scopus (https://www.scopus.com/authid/detail.uri?authorId=6506156879)

Research interests: Biotechnology, Reaction Engineering, Process Intensification, Separation Technology, Environmental Engineering, Ionic Liquids, Nanotechnology, CFD, Modeling & Simulation, and Reliability Engineering;

Amir Mohammad Mortazavian

Faculty of Nutrition Sciences, Food Science and Technology, Shahid Beheshti University of Medical Sciences, Iran

Scopus (https://www.scopus.com/authid/detail.uri?authorId=12792054500)

Research interests: Dairy science and technology (esp., fermented milks) Functional foods; Probiotics and prebiotics in food products; Food chemistry (esp., food ingredient interactions);

Poonam Tandon

Physics Department, University of Lucknow, Lucknow, India

Scopus (https://www.scopus.com/authid/detail.uri?authorId=36765652500)

Research interests: Working on gas sensing applications of nano-materials, active pharmaceutical ingredients, synthetic and bio polymers, conducting

polymers, biodegradable polymers. Research forté; Experimental and theoretical studies on vibrational spectroscopy, molecular dynamics, phonon dispersion, phase transition, DFT, ab initio dynamics and structural developments, structure activity relationship.

Keng-Liang Ou

College of Oral Medicine, Taipei Medical University, Taiwan

Scopus (https://www.scopus.com/authid/detail.uri?authorId=55660541800)

Research interests: Biomedical Engineering; Bioengineering; Clinical Trials; Dentistry; Engineering Physics; Dental Surgery;

Eugenia Bezirtzoglou

Democritus University of Thrace Faculty of Agricultural Development, Department of Food Science and Technology, Greece

Scopus (https://www.scopus.com/authid/detail.uri?authorId=7003748111)

Research interests: microbial ecology, gastrointestinal microflora, food and environmental microbiology.

Carmen Limban

Department of Pharmaceutical Chemistry, “Carol Davila” University of Medicine and Pharmacy, Romania

Scopus (https://www.scopus.com/authid/detail.uri?authorId=15072175400)

Research interests: Medicinal and Pharmaceutical Chemistry; Materials Chemistry; Antimicrobials; Natural Product Chemistry; Heterocyclic Chemistry; Organic Chemistry; Chemical Synthesis; IR; Pharmaceutical Chemistry;

Goodarz Ahmadi

Department of Mechanical and Aeronautical Engineering, Clarkson University, USA

Scopus (https://www.scopus.com/authid/detail.uri?authorId=35547337300)

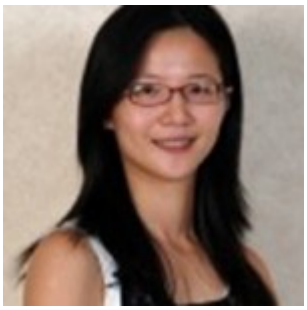
Research interests: modeling pollutant transport, dispersion and turbulent flows of dense and dilute, solid-gas or liquid mixtures with application to coal transport and processing, spray formation, and hot-gas filtration

Chih-Hui Yang

Department of Biomedical Engineering Research Center, I-Shou University, Taiwan / National Applied Research Laboratories Taiwan, Taipei, Taiwan

Scopus (https://www.scopus.com/authid/detail.uri?authorId=35231667200)

Research interests:



Ming-Yu Lin

Instrument Technology Research Center, National Applied Research Laboratories, Taiwan

Scopus (https://www.scopus.com/authid/detail.uri?authorId=55476715600)

Research interests:

Chih-Yu Wang

Department of Biomedical Engineering, I-Shou University, Taiwan

Scopus

Research interests:

Biomedical Engineering; Biomedical Devices; Biomedical Imaging; Biomedical Instrumentation; Medical Electronics;

Yung-Sheng Lin

Department of Chemical Engineering, National United University, Taiwan

Scopus (https://www.scopus.com/authid/detail.uri?authorId=7406582638)

Research interests: Implants; Tissue engineering; Biomedical Engineering; Biomedical Devices; Biomedical Imaging; Biomedical Instrumentation; Medical Electronics;

Veronica Lazar

Department of Microbiology, Faculty of Biology, Universtity of Bucharest, Romania

Scopus (https://www.scopus.com/authid/detail.uri?authorId=16310319700)

Research interests: applied microbiology; Immunology; Virology;

Mariana Chirea

Faculdade de Ciências, Universidade do Porto, Portugal

Scopus (https://www.scopus.com/authid/detail.uri?authorId=9940726100)

Research interests: Electron transfer kinetics at films composed of spherical nanomaterials and polymers, thiol and nanorods, thiol and nanostars or films of nanodendrites for applications in electrochemical sensing, fuel cells or energy storage devices; catalytic activity of nanomaterials in various chemical reactions with industrial applications;

Coralia Bleotu

Stefan S. Nicolau Institute of Virology, Bucharest, Romania

Scopus (https://www.scopus.com/authid/detail.uri?authorId=8315543500)

Research interests: Bacterial Cell Culture; Antimicrobials; Antibiotic Resistance; Antibiotics; Pathogens; Bacteria; Microscopy; Bacterial Antibiotic Resistance; Biofilm Formation; nflammatory Diseases;

Francesco Baino

Department of Applied Science and Technology, Politecnico di Torino, Italy

Scopus (https://www.scopus.com/authid/detail.uri?authorId=23395786300)

Research interests: bioceramics, bioactive glasses and composite biomaterials for tissue engineering and medical implants, as well as processing and testing of advanced ceramics

Nejat Düzgünes

University of the Pacific, Arthur A. Dugoni School of Dentistry, San Francisco, USA

Scopus (https://www.scopus.com/authid/detail.uri?authorId=7005556406)

Research interests: Gene therapy of oral cancer; Eliminating HIV-infected cells; Targeted non-viral vectors for gene delivery; Therapy of oral Candida and Porphyromonas infections;

Oguzhan Gunduz

Centre of Nanotechnology & Biomaterials Applied and Research at Marmara University, Turkey

Scopus (https://www.scopus.com/authid/detail.uri?authorId=12797373800)

Research interests: Bone cements, Bioceramics, Drug delivery nanocarries.

Jianlin Liu

School of Pipleline and Civil Engineering, China University of Petroleum, Qingdao, P.R. China

Scopus (https://www.scopus.com/authid/detail.uri?authorId=55705987500)

Research interests: soft matter mechanics, applied mathematics, nonlinear mechanics in structures and micro/nano-mechanics;

Nicolae Corcionivoschi

National Children Research Centre, Crumlin, Dublin, Ireland

Scopus (https://www.scopus.com/authid/detail.uri?authorId=26534062800)

Research interests: bacterial virulence, isolation and testing of novel pre and probiotics, and the development of novel technologies for more efficient detection of foodborne pathogens

Wameath Sh. Abdul-Majeed

University of Nizwa, Oman

Scopus (https://www.scopus.com/authid/detail.uri?authorId=54402262400)

Research interests: application of non-thermal plasma in industrial fields, and the environmental and health sectors;

Alina Maria Holban

Department of Microbiology, Faculty of Biology, University Politehnica of Bucharest, Romania

Scopus (https://www.scopus.com/authid/detail.uri?authorId=55630243600)

Research interests: antimicrobial therapy; nanostructured drugs; biofilms; host-pathogen interactions;

Valentina Grumezescu

Lasers Department, National Institute for Lasers, Plasma and Radiation Physics – INFLPR, Magurele, Romania

Scopus (https://www.scopus.com/authid/detail.uri?authorId=55209888700)

Research interests: thin coatings; modulation of microbial biofilm; drug targeting; hard tissue engineering;

Ming Miao

State Key Laboratory of Food Science and Technology, 1800 Lihu Avenue, China

Scopus (https://www.scopus.com/authid/detail.uri?authorId=36840373200)

Research interests: Nutraceuticals; Functional foods; Nutrition; Food Science;

Majid Monajjemi

Department of Chemistry, Science and Research Branch, Islamic Azad University, Iran

Scopus (https://www.scopus.com/authid/detail.uri?authorId=6701810683)

Research interests: molecular modeling and QM/MM calculations of macro-biomolecules, electronic structure calculations of nano-biomolecules, non-bonded electronic structure of BnNn rings, NMR contour maps, and quantum investigations of non-bonded interactions

Andivelu Ilangovan

School of Chemistry, Bharathidasan University, India

Scopus (https://www.scopus.com/authid/detail.uri?authorId=6506677005)

Research interests: organic chemistry; natural products; biological evaluation of organic compounds; crystal structure; biomimetic structures;

Elias C. Aifantis

Aristotle University of Thessaloniki, Greece / Mechanics and Optics University ITMO, Saint Petersburg, Russian Federation

Scopus (https://www.scopus.com/authid/detail.uri?authorId=34871245600)

Research interests: dislocation patterning and material instabilities, gradient elasticity and plasticity, chemomechanics and nanomechanics.

Tadeusz Hryniewicz

Department of Engineering and Informatics Systems, Koszalin University of Technology, Poland

Scopus (https://www.scopus.com/authid/detail.uri?authorId=6604026438)

Research interests: Machine technology, Surface technology, Surface electrochemistry studies, Hydrogen embrittlement cases, Electrochemical corrosion studies, Plasma Electrolytic Oxidation.

Iola Melissa Fernandes Duarte

CICECO – Aveiro Institute of Materials, Department of Chemistry, University of Aveiro, Portugal

Scopus (https://www.scopus.com/authid/detail.uri?authorId=7007025414)

Research interests: immune metabolic deregulations in chronic inflammatory diseases; tumour metabolism, anticancer drugs and nanomedicines, biological responses to nanomaterials.

Mustafa Turkyilmazoglu

Department of Mathematics, University of Hacettepe, Turkey

Scopus (https://www.scopus.com/authid/detail.uri?authorId=6603562364)

Research interests: Fluid mechanics, Hydrodynamic stability theory, Rotating-disk flow, High-Reynolds number flows, Triple-deck asymptotic theory of compressible viscous flows, Numerical simulation.

Javed Ali

Department of Pharmaceutics, Faculty of Pharmacy, Jamia Hamdard, Hamdard Nagar, India

Scopus (https://www.scopus.com/authid/detail.uri?authorId=25641028400)

Research interests: Improving oral bioavailability of BCS class II and Class IV drugs using polymeric conjugates and lipid based systems like microemulsions, nanoemulsions, solid lipid nanoparticles and nanostructured lipid carriers

Mieczysław Jurczyk

Institute of Materials Science and Engineering, Poznan University of Technology, Poland

Scopus (https://www.scopus.com/authid/detail.uri?authorId=26643557700)

Research interests: nanoscience, nanotechnology, nanostructured materials; non-equilibrium processing and properties of advanced materials/nanomaterials; microstructural characterization; powder processing; composites/nanocomposites; porous metallic bionanomaterials/bionanocomposites; hydrogen storage materials/nanomaterials

Hamidreza Sadegh

West Pomeranian University of Technology, Faculty of Chemical Technology and Engineering, Poland

Scopus (https://www.scopus.com/authid/detail.uri?authorId=57050269300)

Research interests: nanomaterials, adsorption, wastewater management, adsorbent, polymer membrane, and photocatalyst.

Tony Hadibarata

Faculty of Engineering and Science, Curtin University, Malaysia

Scopus (https://www.scopus.com/authid/detail.uri?authorId=16233109100)

Research interests: Environmental engineering; Bioremediation of toxic Pollutants; Environmental chemistry, Microbiology, Toxicology; Water and wastewater treatment; Industrial microbiology.

Emir Baki Denkbas

Bioengineering Department, Hacettepe University, Turkey

Scopus (https://www.scopus.com/authid/detail.uri?authorId=6701662131)

Research interest: Polymer Technology: Production of polymers which have different type of bulk and surface charecteristics, shape and geometries; Biomaterials: Production and charecterization of polymeric biomaterials and modification of the surface of polymeric biomaterials by different methods (by chemically, biologically, plasma etc.); Biotechnology: Preparation of polymeric biomaterials for cell culture studies and their applications; Controlled Drug Release Systems: Microencapsulation of some drugs by biodegradable polymeric microspheres; Tissue Culture Engineering: Hepatocyte immobilization on chemical, biological or plasma modified polymeric surfaces; Nanobiotechnology: Preparation and characterization of nanocarriers for gene and cancer therapy.

Sibel A. Ozkan

Ankara University, Faculty of Pharmacy, Department of Analytical Chemistry, Tandogan, Turkey

Scopus (https://www.scopus.com/authid/detail.uri?authorId=7102661492)

Research interest: analysis of pharmaceuticals with using separation techniques especially on liquid chromatography, method development and their validation, electroanalytical techniques, novel electrode materials, nano-structured materials, surface–modified electrodes, fabrication of biosensors and nano-sensors, analysis of pharmaceuticals from their dosage forms and biological samples.

Cristobal Noe Aguilar Gonzalez

Department of Food Research (DIA-UAdeC), School of Chemistry, University Autonomous of Coahuila, Mexico

Scopus (https://www.scopus.com/authid/detail.uri?authorId=7102461199)

Research interest: Tannase; Bioactive Extraction; Active Peptides; Active Oligosaccharides; Candelilla Wax; Tannins-Gallic acid-Ellagic acid; Solid-State Fermentation; Edible Films and Coatings; Bioactives and Bioactivities; Biocontrol

Rajeshwar Sinha

Laboratory of Photobiology and Molecular Microbiology, Centre of Advanced Study in Botany, Banaras Hindu University, India

Scopus (https://www.scopus.com/authid/detail.uri?authorId=35485458700)

Research interest: UV radiation effects on aquatic ecosystems (DNA damage and repair, phycobiliproteins, mycosporine-like amino acids and scytonemin)

Pathik Kumbhakar

Nanoscience Laboratory, Dept. of Physics, National Institute of Technology Durgapur, India

Scopus (https://www.scopus.com/authid/detail.uri?authorId=6701424407)

Research interest: Biosensors, Electrochemical Biosensors, DNA and Aptamer Biosensors, Bioelectro-analytical Chemistry, Material Sciences, Conducting Polymer, NanoMaterials, Surface Modification.

Hassan Vatandoost

Department of Environmental Chemical Pollutants and Pesticides, National Institute for Environmental Research, School of Public Health , Tehran University of Medical Sciences, Iran

Scopus (https://www.scopus.com/authid/detail.uri?authorId=9743822200)

Research interest: Study on arthropod borne disease such as CCHF, relapsing fever, Dengue fever, leishmaniasis; Study on epidemiology of malaria; Study on insecticide residue; Evaluation of different insecticide at phase I, II and III of WHOPES; Investigation of ecology of mosquitoes; Study on the identification of mosquitoes using molecular genetics; Investigation on the mechanisms involved in insecticide resistance in arthropods; Study on the functional basis of insecticide resistance on malaria vectors; Using of biological contort agents including Lagenidium giganteum, Bacillus thuringiensis for malaria vectors.

N. Sandeep

Department of Mathematics, Central University of Karnataka, Kalaburagi, India

Scopus (https://www.scopus.com/authid/detail.uri?authorId=56626558400)

Research interest: Computational Fluid Dynamics; Convective Heat and Mass Transfer in MHD flows; Heat and Mass Transfer in Nanofluids; Heat and Mass Transfer in Dusty fluids; Heat and Mass Transfer in Dusty nanofluids; Ordinary and Partial Differential equations; Flows through porous media; Mathematical Modelling; Numerical Methods.

Trchounian Armen

Department of Biochemistry, Microbiology and Biotechnology, Yerevan State University, Armenia

Scopus (https://www.scopus.com/authid/detail.uri?authorId=7003534638)

Research interest: Microbiology & Plants and Microbes

Kaushik Pal

Department of Mechanical and Industrial Engineering, Centre of Nanotechnology, Indian Institute of Technology, , India

Scopus (https://www.scopus.com/authid/detail.uri?authorId=26427760700)

Research interest: synthesis and modification of different types of nanofillers (especially CNTs and graphene) for their applications in sensors, fuel cells, energy storage devices and polymer/metal matrix composites for aerospace and structural applications

Mehdi Shahedi Asl

Department of Mechanical Engineering, University of Mohaghegh Ardabili, Iran

Scopus (https://www.scopus.com/authid/detail.uri?authorId=56270801900)

Research interest: Ceramic Matrix Composites; Ultrahigh Temperature Ceramics (UHTCs); Sintering Processes; Archaeometallurgy; Casting; Welding; Nanotechnology and Nano Materials; Coating.

Nguyễn Đình Đức

Advanced Materials and Structures Laboratory, University of Engineering and Technology, Vietnam

Scopus (https://www.scopus.com/authid/detail.uri?authorId=55178688800)

Research interest: Composite with space structure (Carbon-carbon composite 3D, 4D); Dynamic and Vibration of Advanced Structures and Mechanics of composite materials; Nonlinear stability of FGM plates and shells; Composite structures

with dynamic crack propagation; Constructions and composite structures subjected to special loads; Piezoelectric composite and auxetic materials; Three phase composite and nanocomposite polymer; Advanced materials and structures in Infrastructure Engineering and in Civil Engineering; Nanocomposite and advanced materials in new energy and in renewable energy; Mechanical problems related to climate change; Applied Mathematics and Applied Mechanics.

Domenico Lombardo

Consiglio Nazionale Delle Ricerche (CNR), Istituto per i Processi Chimico-Fisici (IPCF), Messina, Italy

Scopus (https://www.scopus.com/authid/detail.uri?authorId=7007159432)

Research interest: Study of the Soft Interaction in Nanostructured Material and Supramolecular Aggregates; odeling of Structure and Dynamic Properties in Polymers, Dendrimers and Lipid Bio-Membranes in Solution; Study of the Self-Assembly Processes in Organic-Inorganic Ibrid Materials (Zeolite Synthesis on Nanocolloids).

Zeinab Abdel Hamid

Department of Corrosion Control and Surface Protection, Central Metallurgical Research and Development Institute (CMRDI), Egypt

Scopus (https://www.scopus.com/authid/detail.uri?authorId=56117664400)

Research interest: surface coating and corrosion prevention, as electroplating and electroless plating of metal, alloys and composite coatings, nanocomposite coating for different applications, metallization of plastics and printed circuit boards, conventional coatings, biomedical coatings, powder coatings, black coatings, High temperature coating such as, Hot- dip, Pack cementation, plasma enhanced chemical vapor deposition (PECVD), Plasma spray coatings and physical vapor deposition (PVD)

Jia-Qian Jiang

School of Engineering and Built Environment, Glasgow Caledonian University, Glasgow G4 0BA, Scotland, United Kingdom

Scopus (https://www.scopus.com/authid/detail.uri?authorId=22979801300)

Research interest: advanced water and wastewater treatment technologies and processes; pollution remediation;

Sanjay K. Jain

Pharmaceutics Research Projects Laboratory, Department of Pharmaceutical Sciences, Dr. H. S. Gour Central University, India

Scopus (https://www.scopus.com/authid/detail.uri?authorId=57207930125)

Research interest: Controlled Release, Nanoparticles, Formulations, Controlled Drug Delivery, Nanotechnology in Drug Delivery, Pharmaceutics

and Pharmaceutical Technology, Biomaterials, Liposomes, Nano Drug Delivery

Gaurav Sharma

School of Chemistry, Shoolini University, India

Scopus (https://www.scopus.com/authid/detail.uri?authorId=57200185826)

Research interest: Nanocomposites, Bimetallic & trimetallics nanoparticles,Green Chemistry, Photocatalysis, Ion exchanger and Environmental remediation

Wei (Willy) Chu

School of Chemical Engineering, Sichuan University, China

Scopus (https://www.scopus.com/authid/detail.uri?authorId=55760847300)

Research interest: Energy Catalysis and Chemical Engineering, Nano Functional Materials, Petrochemicals, Carbon management (CCUS) , Environmental Engineering, Polymer & Chemical Sciences; Fischer Tropsch Synthesis, Clean Energy (Hydrogen, etc), Li Battary, Supecapacitor, CNT, GN, Plasma

Lala Behari Sukla

Biofuels & Bioprocessing Research Center, ITER, Siksha 'O' Anusandhan University, Bhubaneswar-751030, India

Scopus (https://www.scopus.com/authid/detail.uri?authorId=6603724593)

Research interest: Biodiesel from Microalgae, Biomineral processing for extraction of metal values from ores, concentrates and wastes. Bioleaching, Biobenefication, Bioadsorption, Bioprecipitation, Bioremediation, Microbial strain improvement.

Hermann Ehrlich

Institute of Electronics and Sensor Materials, TU Bergakademie Freiberg, Germany.

Scopus (https://www.scopus.com/authid/detail.uri?authorId=55722706100)

Research interest: marine biomaterials, biominerals, biocomposites and biomimetics.

A. Ghasem Jouyban

Faculty of Pharmacy, Tabriz University of Medical Sciences, Tabriz 51664, Iran

Scopus (https://www.scopus.com/authid/detail.uri?authorId=7003522866)

Research interest: Prediction of drug solubility in mixed solvent systems; Prediction of drug solubility in supercritical fluids; Application of chemometric approaches in pharmaceutical/analytical sciences; Pharmaceutical and Biomedical analyses of drugs; Development and validation of analytical methods using capillary electrophoresis; Development and validation of analytical methods using HPLC; Development and validation of analytical methods using spectroscopic methods.

Dinesh Kumar Mishra

Indore Institute of Pharmacy, IIST Campus, Opposite IIM, Rau, Indore (M.P.) India

Scopus (https://www.scopus.com/authid/detail.uri?authorId=55418736500)

Research interest: novel drug delivery systems, nanotechnology, nanomedicine, liposomes, nanoparticles, transdermal drug delivery, vaccine etc.

Gian Maria Pacifici

Department of Pharmacology, Medical School, University of Pisa, Pisa, Italy

Scopus (https://www.scopus.com/authid/detail.uri?authorId=7006598411)

Research interest: Clinical Pharmacology.

Robert E Smith

Park University, Parkville, United States

Scopus (https://www.scopus.com/authid/detail.uri?authorId=55727386100)

Research interest: pharmacology, toxicology, analytical chemistry, food chemistry, biochemistry and materials science.

Hasan Türkez

Technical University, Erzurum, Turkey

Scopus (https://www.scopus.com/authid/detail.uri?authorId=9134233800)

Research interest: Nanobiotechnology, Nanotoxicity.

Chee Kong Yap

Universiti Putra Malaysia, Serdang, Malaysia

Scopus (https://www.scopus.com/authid/detail.uri?authorId=57007806600)

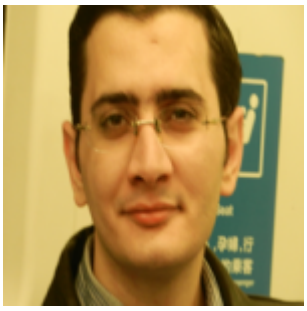
Research interest: ecotoxicology, environmental biology, environmental sciences, water quality and ecotoxicological genetics.

Mohamed Bououdina

University of Bahrain, Sakhir, Bahrain

Scopus (https://www.scopus.com/authid/detail.uri?authorId=7004156513)

Research interest: biosynthesis & nanotoxicology.



Hani Nasser Abdelhamid

Department of Chemistry, Assiut University, Egypt

Scopus (http://www.scopus.com/authid/detail.url?authorId=55370888300)

Research interest: Nanotechnology: synthesis, characterization, and applications; Material Chemistry, synthesis, characterization, and applications; Metal-Organic Frameworks (MOFs), synthesis, characterization, and applications; Inorganic and structural chemistry.

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Sugary Foods and Beverages Relationship to Fungal Colonization and Oral Hygiene in School Children

Machrumnizar Machrumnizar[1], Suriyani Tan, Yuliana Yuliana [3]

[1] Parasitology Department Faculty of Medicine, Universitas Trisakti, Jakarta, Indonesia; machrumnizar_md@trisakti.ac.id (M.); suriyani@trisakti.ac.id (S.T.); dr.yuliana@trisakti.ac.id (Y.);
* Correspondence: machrumnizar_md@trisakti.ac.id;

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Abstract: Sugary foods and beverages are highly consumed by children. It is a substrate for fungal growth and has effects on oral hygiene. The study aimed to determine sugary foods and beverages' relationship to oral fungi and hygiene. This cross-sectional study was conducted on 150 students aged 11-12 years old, selected based on inclusive-exclusive criteria. Demographic data and sugary foods and beverages consumption were recorded in a questionnaire. The oral material was collected and cultured in SDA media. Fungal growth was evaluated microscopically, and then fungal identification used the Integral System YEASTS Plus (Liofilchem®). OHI was used to assess oral hygiene. Results showed that 72.0% were 12 years old, the frequency of sugary foods and beverages consumption was more than once per week in 85 children (56.67 %), mostly girls (30.9%). The fungus found was mostly Candida (55.3%), and 43.3% of children had poor oral hygiene. Statistical analysis showed a significant association between the frequency of sugary foods and beverages consumption with fungal colonization ($p<0.05$) and oral hygiene ($p<0.05$). The correlation between fungal colonization and oral hygiene was statistically significant ($p<0.05$). This study provides insight into the relationships between sugary foods and beverages, fungal colonization, and oral hygiene.

Keywords: sugary foods and beverages; oral hygiene; fungal colonization.

1. Introduction

Nowadays, people's lifestyles tend to adopt an "unhealthy" behavior [1]. In this case, school-age children are an interesting sub-population to study because of the high burden and demand of subjects in primary school and its associated high intense stress levels. This condition further facilitates unhealthy behavior, such as a tendency to overeat and consume foods and beverages high in sugar [2, 3]. More than half of children consumed sugary foods and beverages occurred at home. Thus, the family's food eating environment and parental behavior may influence children's behavior in consuming sugary foods and beverages [2,4].

Improper eating habits, such as the high consumption of sugary drinks, can cause many health problems [5-7]. One study found the drinks most in-demand and consumed by children and adolescents are those sweetened with sugar [8].

Sugar-rich foods and drinks are excellent substrates for the microorganisms that inhabit the early parts of digestion [9, 10], and excess sugar can cause an overproduction of fungi. A study in China reported that 21.7% of Chinese children received more than one portion of sweet foods and drinks per week, while 9.5% received one or more portions of sugary foods and drinks per day [11]. Daily consumption of sugar had exceeded recommended sugar intake

among adolescents and declined through adulthood [12]. In addition, some researchers have reported that consuming excessive sugar decreases the pH of the oral cavity and changes the microenvironment [7,13].

The oral cavity is one of the most colonized parts of the human body [14, 15]. The prevalence of fungi in humans increases, estimated to range from 2% to 70% in the immunocompetent population and immunocompromised people about 96% [16]. Poor oral hygiene is often considered a predisposing factor for oral candida colonization, and the species most frequently isolated is *Candida albicans* [17-19]. *Candida albicans* is a commensal fungus commonly found in the oral cavity of 18,5-40,9% of healthy people [19]. Other Candida species, such as *C. glabrata, C. tropicalis, C. guilliermondii, C. krusei*, and *Kluyveromyces marxianus*, have rarely been isolated, but their prevalence has increased over the last decade [20]. Candida is an opportunistic-pathogen, commensal and normally found in the oral cavity and found more frequently in younger children because the immune system in children is still in the development stage [19,21].

Current research focuses on finding the relationship between sugary foods/drinks consumption and their impact on nutritional status, cardiovascular system, digestive tract microbiota, obesity, and obesity-related diseases. There is evidence that the consumption of sugary foods and beverages is related to the oral ecosystem. However, the relation between the frequency of sugary foods and beverages consumption and oral microorganisms of school children and early adolescence is still rarely studied. This study objective was to determine the relationships between the frequency of sugary foods and beverages consumption, oral fungal colonization, and oral hygiene of school-age children.

2. Materials and Methods

2.1. Study design.

The study was cross-sectional, and the recruitment of subjects used a consecutive sampling technique based on the inclusion criteria. The students who participated in the study were 150 students aged 11-12 years from a public primary school in Gambir sub-district, Central Jakarta. The children must have parental consent in the study. Signed informed consent from parents was requested. This study had ethical clearance from the Medical Research Ethics Commission of Universitas Trisakti, which reviewed and approved the research protocol.

Demographic information and consumption of sugary foods and drinks for one week were examined using the modified questionnaire of Neuhouser *et al*. [22]. Oral hygiene status was determined after examination of oral conditions and was assessed using the Simplified Oral Hygiene Index (OHI-S), which summed the Debris Index and Calculus Index. Each was determined from the amounts of debris and calculus on the six tooth surfaces [23].

2.2. Sample collection and direct microscopic examination.

The tools and materials used are sterile distilled water, beaker glass, phosphate buffer solution, solid Sabouraud's Dextrose Agar (SDA) media, object-glass, inoculum loop, bunsen burner, agar plate, LPCB, microscope.

Procedure: All the respondents were asked to thoroughly rinse their mouths with 100 ml of distilled water to remove any food debris. After 10 min, phosphate buffer solution was used as an oral rinse method for saliva collection. Samples were obtained by requesting

respondents to keep and swirl the solution for 1 min, and then expectorate all saliva into pre-sterilized container without swallowing. Then the saliva was carried with a pipette and inoculated in Sabouraud's Dextrose Agar media. The sample was streaked using inoculating loop and incubated at 37°C for 48 hours. The growth appeared in 48 hours as cream/white-colored, smooth, and pasty colonies. Fungal growth was evaluated using a microscope with LPCB staining, positive culture then was transmitted on solid media Sabouraud's Dextrose Agar (SDA) to obtain pure isolates.

2.3. Isolation and species identification.

Furthermore, the obtained fungi were identified using a commercial kit (Liofilchem® Integral System YEASTS Plus, cat. no. 7182279822, Italy), a 24 reaction well panel containing biochemical substrate and antimycotics for the identification of the most clinically important yeasts. This tool also includes a chromogenic well (no. 13-CHR) which delivers a color-based distinction: green color for *Candida albicans*, and purple color for *Candida tropicalis*. The panel is inoculated with the cell suspension, and identification results are delivered after incubating at 36°C for 48 hours (Fig.1B) [24]. The relationship between consumption of sugary foods and drinks to the risk of mold in the oral cavity was then determined.

2.4. Procedure of oral hygiene examination.

The instruments and supplies required for the oral examination included plane mouth mirrors; metallic periodontal probes; containers and concentrated disinfecting solution; rubber gloves; washbasin for water and soap or disinfectant solution; cloth or paper hand towels; and gauze. Used instruments should be placed in a disinfectant solution, then washed and drained well before sterilization. The area for conducting examinations should be arranged for optimum efficiency. The lighting should be consistent throughout the examination. If necessary, examinations can be carried out outside.

The Oral Hygiene Index is composed of the combined Debris Index and Calculus index; each of these indexes is in turn based on 12 numerical determinations representing the number of debris or calculus found on the buccal and lingual surfaces of each of three segments of each dental arch, namely distal segment to the right cuspid, distal segment to the left cuspid, and mesial segment to the right and left first bicuspids. The maxillary and the mandibular arches are each composed of three segments. Each segment is examined for debris or calculus. From each segment, one tooth is used for calculating the individual index for that particular segment. The tooth used for the calculation must have the greatest area covered by either debris or calculus. The method for scoring calculus is the same as that applied to debris.

Debris Index Criteria

0 = No debris or stain present.

1 = Soft debris covering not more than one-third of the tooth surface or presence of extrinsic stains without other debris regardless of surface area covered.

2 = Soft debris covering more than one-third, but not more than two-thirds, of the exposed tooth surface.

3 = Soft debris covering more than two-thirds of the exposed tooth surface.

Calculus Index Criteria

0 = No calculus present.

1 = Supragingival calculus covering not more than a third of the exposed tooth surface.

2 = Supragingival calculus covering more than one-third but not more than two-thirds of the exposed tooth surface or the presence of individual flecks of subgingival calculus around the cervical portion of the tooth or both.
3 = Supragingival calculus covering more than two-thirds of the exposed tooth surface or a continuous heavy band of subgingival calculus around the cervical portion of the tooth or both.
The oral hygiene index is the sum of the debris index and calculus index (Oral Hygiene Index = Debris Index + Calculus Index).

2.5. Statistical analysis.

The data were statistically analyzed using the Chi-square test to identify relationships in the data obtained in the survey and from the fungal identification and OHI test results. Statistical analyzes were performed using SPSS 21.0 for Windows (SPSS Inc., Chicago, IL, USA) software with a 95% confidence level (a = 0.05). The results were considered statistically significant at a p-value <0.05.

3. Results and Discussion

The number of respondents' gender in this study was not much different; namely, 54.0% (81/150) girls and 46.0% (69/150) boys, and most of the respondent's age was 12 years (108/150; 72.0%), and the rest was aged 11 years (42/150; 28.0% - Table 1). The result of this study showed that 56.67% (85/150) of respondents consumed sugary foods and drank more than once per week (≤1 time per week), and 65/150 (43.33%) had consumed sugary foods and drank less than once per week (< 1 time per week).

Table 1. Characteristics of respondents, sweet foods, and drinks.

Category	Frequency	Sugary Foods and Drinks Consumption		p-Value
	n (%)	<1x/week (%), n=65	≥1x/week (%), n=85	
Age 11 yo 12 yo	 42 (28.0) 108 (72.0)	 31 (20.7) 20 (13.3)	 12 (8.0) 87 (58.0)	0.000[a]
Gender Male Female	 69 (46.0) 81 (54.0)	 26 (17.1) 39 (25.7)	 38 (25.0) 47 (30.9)	0.000[a]
Colony Candida Unidentified	 83 (55.3) 67 (44.7)	 41(27.3) 23 (15.3)	 42(28.0) 44 (29.4)	0.000[a]
OHI Good Poor	 85 (56.7) 65 (43.3)	 39(26.0) 26 (17.3)	 46(30.7) 39 (26.0)	0.000[a]

[a] Chi-square test, p < 0.05.

All collected samples were directly streaked on SDA. Of the 150 samples, 55.33% were yeasts in 83 isolates, and 44.67% were unidentified in 67 isolates (Table 1). The colonies' growth was cream/white colored colonies, protruding from the surface of the medium; the colony's surface was smooth and pasty (Fig.1A). Candida species identification used Integral System YEASTS Plus that showed a chromogenic well (no. 13-CHR) changing color into green, indicating *Candida albicans* (Fig.1B). The proportion of respondents with a good Oral Hygiene Index (OHI) was 56.7%, and 43.3% had poor OHI.

This study found that respondents aged 12 years who consume sugary foods and beverages more than once per week were 58.0% (87 children), and 30.9% (47 children) were girls. Statistical analysis showed that the age and gender of respondents were significantly associated with sugary foods and beverages consumption (p < 0.05, Chi-square test).

(a) (b)

Figure 1. (a) Colonies of Candida on solid media Sabouraud's Dextrose Agar; (b) Identification of Candida albicans with Integral System YEASTS Plus.

Previously, it has been known that behavioral differences connected with caries are related to gender, for instance, girls generally maintain better oral health by brushing their teeth more regularly, but they also consume more sugary foods than boys [25]. In general, the age of 12 is considered an important period in developing dental caries and oral health impairment [26]. The consumption of high amounts of simple carbohydrates can increase the risk of dental caries because the cariogenic microorganisms require sugar for-their nutrition and protect oral health [27, 28]. The frequency of sugar intake is responsible for changing the balance of the microorganism's population. In addition, the acidity of the oral cavity is a prerequisite for caries formation, and acidogenic microorganisms play an important role in oral hygiene [29, 30]. Thus, it is recommended for children and adults to reduce free sugars intake to 10% of total energy intake [31, 32].

One study reported that 50.9% of 915 respondents were boys at 10 years follow-ups, 52,7% of 996 respondents were girls at 15 years follow-ups [29], and Guo *et al*. [33] also found that 51,0% of respondents were boys at 6-11 years. He *et al*. [11] reported that age and gender were associated significantly with the frequency of sugary foods and beverages consumption. In a study involving 2,032 respondents consisting of 1,019 girls (50.15%) and 1,013 boys (49.85%), with the age of respondents ranging from 6 to 12 years, as many as 69.0% consumed sugary drinks. They also found that 34.7% of respondents did not consume sugary drinks, and 21.6% consumed sugary drinks of more than 120 ml per day (equivalent to more than 3 times per week), mostly in girls. Similar to the finding in New Zealand, involving 578 school-age children found 313 girls (54%) with an age range of 8 to 12 years, and 16.7% of respondents consumed sugary beverages once a day or more per week they were also girls [34]. Another study reported that 9.6% of respondents consumed sugary beverages more than 7 portions per week [35]. In Germany found, high daily consumption of sugary beverages was more than 4 times in girls aged 3 – 17 years and more than 6 times in boys [36]. Based on previous studies, it is known that children aged 11-12 years often consume sugary foods and more in boys, while in this study was more in girls. This may be related to various factors, e.g., parenting patterns and puberty period in some girls start at age 11-12 years. The literature suggests that hormones and stress can affect the increase in consumption of sweet foods in women.

Fungal colonization in this study was identified in respondents with consumption frequency of sugary foods and beverages more than once a week (28.0%) and less than once a week (27.3%) had a similar proportion (Table 1). Furthermore, fungus grew on all culture media and mostly was Candida species; due to the commercial kit's limitations, 67 fungus

isolates could not be identified. Candida species that were found in respondents who consume sugary foods and beverages more than once a week consisted of *Candida albicans* (24.09%), *Candida glabrata* (10.84%), *Candida tropicalis* (8.43%), *Candida krusei* (6.02%), and 44 isolates (53.01%) were unidentified (Fig.2). Fungal colonization was significantly increased in respondents who consumed sugary foods and beverages ($p < 0.05$, Table 1).

The oral microbiota can cause various oral health interference, and Candida species can lead to uncontrolled proliferation, one of which depends on diet. Consumption of sugary foods and drinks is a predisposing factor for fungal colonization. Candida species are opportunistic pathogens that are common inhabitants of the normal oral microorganisms, and *Candida albicans* is a very common fungal species in the oral cavity [37-39]. A previous study reported that fungi incidence in the oral cavity was statistically significant ($p = 0.004$) in those adding sugar to beverages [40]. Another study demonstrated that 93,8% of respondents were positive for Candida spp. and *Candida albicans* was the most dominant species 97,5%, while *Candida krusei* 40%, *Candida tropicalis* 17,5%, and *Candida glabrata* were found to be 7,5% [41].

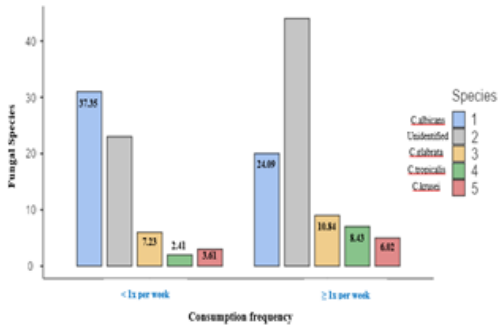

Figure 2. Prevalence of oral fungal species to the frequency of sweetened foods and beverages consumption.

Respondents in this study who had a frequency of sugary foods and beverages consumption more than once a week and had good OHI were 30.7%, and 26.0% had poor OHI. Oppositely, 26.0% of respondents with a frequency of sugary foods and beverages consumption less than once a week had good OHI, and 17.3% had poor OHI. The Oral Hygiene Index showed significantly associated respondents who consumed sugary foods and beverages ($p < 0.05$, Table 1).

Table 2. Characteristics of respondents, sweet foods, and drinks.

Fungal colony	Oral Hygiene Index				p-Value
	Good		Poor		
	n	%	n	%	
Candida spp Unidentified	49 36	32.67 24.00	34 31	22.67 20.66	0.044[a]
Total	85	56.67	65	43.33	

[a] McNemar test, $p < 0.05$

Table 2 showed that Candida species were found on 34/65 (22.67%) of respondents with poor oral hygiene, and respondents with good oral hygiene were 49/85 (32.67%). Based on Table 2, it could be concluded that the association between Oral Hygiene Index and oral fungal colonization was statistically significant ($p = 0.044$).

The acidity condition of the oral cavity and the microorganism in the oral cavity are factors of caries formation which play an important role in oral hygiene [28,30]. It has been known previously that fungi constitute a small part of the salivary oral microbiome, with Candida albicans being the most dominant species [42].

Previous studies observed that children with a sugary food diet were found to have more caries and identified Candida albicans ranged from 12% to 93% in children with caries

[31,43]. The study of Wu *et al*. [44] showed the decrease of salivary s-IgA level correlated with caries in children was statistically significant. In contrast, Hemadi *et al*. [45] found a weak association between Candida spp. in the oral cavity and caries levels in children. In addition to dietary habits, consuming sugary foods and beverages has a role in regulating the ecological balance of oral microorganisms, thus being responsible for changes in oral hygiene [46, 47].

4. Conclusions

This study provides additional insight into the relationship between sugary foods and beverages consumption with fungal colonization and oral hygiene in primary school children.

This study showed that sugary foods and beverages consumption has a strong association with demographic factors (age and gender). Our findings were that high intake of sugary foods and beverages consumption was associated with oral fungal colonization. Furthermore, sugary foods and beverages consumption can be one of the factors that play a role in oral hygiene due to its significant relationship with fungal colonization ($p<0.05$) and OHI ($p< 0.05$).

The consumption of sugary food and beverages in children should be controlled by promoting a healthy lifestyle in school. In addition, counseling is highly recommended to change the lifestyle of the families, especially high-risk groups, which may help improve dental and oral health in children.

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Conflicts of Interest

The authors declare no conflict of interest. The funders had no role in the design of the study, in the collection, analyses, or interpretation of data, in the writing of the manuscript, or in the decision to publish the results.

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Sugary Foods and Beverages Relationship to Fungal Colonization and Oral Hygiene in School Children

Machrumnizar Machrumnizar[1], Suriyani Tan, Yuliana Yuliana [3]

[1] Parasitology Department Faculty of Medicine, Universitas Trisakti, Jakarta, Indonesia; machrumnizar_md@trisakti.ac.id (M.); suriyani@trisakti.ac.id (S.T.); dr.yuliana@trisakti.ac.id (Y.);
* Correspondence: machrumnizar_md@trisakti.ac.id;

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Abstract: Sugary foods and beverages are highly consumed by children. It is a substrate for fungal growth and has effects on oral hygiene. The study aimed to determine sugary foods and beverages' relationship to oral fungi and hygiene. This cross-sectional study was conducted on 150 students aged 11-12 years old, selected based on inclusive-exclusive criteria. Demographic data and sugary foods and beverages consumption were recorded in a questionnaire. The oral material was collected and cultured in SDA media. Fungal growth was evaluated microscopically, and then fungal identification used the Integral System YEASTS Plus (Liofilchem®). OHI was used to assess oral hygiene. Results showed that 72.0% were 12 years old, the frequency of sugary foods and beverages consumption was more than once per week in 85 children (56.67 %), mostly girls (30.9%). The fungus found was mostly Candida (55.3%), and 43.3% of children had poor oral hygiene. Statistical analysis showed a significant association between the frequency of sugary foods and beverages consumption with fungal colonization ($p<0.05$) and oral hygiene ($p<0.05$). The correlation between fungal colonization and oral hygiene was statistically significant ($p<0.05$). This study provides insight into the relationships between sugary foods and beverages, fungal colonization, and oral hygiene.

Keywords: sugary foods and beverages; oral hygiene; fungal colonization.

1. Introduction

Nowadays, people's lifestyles tend to adopt an "unhealthy" behavior [1]. In this case, school-age children are an interesting sub-population to study because of the high burden and demand of subjects in primary school and its associated high intense stress levels. This condition further facilitates unhealthy behavior, such as a tendency to overeat and consume foods and beverages high in sugar [2, 3]. More than half of children consumed sugary foods and beverages occurred at home. Thus, the family's food eating environment and parental behavior may influence children's behavior in consuming sugary foods and beverages [2,4].

Improper eating habits, such as the high consumption of sugary drinks, can cause many health problems [5-7]. One study found the drinks most in-demand and consumed by children and adolescents are those sweetened with sugar [8].

Sugar-rich foods and drinks are excellent substrates for the microorganisms that inhabit the early parts of digestion [9, 10], and excess sugar can cause an overproduction of fungi. A study in China reported that 21.7% of Chinese children received more than one portion of sweet foods and drinks per week, while 9.5% received one or more portions of sugary foods and drinks per day [11]. Daily consumption of sugar had exceeded recommended sugar intake

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among adolescents and declined through adulthood [12]. In addition, some researchers have reported that consuming excessive sugar decreases the pH of the oral cavity and changes the microenvironment [7,13].

The oral cavity is one of the most colonized parts of the human body [14, 15]. The prevalence of fungi in humans increases, estimated to range from 2% to 70% in the immunocompetent population and immunocompromised people about 96% [16]. Poor oral hygiene is often considered a predisposing factor for oral candida colonization, and the species most frequently isolated is *Candida albicans* [17-19]. *Candida albicans* is a commensal fungus commonly found in the oral cavity of 18,5-40,9% of healthy people [19]. Other Candida species, such as *C. glabrata, C. tropicalis, C. guilliermondii, C. krusei*, and *Kluyveromyces marxianus*, have rarely been isolated, but their prevalence has increased over the last decade [20]. Candida is an opportunistic-pathogen, commensal and normally found in the oral cavity and found more frequently in younger children because the immune system in children is still in the development stage [19,21].

Current research focuses on finding the relationship between sugary foods/drinks consumption and their impact on nutritional status, cardiovascular system, digestive tract microbiota, obesity, and obesity-related diseases. There is evidence that the consumption of sugary foods and beverages is related to the oral ecosystem. However, the relation between the frequency of sugary foods and beverages consumption and oral microorganisms of school children and early adolescence is still rarely studied. This study objective was to determine the relationships between the frequency of sugary foods and beverages consumption, oral fungal colonization, and oral hygiene of school-age children.

2. Materials and Methods

2.1. Study design.

The study was cross-sectional, and the recruitment of subjects used a consecutive sampling technique based on the inclusion criteria. The students who participated in the study were 150 students aged 11-12 years from a public primary school in Gambir sub-district, Central Jakarta. The children must have parental consent in the study. Signed informed consent from parents was requested. This study had ethical clearance from the Medical Research Ethics Commission of Universitas Trisakti, which reviewed and approved the research protocol.

Demographic information and consumption of sugary foods and drinks for one week were examined using the modified questionnaire of Neuhouser *et al*. [22]. Oral hygiene status was determined after examination of oral conditions and was assessed using the Simplified Oral Hygiene Index (OHI-S), which summed the Debris Index and Calculus Index. Each was determined from the amounts of debris and calculus on the six tooth surfaces [23].

2.2. Sample collection and direct microscopic examination.

The tools and materials used are sterile distilled water, beaker glass, phosphate buffer solution, solid Sabouraud's Dextrose Agar (SDA) media, object-glass, inoculum loop, bunsen burner, agar plate, LPCB, microscope.

Procedure: All the respondents were asked to thoroughly rinse their mouths with 100 ml of distilled water to remove any food debris. After 10 min, phosphate buffer solution was used as an oral rinse method for saliva collection. Samples were obtained by requesting

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respondents to keep and swirl the solution for 1 min, and then expectorate all saliva into pre-sterilized container without swallowing. Then the saliva was carried with a pipette and inoculated in Sabouraud's Dextrose Agar media. The sample was streaked using inoculating loop and incubated at 37°C for 48 hours. The growth appeared in 48 hours as cream/white-colored, smooth, and pasty colonies. Fungal growth was evaluated using a microscope with LPCB staining, positive culture then was transmitted on solid media Sabouraud's Dextrose Agar (SDA) to obtain pure isolates.

2.3. Isolation and species identification.

Furthermore, the obtained fungi were identified using a commercial kit (Liofilchem® Integral System YEASTS Plus, cat. no. 7182279822, Italy), a 24 reaction well panel containing biochemical substrate and antimycotics for the identification of the most clinically important yeasts. This tool also includes a chromogenic well (no. 13-CHR) which delivers a color-based distinction: green color for *Candida albicans*, and purple color for *Candida tropicalis*. The panel is inoculated with the cell suspension, and identification results are delivered after incubating at 36°C for 48 hours (Fig.1B) [24]. The relationship between consumption of sugary foods and drinks to the risk of mold in the oral cavity was then determined.

2.4. Procedure of oral hygiene examination.

The instruments and supplies required for the oral examination included plane mouth mirrors; metallic periodontal probes; containers and concentrated disinfecting solution; rubber gloves; washbasin for water and soap or disinfectant solution; cloth or paper hand towels; and gauze. Used instruments should be placed in a disinfectant solution, then washed and drained well before sterilization. The area for conducting examinations should be arranged for optimum efficiency. The lighting should be consistent throughout the examination. If necessary, examinations can be carried out outside.

The Oral Hygiene Index is composed of the combined Debris Index and Calculus index; each of these indexes is in turn based on 12 numerical determinations representing the number of debris or calculus found on the buccal and lingual surfaces of each of three segments of each dental arch, namely distal segment to the right cuspid, distal segment to the left cuspid, and mesial segment to the right and left first bicuspids. The maxillary and the mandibular arches are each composed of three segments. Each segment is examined for debris or calculus. From each segment, one tooth is used for calculating the individual index for that particular segment. The tooth used for the calculation must have the greatest area covered by either debris or calculus. The method for scoring calculus is the same as that applied to debris.

Debris Index Criteria

0 = No debris or stain present.

1 = Soft debris covering not more than one-third of the tooth surface or presence of extrinsic stains without other debris regardless of surface area covered.

2 = Soft debris covering more than one-third, but not more than two-thirds, of the exposed tooth surface.

3 = Soft debris covering more than two-thirds of the exposed tooth surface.

Calculus Index Criteria

0 = No calculus present.

1 = Supragingival calculus covering not more than a third of the exposed tooth surface.

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2 = Supragingival calculus covering more than one-third but not more than two-thirds of the exposed tooth surface or the presence of individual flecks of subgingival calculus around the cervical portion of the tooth or both.
3 = Supragingival calculus covering more than two-thirds of the exposed tooth surface or a continuous heavy band of subgingival calculus around the cervical portion of the tooth or both.
The oral hygiene index is the sum of the debris index and calculus index (Oral Hygiene Index = Debris Index + Calculus Index).

2.5. Statistical analysis.

The data were statistically analyzed using the Chi-square test to identify relationships in the data obtained in the survey and from the fungal identification and OHI test results. Statistical analyzes were performed using SPSS 21.0 for Windows (SPSS Inc., Chicago, IL, USA) software with a 95% confidence level (a = 0.05). The results were considered statistically significant at a p-value <0.05.

3. Results and Discussion

The number of respondents' gender in this study was not much different; namely, 54.0% (81/150) girls and 46.0% (69/150) boys, and most of the respondent's age was 12 years (108/150; 72.0%), and the rest was aged 11 years (42/150; 28.0% - Table 1). The result of this study showed that 56.67% (85/150) of respondents consumed sugary foods and drank more than once per week (≤1 time per week), and 65/150 (43.33%) had consumed sugary foods and drank less than once per week (< 1 time per week).

Table 1. Characteristics of respondents, sweet foods, and drinks.

Category	Frequency	Sugary Foods and Drinks Consumption		p-Value
	n (%)	<1x/week (%), n=65	≥1x/week (%), n=85	
Age 11 yo 12 yo	 42 (28.0) 108 (72.0)	 31 (20.7) 20 (13.3)	 12 (8.0) 87 (58.0)	0.000[a]
Gender Male Female	 69 (46.0) 81 (54.0)	 26 (17.1) 39 (25.7)	 38 (25.0) 47 (30.9)	0.000[a]
Colony Candida Unidentified	 83 (55.3) 67 (44.7)	 41(27.3) 23 (15.3)	 42(28.0) 44 (29.4)	0.000[a]
OHI Good Poor	 85 (56.7) 65 (43.3)	 39(26.0) 26 (17.3)	 46(30.7) 39 (26.0)	0.000[a]

[a] Chi-square test, p < 0.05.

All collected samples were directly streaked on SDA. Of the 150 samples, 55.33% were yeasts in 83 isolates, and 44.67% were unidentified in 67 isolates (Table 1). The colonies' growth was cream/white colored colonies, protruding from the surface of the medium; the colony's surface was smooth and pasty (Fig.1A). Candida species identification used Integral System YEASTS Plus that showed a chromogenic well (no. 13-CHR) changing color into green, indicating *Candida albicans* (Fig.1B). The proportion of respondents with a good Oral Hygiene Index (OHI) was 56.7%, and 43.3% had poor OHI.

This study found that respondents aged 12 years who consume sugary foods and beverages more than once per week were 58.0% (87 children), and 30.9% (47 children) were girls. Statistical analysis showed that the age and gender of respondents were significantly associated with sugary foods and beverages consumption (p < 0.05, Chi-square test).

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(a) (b)

Figure 1. (a) Colonies of Candida on solid media Sabouraud's Dextrose Agar; (b) Identification of Candida albicans with Integral System YEASTS Plus.

Previously, it has been known that behavioral differences connected with caries are related to gender, for instance, girls generally maintain better oral health by brushing their teeth more regularly, but they also consume more sugary foods than boys [25]. In general, the age of 12 is considered an important period in developing dental caries and oral health impairment [26]. The consumption of high amounts of simple carbohydrates can increase the risk of dental caries because the cariogenic microorganisms require sugar for-their nutrition and protect oral health [27, 28]. The frequency of sugar intake is responsible for changing the balance of the microorganism's population. In addition, the acidity of the oral cavity is a prerequisite for caries formation, and acidogenic microorganisms play an important role in oral hygiene [29, 30]. Thus, it is recommended for children and adults to reduce free sugars intake to 10% of total energy intake [31, 32].

One study reported that 50.9% of 915 respondents were boys at 10 years follow-ups, 52,7% of 996 respondents were girls at 15 years follow-ups [29], and Guo *et al*. [33] also found that 51,0% of respondents were boys at 6-11 years. He *et al*. [11] reported that age and gender were associated significantly with the frequency of sugary foods and beverages consumption. In a study involving 2,032 respondents consisting of 1,019 girls (50.15%) and 1,013 boys (49.85%), with the age of respondents ranging from 6 to 12 years, as many as 69.0% consumed sugary drinks. They also found that 34.7% of respondents did not consume sugary drinks, and 21.6% consumed sugary drinks of more than 120 ml per day (equivalent to more than 3 times per week), mostly in girls. Similar to the finding in New Zealand, involving 578 school-age children found 313 girls (54%) with an age range of 8 to 12 years, and 16.7% of respondents consumed sugary beverages once a day or more per week they were also girls [34]. Another study reported that 9.6% of respondents consumed sugary beverages more than 7 portions per week [35]. In Germany found, high daily consumption of sugary beverages was more than 4 times in girls aged 3 – 17 years and more than 6 times in boys [36]. Based on previous studies, it is known that children aged 11-12 years often consume sugary foods and more in boys, while in this study was more in girls. This may be related to various factors, e.g., parenting patterns and puberty period in some girls start at age 11-12 years. The literature suggests that hormones and stress can affect the increase in consumption of sweet foods in women.

Fungal colonization in this study was identified in respondents with consumption frequency of sugary foods and beverages more than once a week (28.0%) and less than once a week (27.3%) had a similar proportion (Table 1). Furthermore, fungus grew on all culture media and mostly was Candida species; due to the commercial kit's limitations, 67 fungus

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isolates could not be identified. Candida species that were found in respondents who consume sugary foods and beverages more than once a week consisted of *Candida albicans* (24.09%), *Candida glabrata* (10.84%), *Candida tropicalis* (8.43%), *Candida krusei* (6.02%), and 44 isolates (53.01%) were unidentified (Fig.2). Fungal colonization was significantly increased in respondents who consumed sugary foods and beverages ($p < 0.05$, Table 1).

The oral microbiota can cause various oral health interference, and Candida species can lead to uncontrolled proliferation, one of which depends on diet. Consumption of sugary foods and drinks is a predisposing factor for fungal colonization. Candida species are opportunistic pathogens that are common inhabitants of the normal oral microorganisms, and *Candida albicans* is a very common fungal species in the oral cavity [37-39]. A previous study reported that fungi incidence in the oral cavity was statistically significant ($p = 0.004$) in those adding sugar to beverages [40]. Another study demonstrated that 93,8% of respondents were positive for Candida spp. and *Candida albicans* was the most dominant species 97,5%, while *Candida krusei* 40%, *Candida tropicalis* 17,5%, and *Candida glabrata* were found to be 7,5% [41].

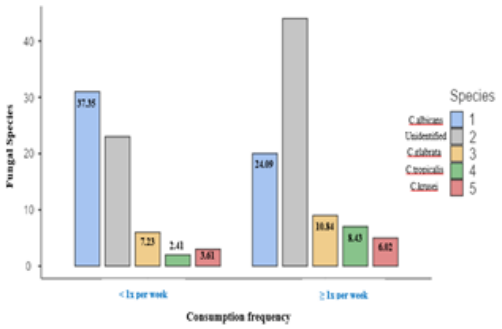

Figure 2. Prevalence of oral fungal species to the frequency of sweetened foods and beverages consumption.

Respondents in this study who had a frequency of sugary foods and beverages consumption more than once a week and had good OHI were 30.7%, and 26.0% had poor OHI. Oppositely, 26.0% of respondents with a frequency of sugary foods and beverages consumption less than once a week had good OHI, and 17.3% had poor OHI. The Oral Hygiene Index showed significantly associated respondents who consumed sugary foods and beverages ($p < 0.05$, Table 1).

Table 2. Characteristics of respondents, sweet foods, and drinks.

Fungal colony	Oral Hygiene Index				p-Value
	Good		Poor		
	n	%	n	%	
Candida spp Unidentified	49 36	32.67 24.00	34 31	22.67 20.66	0.044[a]
Total	85	56.67	65	43.33	

[a] McNemar test, $p < 0.05$

Table 2 showed that Candida species were found on 34/65 (22.67%) of respondents with poor oral hygiene, and respondents with good oral hygiene were 49/85 (32.67%). Based on Table 2, it could be concluded that the association between Oral Hygiene Index and oral fungal colonization was statistically significant ($p = 0.044$).

The acidity condition of the oral cavity and the microorganism in the oral cavity are factors of caries formation which play an important role in oral hygiene [28,30]. It has been known previously that fungi constitute a small part of the salivary oral microbiome, with Candida albicans being the most dominant species [42].

Previous studies observed that children with a sugary food diet were found to have more caries and identified Candida albicans ranged from 12% to 93% in children with caries

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[31,43]. The study of Wu *et al*. [44] showed the decrease of salivary s-IgA level correlated with caries in children was statistically significant. In contrast, Hemadi *et al*. [45] found a weak association between Candida spp. in the oral cavity and caries levels in children. In addition to dietary habits, consuming sugary foods and beverages has a role in regulating the ecological balance of oral microorganisms, thus being responsible for changes in oral hygiene [46, 47].

4. Conclusions

This study provides additional insight into the relationship between sugary foods and beverages consumption with fungal colonization and oral hygiene in primary school children.

This study showed that sugary foods and beverages consumption has a strong association with demographic factors (age and gender). Our findings were that high intake of sugary foods and beverages consumption was associated with oral fungal colonization. Furthermore, sugary foods and beverages consumption can be one of the factors that play a role in oral hygiene due to its significant relationship with fungal colonization ($p<0.05$) and OHI ($p< 0.05$).

The consumption of sugary food and beverages in children should be controlled by promoting a healthy lifestyle in school. In addition, counseling is highly recommended to change the lifestyle of the families, especially high-risk groups, which may help improve dental and oral health in children.

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Conflicts of Interest

The authors declare no conflict of interest. The funders had no role in the design of the study, in the collection, analyses, or interpretation of data, in the writing of the manuscript, or in the decision to publish the results.

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