

Journal of Applied Environmental and Biological Sciences (JAEBS)



An International Peer-reviewed journal

Number of issues per year: 12

ISSN (Print): 2090-4274

ISSN (Online): 2090-4215

[Home](#)[Journals](#)[Contact Us](#)

TEXTROAD JOURNALS

Journal of Applied Environmental and Biological Sciences



J. Appl. Environ. Biol. Sci., Vol. 9 No. 7: pp. 1-20, Year 2019

Journal of Applied Environmental and Biological Sciences (JAEBS)

Monthly Publication



Number of issues per year: 12

ISSN: 2090-4274 (Print)

ISSN: 2090-4215 (Online)

Journal of Applied Environmental and Biological Sciences (JAEBS) is a peer reviewed, open access international scientific journal dedicated for rapid publication of high quality original research articles as well as review articles in the all areas of Applied Environmental and Biological Sciences.

Scope

Journal of Applied Environmental and Biological Sciences (JAEBS) is devoted to the monthly publication of research papers of outstanding significance in the all fields of environmental sciences, environmental engineering, environmental Pollution, green chemistry, environmentally friendly synthetic pathways, alternatively fuels, environmental analytical chemistry, biomolecular tools and tracers, water and soil, environmental [management, economics, humanities], Mathematics, multidisciplinary aspects such as Business Management, Organizational Behavior, all areas of biological sciences, including cell biology, developmental biology, structural biology, microbiology, molecular biology & genetics, biochemistry, biotechnology, biodiversity, ecology, marine biology, plant biology, bioinformatics, toxicology, developmental biology, structural biology, microbiology, molecular biology & genetics, biotechnology, biodiversity and related fields. The journal presents the latest developments in the fields of environmental social marketing, environmental journalism, environmental education, sustainability education, environmental interpretation, and environmental health communication.

Editorial Board

Editor -in-Chief

William Ebomoyi

Ph.D., Professor, Department of Health Studies, College of Health Sciences, Chicago State University, **USA**.

E-mail: editor@textroad.com

Associate Editors

Prof. Dr. Sanaa T. El-Sayed

Ex Head of Biochemistry Department, Professor of Biochemistry, Genetic Engineering & Biotechnology Division, National I Centre, **Egypt**

Saeid Chekani Azar

PhD of Veterinary Physiology; Faculty of Veterinary, Department of Physiology, Ataturk University, Erzurum 25010, **Turki**

Prof. Dr. Sarwoko Mangkoedihardjo

Professor, Professional Engineer of Indonesian Society of Sanitary and Environmental Engineers, **Indonesia**

Prof. Dr. Ashraf Latif Tadross

Head of Astronomy Department, Professor of Star Clusters and Galactic Structure, National Research Institute of Astronomy Geophysics (NRIAG), 11421 Helwan, Cairo, **Egypt**.

Dr. Chandrasekar Raman

Research Associate, Department of Biochemistry & Molecular Biophysics, Biotechnology Core Facility, 238, Burt Hall, Kan University, Manhattan 66506, KS, **USA**.

Dr. YUBAO CUI

Associate Professor, Department of Laboratory Medicine, Yancheng Health Vocational & Technical College, Jiangsu Provin P. R. **China**

Dr. Muhammad Altaf Khan

Department of Mathematics, Abdul Wali Khan University Mardan **Pakistan**

Dr. Fahrettin Tilki

Assoc. Professor, Artvin Coruh University, Faculty of Forestry, Department of Forest Science, Artvin, **TURKEY**.

Dr. Ibtisam abd el ghany hammad

Associate Professor of Genetics, Faculty of Science, Helwan University. **Egypt**.

Dr. Charalambos Tsekeris

Department of Psychology, Panteion University of Social and Political Sciences, Athens, **Greece**.

Dr. Elsayed E. Hafez

Associate Professor, Molecular Biology, Plant Molecular Pathology & Arid Lands Institute, **Egypt**.

Dr. Naushad Mamode Khan

University of Mauritius, Reduit, **Mauritius**.

Mirza Hasanuzzaman

Department of Agronomy, Faculty of Agriculture, Sher-e-Bangla Agricultural University, Dhaka-1207, **Bangladesh**.

Dr. Hala Ahmed Hafez Kandil

Professor Researcher, National Research Centre, Plant Nutrition Dept. El-Bhouth St. Dokki, Giza, **Egypt**.

Dr. Yule Yue Wang

Biotechnology and Medicinal Biochemistry, Division of Life Science, The Hong Kong University of Science & Technology

Dr. Aziza Sharaby

Professor of Entomology. Plant Protection Department, National Research Center. Cairo, **Egypt**.

Dr. Sulaiman

Assistant Professor, Department of Biochemistry, Abdul wali Khan University Mardan, Khyber Pakhtunkhwa, **Pakistan**.

Editors

Maulin P Shah

PhD-Microbiology, Chief Scientist & Head Industrial Waste Water Research Laboratory, Division of Applied & Environmental Microbiology, Enviro Technology Limited, Ankleshwar-393002, Gujarat, **India**

Dr. Josphert N. Kimatu

Department of Biological Sciences. South Eastern University College, **Kenya**.

Dr. Mukesh Kumar Meena

Assistant Professor (Crop Physiology), Department of Crop Physiology, University of Agricultural Sciences, Raichur-584104, Karnataka , **India**

Jehngir Khan

Lecturer in Zoology Department, Abdul Wali Khan University Mardan (AWKUM), Buner Campus, Buner, Khyber Pakhtunkhwa, **Pakistan**.

Syed Muhammad Nurulain

Medical Research Specialist, FMHS, UAE University, **Emirates**

Dr. Ayman Batisha

Environment and Climate Research Institute, National Water Research Center, Cairo, **Egypt**.

Dr. Hakeem Ullah

Assistant Professor, Department of Mathematics Abdul Wali Khan University Mardan **Pakistan**.

DR. DATTA ASARAM DHALE

Assistant Professor, Post Graduate Department of Botany, Ghogrey Science College, Dhule, Maharashtra State, **India**.

Dr. Muhammad Ismail Mohmand

Tutor/Administrator in the Excellence Training Den College in Newcastle, **United Kingdom**

Prof. Dr. Valdenir José Belinelo

Department of Health Sciences and Postgraduate Program in Tropical Agriculture, Federal University of Espirito Santo (UFES),
São Mateus, ES, **Brazil**.

Siva Sankar. R

Department of Ecology and Environmental Sciences, School of Life Sciences, Pondicherry University, **India**.

Table of Contents, July 2019

Slimani Alaa and Moussaoui Abdellah

Contribution to the Mycological and Mycotoxicology Study of Green and Torrified Coffee Beans Imported to Algeria

J. Appl. Environ. Biol. Sci. 2019 9(7): 1-5. [\[Abstract\]](#) [\[Full-Text PDF\]](#)

Sunarno, Wahyono Hadi

Risk Factor Study in Operation of Chlorine Dosing for Water Treatment

J. Appl. Environ. Biol. Sci. 2019 9(7): 6-9. [\[Abstract\]](#) [\[Full-Text PDF\]](#)

Denesya Natalia Paris and Sarwoko Mangkoedihardjo

Toxicity of Single and Mixed Compounds to Water Hyacinth

J. Appl. Environ. Biol. Sci. 2019 9(7): 10-12. [\[Abstract\]](#) [\[Full-Text PDF\]](#)

Rahadhian P. Herwindo

Reconstruction of Architectonic Transformation of the Grand Mosque of Sang *Ciptarasa* Cirebon, from the Pyramidal *Tajug* to the Hipped *Limasan* Roof

J. Appl. Environ. Biol. Sci. 2019 9(7): 13-20. [\[Abstract\]](#) [\[Full-Text PDF\]](#)

Contribution to the Mycological and Mycotoxicology Study of Green and Torried Coffee Beans Imported to Algeria

Slimani Alaa* and Moussaoui Abdellah

Laboratory of Plant Resource Development and Food Security in Semi Arid Areas, South West of Algeria,
Department of Biology, University of Bechar, Algeria

Received: April 18, 2019

Accepted: June 12, 2019

ABSTRACT

The objective of this study is to characterize the fungal flora of roasted green coffee beans under official control in order to investigate the toxinogenic potential of isolated aflatoxin- and ochratoxin A producing strains.

The results of the Ulster method have shown a contamination rate ranging from [17% to 90%] for the green beans and [10% to 86%] for roasted beans. Concerning the Ulster modified method, the same ratio is between [4% to 40%] from the green beans and between [0 to 18%] for the roasted beans. The main species dominating our samples are *Aspergillus* and *Penicillium*.

Mycological investigation carried out on PDA medium has revealed fungal contamination [0 to 3.80 x10²UF/g] for the green beans and [0 to 2.90 x10²UF/g] for roasted beans. In CDA medium the recorded values are between [0 and 4.60x10²UF/g] for the green beans and between [0 to 2.70x10²UF/g] for roasted beans. In DRBC medium, the recorded rate of [0.20x10²UF/g to 4.7x10²UF/g] for the green beans [0.20 x10²UF/g to 2.40x10²UF/g] for roasted beans.

Aspergillus section *flavi* (*Aspergillus flavus*, *Aspergillus parasiticus* and *Aspergillus ochraceus*) are present in different coffee samples. *Aspergillus* section *nigri* (*Aspergillus niger*) has been reported to.

66.66% of the strains *Aspergillus ochraceus* are producers of ochratoxin A and all strains of *Aspergillus flavus-parasiticus* are aflatoxin producing. The toxicity of different coffee samples has been positive on TLC.

KEYWORDS: Green coffee, Roasted coffee, Ochratoxin A, Aflatoxin, *A.ochraceus*, *A.flavus-parasiticus*.

INTRODUCTION

One of the problems associated with the consumption of coffee is the possible presence of aflatoxins and Ochratoxin A. that may be found on the green coffee beans, and those roasted [12]. One of the problems associated with the consumption of coffee is the possible presence of aflatoxins and Ochratoxin A. mycotoxins produced by fungi belonging to the genera *Aspergillus* and *Penicillium*. These molecules have been classified in the list of the most dangerous molecules.

Coordinated with previous work, the ambition of this work frames the problematic approach to quality and food safety by focusing on contamination of green and roasted coffee beans collected from various regions and different origins by toxigenic fungi producing mycotoxins aflatoxins and Ochratoxin A.

MATERIALS AND METHODS

I. sampling

The purposes of our study analysis was conducted on eight samples of coffee beans Greens and nine samples of the roasted beans from different origins. Samples were immediately placed in sealed own bags for analysis in the laboratory.

II. Mycological analysis

II.1. Enumeration of the fungal flora

II.1.1. Direct method

It informs us on the rate of contamination of different grains studied as a percentage under the defined optimal environment and an incubation time of 5 days at 25 ° C [5].

II.1.1.1. method of Ulster medium RBC: ²

Isolation of moulds made by depositing 100 grains taken random samples in some boxes of Petri dishes containing the medium rose bengal Chloramphenicol (RBC) at the rate of 10 grains by box. The incubation period lasts 5 to 7 days at 25 ° C.

II.1.1.2 method of Ulster modified medium RBC:

100 grains of each sample taken randomly are soaked in a solution of 2 minutes sodium hypochlorite at 12 ° (NaClO₃). After rinsing in distilled water, the grains are deposited in the boxes of Petri dishes containing the RBC medium at the rate of 10 grains by box. The incubation period lasts 5 to 7 days at 25 ° C.

II.1.2. dilution method

A sample of 5g of each sample is added to 45 ml of sterile saline water. Of boxes Petrie containing media are inoculated with inoculum of 1 ml spread surface on the following media: PDA (Potatoes Dextrose Agar acidified), CDA (Czapek Dextrose Agar), DRBC (Dicholoro Rose Bengal Chloramphenicol). The incubation period lasts 5 to 7 days at 25 ° C [14].

II.2. Molds Identification

II.2.1. Identification of genera

According to [4], of molds identification mainly appeals to cultural and morphological characters.

II.2.2. Identification of species

Single Spore is a method used to identify species of *Aspergillus* and *Penicillium* genera [21, 22].

This method is based on the relationship between the aw of the culture medium and temperature of incubation on the one hand and the speed of growth on the other.

III. Analysis mycotoxicologique

III.1. Recherche of mycotoxin-producing strains

All strains of *Aspergillus flavus-parasiticus* and *Aspergillus ochraceus* group are subject to the test of productivity of mycotoxins (aflatoxins, Ochratoxin A).

III.2. chromatographic analysis by TLC

Aspergillus flavus-parasiticus and *Aspergillus ochraceus* strains are seeded on 50ml of YES medium (Yeast Extract Suggar) After 14 days of incubation, the biomass formed is debarassed by filtering the environment YES by a paper filter Wattman. 50ml of the filtrate obtained are added up to 180ml of chloroform. the chloroform phase is concentrated by evaporation under vacuum until 2 to 3ml of volume using a rotavapor. The plate is then placed in a chromatographic tank containing of elution solvents consisting of Toluene, Acetated'ethyl acid formic. the presence of aflatoxins and Ochratoxin A was conducted at UV light at 365 nm. The presence of aflatoxins and Ochratoxin A translates the characteristic fluorescence (blue for Aflatoxin B1, green for the Aflatoxin G1 and blue fluorescence for Ochratoxin A the same Rf of standard).

RESULTS AND DISCUSSIONS

I. Results of Mycological analysis

I.1. Direct method

The exploitation of the results of the study of the total fungal flora, carried out by the method of Ulster and Ulster modified shows the dominance of the genera *Apergillus* and *Penicillium* on the samples of the coffee beans. These genera are the essential flora of storage because they tolerate low water content [1,2, 3, 10].

According to [16 ; 24], the fungal investigation reveals the presence of *Aspergillus* (*A.ochraceus*, *A.niger* and *A.flavus*), the mycological analyzes performed on green coffee samples show a significant contamination by these species. Let us note the participation of molds of the field such as *Fusarium* and *Alternaria* [6]. Sign the presence of *Rhizopus* which indicates the bad conditions of storage and marketing [4].

The results of the modified Ulster method recorded a lower contamination rate than that of the Ulster method, which confirms the hypothesis of the external location of the molds.

The G.V3 and G.T2 samples showed higher contamination rates. This variation may be due to the difference in physicochemical conditions (humidity, temperature, pH) allowing the spores to germinate in these samples. This may lead to a qualitative and quantitative modification of mycoflora [15].

II.2. Results of the dilution method

The reading of the results reveals strong fungal contamination of all our samples. the total contamination rate differs from one sample to another [14]. It should be noted that samples G.V4 and G.T6 reported the highest contamination rates (Figure 1).

The rate of contamination (total mycoflora) of our samples shows that samples of green coffee beans are more contaminated than those of roasted beans, according to [7] among the detoxification methods, roasting, can lead to reduction of the contamination rate. The clear difference in contamination of our samples is due to the harvest period and the storage period.

The specific enumeration of the mycological analysis revealed by the dilution method indicates the dominance of molds with a high degree of dissemination, namely *Aspergillus* and *Penicillium* [15].

II.3. Results of molds Identification

II.3.1. Identification of genera

The following genera have been identified: *Penicillium*, *Aspergillus*, *Rhizopus*, *Alternaria* and *Fusarium*.

II.3.2. Identification of species

The species are determined after reading the diameters, the color of the mycelia and the metabolites produced (Photo 1).

Previous work has reported a frequency of occurrence of *Aspergillus* isolated from coffee beans. Indeed, [23] revealed that *A.niger* are the most common species found on coffee beans (63%), while the percentage of contamination by *A. carbonarius* and *A.ochraceus* was 6% and 31%, respectively. On the other hand [13] showed that *A..carbonarius* has a percentage (50%), whereas only 7% of strains of *A. ochraceus* were isolated on the coffee beans.

III. Analysis mycotoxicologic

III.1.Research of mycotoxin-producing strains

The *Aspergillus* of the flavi section are the most dominant species in the mycoflora of our samples. The investigation test of toxicity of strains of *A.flavus parasiticus* carried out on YES medium revealed that twenty four strains from which 85.71% of the strains were producing AFB1, and four strains with 14.28% were AFG producers. Of the *A.ochraceus* strains, twelve strains the equivalent of 66.66% were OTA-producing. *A.ochraceus* species isolated from coffee beans were produced of OTA made by [23] revealed that 75% of the global number 269 of these strains produce this toxin. According to [11, 17, 19, 20, 8, 9] (Photo 2).

III.2. chromatographic analysis by TLC

Thin layer chromatographic analysis for the detection of AFB1 and OTA from the substrates revealed the presence of these toxins on all samples.All of these results indicate that contamination of coffee bean samples with these mycotoxins is a concern. In a systematic way, coffee beans are heavily contaminated with AFB1, as well as with OTA (Photo 3).

Following the results obtained and for the objectivity of the analysis, it is important to take into consideration that poorly hydrated foods constitute a favorable environment for the development of molds. Isolates from the flavi section are common in most of our samples, which correlates with Aflatoxin content. However, the low presence of Ochratoxin A can be explained on the one hand by the competition for the substrate between Aflatoxinogenic and Ochratoxinogenic isolates and that Aflatoxinogenic strains can degrade ochratoxin A and on the other hand because of the small percentage of isolated Ochratoxinogenic strains [18].

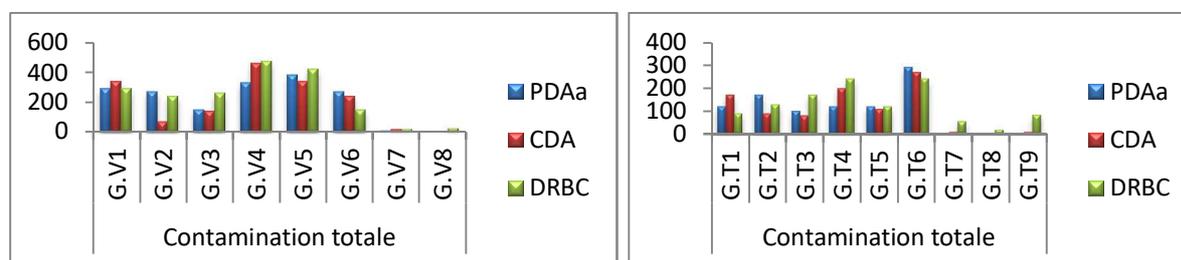


Figure 1 : Mean values of total mycoflora by the dilution method in coffee bean samples (UF / g)



Photo1 : *Aspergillus flavus*, *A.parasiticus*, *A. niger*, *A.ochraceus* et *A.carbonarius*



Photo 2 : A & B TLC of *Aspergillus flavus-parasiticus* C & D TLC of *Aspergillus ochraceus*



Photo 3 : Detection of mycotoxin in substrates

ACKNOWLEDGMENTS

We are highly thankful to head, Department of biology, Faculty of Sciences of Nature and Life, University of Bechar, Algerian.

REFERENCES

- [1]-Adebanjo.A., & Bankole S. A. 2003. « Mycotoxins in food in west Africa; current situation and possibilities of controlling it ». African journal of biotechnology, vol.2, (9), p 254-263- available on line at: < <http://www.Academicjournals.org/AJB> >.
- [2]-Amrouche, A. 2007. Étude mycologique et mycotoxicologique comparative sur le blé tendre local et importé stocké dans la région de Bechar et ces dérivés de meunerie (farines et sons). mémoire de magistère. Inédite, université de Béchar. Algérie.
- [3]-Belyaougoubi, L. 2006. Effet de quelques essences végétales sur la croissance des moisissures de détérioration des céréales. Thèse de Magistère. Inédite. université Abou Bekr Belkaid. Tlemcen.
- [4]-Botton, B., A. Bretton, H.Fevre, S. Gauthier, Ph. Guy, JP. Larpen, P. REYMOND, J. Sanglier, Y. Vayssier & P. Veau. 1990. Moisissures utiles et nuisibles : Importance industrielle. Paris : 2^{ème} Ed. MASSON. p.512.
- [5]-Cahagnier, B. 1998. Qualité microbiologique des grains et teneurs en ergostérol. Cahier Scientifiques et Techniques (Janvier/Février). P.5-15.
- [6]-Cahagnier, B. 1996. Céréales et produits dérivés. In BOURGEOIS, C.M., MESCLE, J.F., ZUCCA, J. Microbiologie alimentaire : Aspect microbiologique de la sécurité et de la qualité des aliments. Tome 1. Paris : Tec et Doc. (Lavoisier). Partie IV, Chapitre 9, p. 392-400.
- [7]-Dano Djédjé., Sébastien, Manda Pierre., Kouadio James. Halbin., Diakité Aissata., Droh Kouï Jérôme., Kouassi Kouakou Serge & Dembélé Adjourma. 2009. European Journal of Scientific Research : Etude de L'incidence de la Torrification Appliquée au Café Vert Sur la Réduction du Taux de L'ochratoxine a (OTA) dans le Produit Fini.
- [8]-Douglas, L., L. Park, W. Trucksess Mary, S. Nesheim, M. Strack., & F. Newell Richard. 1994. «Solvent- Efficient thin- layer chromatographic method for the determination of aflatoxins B1, B2, G1 et

- G2 in corn and peanut products ». Collaborative study- park: journal of AOAC international, VOL. 77, n°3.
- [9]-Frayssinet, C., & Cahagnier, B. 1982. Recherché et dosage des toxines dans les grains et graines et produits dérivés : céréales, oléagineux, protéagineux, aliments pour animaux. Paris : technique et documentation (Lavoisier). p. 558-559.
- [10]-Godon.B., & LoiseL.W, 1997. « Guide Pratiques D’analyses Dans Les Industries Des Céréales » Paris: Tec et Doc : (Lavoisier). 820. P : 78-83.
- [11]-Hussain, A., Ali, J., Shafqatullah, 2011. Studies on Contamination Level of Aflatoxins in Pakistani Rice. Journal of the Chemical Society of Pakistan 33.
- [12]-Irène Ahou Kouadio, Louis Ban Koffi, Jean Gnopo Nemlin, Mireille Bretin Dosso. 2012. Effect of Robusta (*Coffea canephora* P.) coffee cherries quantity put out for sun drying on contamination by fungi and Ochratoxin A (OTA) under tropical humid zone (Côte d’Ivoire). Food and Chemical Toxicology. P 1-11.
- [13]-Joosten, H.M.L.J., Goetz, J., Pittet, A., Schellenberg, M., Bucheli, P., 2001. Production of ochratoxin A by *Aspergillus carbonarius* in coffee cherries. International Journal of Food Microbiology 65, 39–44.
- [14]-Larpent, J.P. 1990. Moisissures Utiles et Nuisibles Importance Industrielle. 2e édition. Masson, Paris. 512 pages.
- [15]-Le Bars, J., & Le Bars, P. 1987. Les moisissures des denrées alimentaires et leurs conséquences. Conférence « Section Midi –Pyrénées » cf. bulletin de l’association des anciens élèves de l’institut pasteur, 4eme trimestre.
- [16]-Martins M.L., Martins H.M & Gimeno A. 2003. Incidence of microflora and of ochratoxin A in green coffee beans (*Coffea arabica*), *Food Addit Contam.*, 20 (12), 1127-1131.
- [17]-Moreno, E.C., Garcia, G.T., Ono, M.A., Vizoni, E., Kawamura, O., Hirooka, E.Y., Sataque Ono, E.Y., 2009. Co-occurrence of mycotoxins in corn samples from the Northern region of Parana State, Brazil. Food Chemistry 116.
- [18]-Nguyen minh tri, M. 2007. Identification des espèces de moisissures potentiellement productrice de mycotoxines dans le riz commercialise dans cinq provinces de la région centrale du Vietnam- étude des conditions pouvant réduire la production des mycotoxines. Thèse de doctorat. Inédite, Institut nationale polytechnique .Toulouse.
- [19]-Pfohl-Leszkowicz, A. 1999. Chapitre II : Ecotoxicogénèse. Première partie : les agents mycotoxiques. Dans. Conseil supérieur d’hygiène publique de France, section de l’alimentation et de nutrition. Les mycotoxines dans l’alimentation : évaluation et gestion du risque,. Lavoisier, France : Technique & Documentation. P 17-30.
- [20]-Pfohl- Leszkowicz A. 1999. Métabolisation Des Mycotoxines. Dans Conseil supérieur d’hygiène publique de France, section de l’alimentation et de nutrition. Les mycotoxines dans l’alimentation évaluation et gestion du risque, (pp. 37-55) Lavoisier, France : Technique & Documentation.
- [21]-Pitt, J.I. 1973. An appraisal of identification methods for *Penicillium* species. Novel taxonomic criteria based on temperature and water relations. Mycology 65, p, 1135-1157.
- [22]-Ramirez, C. 1982. Manual and Atlas of *Penicillia*. New York (USA): Elsevier biomedical press.
- [23]-Taniwaki, M.H., Pitt, J.I., Teixeira, A.A., Iamanaka, B.T., 2003. The source of ochratoxin A in Brazilian coffee and its formation in relation to process methods. International Journal of Food Microbiology 82, 173–179.
- [24]-Urbano G.R., Taniwaki M.H., Leitão M.F., Vicentini M.C. 2001. Occurrence of ochratoxin A-producing fungi in raw Brazilian coffee, *J Food Prot.*, 64 (8), 1226-1230.

Risk Factor Study in Operation of Chlorine Dosing for Water Treatment

Sunarno^{1*}, Wahyono Hadi²

¹Department of Environmental Engineering, Institut Teknologi Adhi Tama Surabaya, Surabaya, Indonesia

²Department of Environmental Engineering, Institut Teknologi Sepuluh Nopember, Surabaya, Indonesia

Received: February 24, 2019

Accepted: April 22, 2019

ABSTRACT

One of the problems that occur at Water Treatment Agency (PDAM) in a city of East Java is the procedure of not appropriately dosing chlorine according to standard operation procedure (SOP). Dosing chlorine at improper injection sites and non-optimum levels at PDAM Reservoir Installation is a risk failure. This study aims to find out the causes of failure risk analyzed from the technical aspects using Fish Bone Analysis (FMEA). The strategy is also based on financial aspects. The research was begun by collecting data both through interviews using questionnaires to PDAM employees and laboratory analysis of water quality data from PDAM Water Treatment in a city of East Java in the form of Chlor Remaining compared to water quality data according to the regulation of the minister of health of Indonesia, No. 492/2010. It was suggested that alternatives to dosing chlorine can be done at several points, namely in the pipe before entering the reservoir and distribution pipes to reduce the risk of failure.

KEY WORDS: Dosing Chlor, Fish Bone, FMEA, water treatment

1. INTRODUCTION

The service coverage of PDAM in a city of East Java is still low at 20.22% (5180 house connections) because the community can still use alternative sources of groundwater. Community perceptions of PDAM are not good about quality, quantity and continuity. The service has not yet covered the entire area for 24 hours service (on average 20-24 hours).

In an effort to improve the quality, PDAM often encounters obstacles that result in process failure from production facilities that can lead to system failure, and also there are risk factors that threaten this.

Dosing chlorine gas to the reservoir manhole gives the results of the quality test on the Chlor remaining content reservoir outlet of 0 mg/L compared to the quality standard data for water quality which does not meet the regulation of the minister of health nu. 492/2010. The impact of the absence of residual chlorine on production water shows that there is still a presence of pathogenic bacteria that are harmful to humans [1 ; 2;10;11;13;14;15;17;18;20].

The company's future hopes are to be able to anticipate and improve the risk of process failure in the Water Treatment Plant, so that the risks of process failure can be minimized which will later be used to fulfill production targets both in quality and quantity.

2. METHODOLOGY

Research Type

The type of research used in this study is descriptive qualitative, and modeling analysis that is research that intends to describe the phenomenon PDAM Water Treatment in a city of East Java.

Data Collection and Processing Method

The methods adopted in the framework of collecting and processing data in this thesis research are as follows:

1. Perform FMEA and FISH BONE modeling Installation of PDAM in a city of East Java
2. Scoring the problems that occur results from the analysis of the FISH BONE and FMEA methods.

FMEA has advantages compared to other risk assessment methods such as FTA and ETA, which are more feasible and effective for operational improvement and able to analyze risks on a larger and more complex scale [4; 5 ;6 ;7 ; 8 ;9 ;19].

3. RESULTS AND DISCUSSION

Technical aspects

From the results of the analysis of the causal relationship between raw water managed by PDAM in a city of East Java and the problem, the factors that influence the risk of failure are as follows.

- a. Raw water
- b. External / Oversight Factors related agencies
- c. Internal Factors
- d. Water Treatment Processing Performance
- e. Maintenance of installation

This failure caused the quality of production water not to fulfill the regulation of the minister of health of Indonesia, No. 492/2010.

Break Point Chlorination

Break Point Chlorination (BPC) is the determination of the amount of chlorine needed in the reaction, so that all oxidized substances become oxidized, ammonia is lost as N₂ gas, and there is still dissolved active chlorine residue whose concentration is considered necessary for microorganism disinfection [1 ; 2 ;3;12;16].

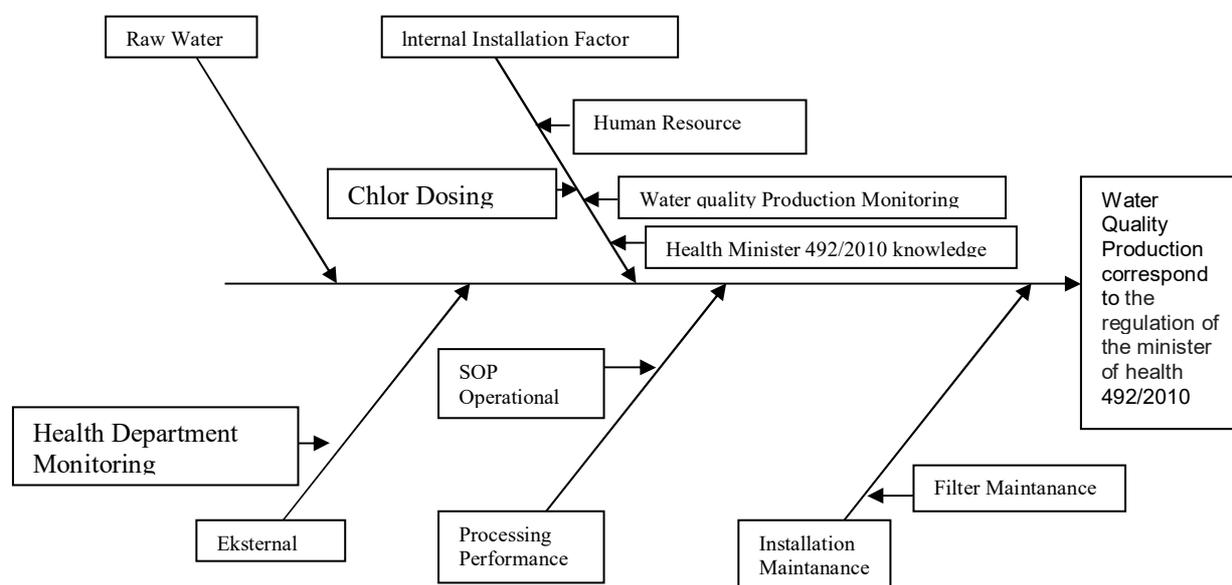


Fig. 1: Fishbone Diagram of PDAM Water Treatment

Efforts to improve chlorine dosing location will have 2 scenarios to be analyzed:

1. Dosing chlorine before entering the reservoir
2. Dosing chlorine after leaving reservoir or in the distribution pipe

Dosing chlorine gas vs water discharge to the pipe before entering the reservoir is fluctuative. However, water discharge is more effective and more stable than after leaving the reservoir or in the distribution pipe. This is due to influenced by peak hour and minimum hour requirements.

Efforts to improve dosing chlorine

From the dosing graph above, dosing chlorine and water discharge to the pipe before entering the reservoir is more effective and more stable than after leaving the reservoir or in the distribution pipe. The cost of transferring piping locations for injection of chlorine gas pipes to pipes before the pipe enters the reservoir.

4. CONCLUSION

Conclusion from the results of observations in the field and technical analysis is as follows. Firstly, there will be chlorine gas usage efficiency if operated in the right place and the optimal dosing. Secondly, the cost is efficient for injection of chlorine gas pipe to pipe before the pipe enters the reservoir.

REFERENCES

1. Elma Sofia, Rony Riduan, dan Chairul Abdi Program Studi Teknik Lingkungan, Fakultas Teknik, Universitas Lambung Mangkurat. Evaluasi Keberadaan Sisa Klor Bebas di Jaringan Distribusi IPA Sungai Lulut PDAM BANDARMASIH
2. Benny Syahputra, Jurusan Teknik Lingkungan Fakultas Teknis UNNISULA. Analisa Sisa Chlor Pada Jaringan Distribusi Air Minum PDAM Kota Semarang.
3. Santika, S.S., 1987Jurnal SainHealth Vol. 1 No. 2 Edisi September 2017 © Fakultas Ilmu Kesehatan Universitas Maarif Hasyim Latif Sidoarjo
4. Barends, D. M. , Oldenhof, M.T., Vredenburg, M.J., & Nauta, M.J. 2012. Risk analysis of analytical validations by probabilistic modification of FMEA. Journal of pharmaceutical and biomedical analysis. (www.ncbi.nlm.nih.gov)
5. Carlson, C. S. 2012. *Effective FMEAs: Achieving Safe, Reliable, and Economical Products and Processes Using Failure Mode and Effects Analysis*. – 1st ed.
6. Imamoto, T. et al. 2008. *Perivesical Abscess Caused by Migration of a Fishbone From The Intestinal tract*. International Journal Of Urology. Vol. 9 (405-409)
7. Jun, L., Huibin, X. 2012. Reability Analysis Of Aircraft Equipment Based On FMECA. Physics Procedia Vol.25, Hal 1816-1822.
8. Dailey, K.W. 2004. The FMEA Pocket Handbook. DW Publishing Co. USA.
9. Karnaningroem, Nieke., Mardiyanto , Mas A., Damayanti, Alia. 2017. Analisis Kegagalan dengan Melakukan Analisis Assessment Risiko Dampak Negatif Pemakaian Air Isi Ulang. Institut Teknologi Sepuluh Nopember. Surabaya
10. Keman, S. 2005. Quality of Reffiled Drinking Water in Surabaya City. Vol. 41. Journal.unair.ac.id
11. Marpaung, M. D. O. 2013. *Uji Kualitas Air Minum Isi Ulang Di Kecamatan Sukolilo Surabaya Ditinjau Dari Perilaku Dan Pemeliharaan Alat*. Jurusan Teknik Lingkungan ITS. Surabaya. Jurnal Teknik ITS
12. Said N. I. 2007. *Desinfeksi Untuk Proses Pengolahan Air Minum*. Pusat Teknologi Lingkungan 3 (1): 15-28. Ejournal.bppt.go.id
13. Widjianti, M, N. L. P., dan Restiati, N. P. 2004. *Analisis Kualitatif Bakteri Koliform Pada Depo Air Minum Isi Ulang Di Kota Singaraja Bali*. Jurnal Ekologi Kesehatan Vol 3 No 1, April 2004: 64-73.
14. Khoeriyah A, & Anis, 2015. Aspek Kualitas Bakteriologis Depot Air Minum Isi Ulang (DAMIU) di Kabupaten Bandung Barat. Program Masgister Ilmu Lingkungan, Universitas Diponegoro. Journal .fk.unpad.ac.id

15. Naibaho. 2008. Analisis Kualitas Fisik dan Kimia Air Bersih di Daerah Medan dan Sekitarnya. Jurnal Ilmiah pendidikan Tinggi 1 (2): 41-45.
16. Herawati D, Yuntarso A 1),2) Dosen Fakultas Ilmu Kesehatan, UMAHA, Sidoarjo, Penentuan Dosis Kaporit Sebagai Desinfektan Dalam Menyisihkan Konsentrasi Ammonium Pada Air Kolam Renang Jurnal SainHealth Vol. 1 No. 2 Edisi September 2017 © Fakultas Ilmu Kesehatan Universitas Maarif Hasyim Latif Sidoarjo
17. Departemen Kesehatan. 2010. Peraturan Menteri Kesehatan Republik Indonesia No 492/Menkes/Per/IV/2010 *Tentang Kualitas Air Minum*. Departemen Kesehatan Republik Indonesia. Jakarta.
18. Departemen Kesehatan, 2010. Peraturan Menteri Kesehatan Republik Indonesia No 736/MENKES/PER/VI/2010 *Tentang Tata Laksana Pengawasan Kualitas Air Minum*. Departemen Kesehatan Republik Indonesia. Jakarta.
19. Hartmann J, Monique van der Aa, Wuijts S, Ana Maria de Roda Husman, Jan Peter van der Hoek. Risk governance of potential emerging risks to drinking water quality: Analysing current practices, Environmental Science and Policy, Procedia Environmental Sciences 28 (2015) 750 – 757
20. Wulandari D. 2006. Uji Mikrobiologi Air Minum Isi Ulang di Wikayah Kecamatan Ngaglik dengan Metode Most Probable Number. Skripsi. Program Studi Farmasi: Universitas Islam Indonesia.

Toxicity of Single and Mixed Compounds to Water Hyacinth

Denesya Natalia Paris* and Sarwoko Mangkoedihardjo

Department of Environmental Engineering, Faculty of Civil, Environmental and Geo Engineering, Institut Teknologi Sepuluh Nopember (ITS), Surabaya, Indonesia

Received: February 26, 2019

Accepted: April 30, 2019

ABSTRACT

The purpose of this study was to determine the level of substance toxicity in individual tests and mixed tests through a comparison of EC₅₀ values by looking at the effect of growth inhibition, namely not the emergence of new shoots. For plants carried out by batch reactor system with observation time for 4 days. This research consists of several stages, namely leach characterization as the initial data for making toxicants, single toxicity test and mixed exposure test. The results showed the biggest removal efficiency in the mixture is formaldehyde.

KEYWORDS: water hyacinth, glucose, ammonium, formaldehyde

INTRODUCTION

The use of aquatic and wetland plants, such as water hyacinth, to uptake pollutants in wastewater treatment is considered by researchers [1]. Some pollutants such as organic matter be toxic for water hyacinth. Ammonium, glucose, and formaldehyde were chosen to represent exposure levels in the environment. Ammonium is widely used as a drug, an agent in the treatment of metabolic alkalosis, in food as an additive for cakes and drinks. Glucose is a source of energy found everywhere in biology. Glucose is widely used especially in the food industry [2]. Formaldehyde is one of the important compounds in the chemical industry, daily household products such as home cleaning materials, paper, shampoo, deodorants, toothpaste, lipstick, nail coloring, pesticides, and has a very large role in the manufacture of hard thermoset resins [3].

Water hyacinth effectively helps clear the river because it is phytoremediation which can absorb organic, inorganic and other heavy metals which are pollutants [4]. The presence of water hyacinth as an aquatic biota can be used as an indicator of certain pollution in water bodies and the adverse effects on the surrounding ecosystem. On many occasions, biota are exposed not only to one type of substance, but to exposure to toxic substances that contain many substances. Negative effects are toxic for living things based on the interaction of many substances in the environment [5].

Based on the description above, it is necessary to do biological testing of toxic mixtures in laboratory-scale research. Toxicity such as ammonium, glucose and formaldehyde are subjected to toxicity tests using test organisms. With this toxicity test, it can be seen all the effects of ammonium, glucose and formaldehyde on aquatic biota which can be in the form of effects on growth which cause effects of ecosystem changes. This can illustrate the level of certain pollution in the environment and the adverse effects on the surrounding ecosystem.

METHODS

Initial Data Collection

The initial data needed in the study was the characterization of leachate in TPA Benowo. This data is used as the basis for making ammonium and organic matter concentrations (BOD and COD). Data were obtained by sampling and analyzing leachate quality of TPA Benowo, Surabaya with the following parameters. The results of the analysis of ammonium, BOD and COD concentrations will be used as the basis for making toxics for toxicity tests namely ammonium, BOD (glucose) and the difference in COD and BOD values for the value of non-biodegradable organic matter (formaldehyde).

Preparation of Test Biota

All plants used in toxicity tests must be propagated in advance to obtain test plant saplings. After the propagules reveal the new leaf buds are used for test biota [6]. The water hyacinth plant (*Eichornia crassipes*) used from the propagation stage is the second generation which has specifications with criteria, namely: leaves that are still fresh and not yellowing, plant age is around 20 days, plant height is 18.3 cm and plant weight is around 27-30 grams. During this process the plants must get enough sunlight for photosynthesis, the space to grow is large, the water is calm, the temperature is between 20-30°C. The reactor is placed in the Plant House and the pH for the growth of water hyacinth ranges from 4.5 to 7.5.

Corresponding Author: Denesya Natalia Paris, Department of Environmental Engineering, Faculty of Civil, Environmental and Geo Engineering, Institut Teknologi Sepuluh Nopember (ITS), Surabaya, Indonesia.
email: denesyantalia@gmail.com

Single Toxicity Test

In each container used, plants with wet weight 1 plant water hyacinth weighing 27-30 grams were placed which had almost the same height. The number of test plants is 4 pieces for the RFT test. Variations in toxic concentrations are distinguished in the percentage of toxicity, which is equal to 0% (control); 20%; 40%; 60%; 80% and 100% [7]. For control, it only contains water hyacinth and diluent water without toxicity.

Mixed Exposure Test

The Acute Toxicity Test aims to determine the toxic concentration that can cause a 50% effect of the test biota in a relatively short time. For each different concentration, repeated 3 times. In each reactor in the plant test 10 water hyacinths were given in 10 liters of water. Toksikan like ammonium, glucose and formaldehyde mixed and put into the reactor according to the concentration obtained from the RFT results. Negative effect data that occurs in plants obtained at 96 hours was used to determine the EC_{50} value. Variations in toxic concentration were determined in the narrowed range finding test. For control, it only contains water hyacinth and diluent water without toxicity.

RESULTS AND DISCUSSION

Characteristics of Leachate

Leachate used came from the Benowo landfill collection pool. Samples were analyzed to determine the initial characteristics of leachate. The parameters used were BOD, COD, pH, temperature, turbidity and NH_4 . They were used as the basis for making artificial waste concentrations.

Single Toxicity Test

Variations in ammonium concentration given are 0%, 20%, 40%, 60%, 80% and 100% or equivalent to the control solution; 147 mg/L; 294 mg/L; 441 mg/L; 588 mg/L and 735 mg/L. The reactor body used is in the form of a plastic tub with a volume of 4 L of water, the number of test plants is 4 [8] and this stage is carried out for 4 days. The result of the range finding test that will be chosen is the concentration of ammonium which does not have a negative effect on plants, namely the concentration that makes the water hyacinth shows new shoots and remains fresh. In this case NH_4^+ inhibits the growth of shoots, but not on the leaves and stems so that they remain green. In the first stage, namely with NH_4 until the fourth day, so the concentration of NH_4^+ used is at 40%, namely the concentration of NH_4^+ 294 mg/L in plants *E. crassipes*, because at concentrations of 60%, 80% and 100% do not show new shoots. The EC_{50} ammonium value of *E. crassipes* obtained was 322 mg/L.

In glucose, all concentrations produce shoots in all plants. Plants themselves produce glucose through photosynthesis which is stored by plants and used as their nutrition. Because at a concentration of 1.017 mg/L, the plants still germinate, the glucose concentration is increased to get a concentration where glucose has a negative effect on the single toxicity test. Based on the above line equation, the EC_{50} glucose value obtained on the single toxicity test was 1,193 mg/L. Glucose can have a negative effect on plants that is not the growth of new shoots when the concentration is excessive in plants. When the density of water in the growing media is lower than the density in plant roots, osmosis can occur well. Addition of glucose in high concentrations can increase osmotic pressure. When high concentration of glucose is added, the osmotic gradient decreases and causes absorption of water to the plant roots to decrease. Plants will lack fluids and growth will be hampered [9].

In formaldehyde, all water hyacinths are able to show new shoots at a concentration of 0.07 mg/L within 3 days. Formaldehyde includes non-biodegradable organic substances which are toxic. Formaldehyde is a toxic organic matter, with the increasing level of toxicity of a substance, the higher the toxicity of a substance can cause biota to die [10]. Formaldehyde is very difficult to decompose in nature and requires a long time to decompose. This can also be seen from the results of the RFT, where almost all concentrations of formaldehyde have an effect on *E. crassipes*. The concentration of effect that causes 50% biota to not sprout is 0.085 mg/L.

Mixed Exposure Test

After getting the concentration range in each test solution, namely the concentration where the water hyacinth is able to live 100% or which shows new shoots, then the three test solutions, namely NH_4 , glucose and formaldehyde will be mixed to find out the effects that occur when the substances interact. The increase of glucose EC_{50} value during individual toxicity test with mixed toxicity test was 1193 mg/L to 1307 mg/L (8.74% decrease in toxic properties). Ammonium EC_{50} value is 322 mg/L to 361 mg/L (10.88% decrease in toxic properties), EC_{50} value of formaldehyde is 0.085 mg/L to 0.4 mg/L (97.6% reduction in toxicity). Based on the results of the study, there were differences in the effect of concentration between individual toxicity tests on each substance and toxicity test when all three substances were mixed. The difference is greater with the decreasing level of formaldehyde toxicity, which indicates that the substance is antagonistic, when the value of $EC_{50-mix} > EC_{50-individual}$.

CONCLUSION

Formaldehyde was the most toxic compound for *Eichhornia crassipes*. In addition, the compound possessed the biggest removal efficiency in the mixture of compounds containing glucose and ammonium. It suggested for further research.

REFERENCES

1. Ting, W.H.T., Tan, I.A.W., Salleh, S.F. and Wahab, N.A. (2018). Application of water hyacinth (*Eichhornia crassipes*) for phytoremediation of ammoniacal nitrogen: A review. *Journal of Water Process Engineering*, 22: 239–249.
2. Buckle, K. A., R. A. Edwards, G. H. Fleet, and M. Wootton. (1987). *Food Science*. Jakarta: UI Press.
3. Agency for Toxic Substances and Disease Registry. (1999), *Toxicological Profile for Formaldehyde*. ATSDR.
4. Ratnani, R.D., Hartati, I. and Kurniasari, L. (2011). Utilization of Hyacinth (*Eichhornia Crassipes*) to Reduce COD Content, pH, Odor, and Color in Tofu Liquid Wastewater. *Momentum*, 7 (1): 41-47.
5. Mangkoedihardjo, S. and Samudro, G. (2009). *Ecotoksikologi Teknosfer*, Guna Widya, Surabaya.
6. Sunarisa, E. (2003). Use of Water Hyacinth as Advanced Effluent Processor for IPAL Surfactants and Copper Smelting. *Tesis*. Institut Teknologi Sepuluh Nopember. Surabaya.
7. Rohmani, I. (2014). Toxic Liquid Waste Toxic Test on Tilapia (*Oreochromis niloticus*) and Apu Wood Plant (*Pistia stratiotes*). *Final Project*. Institut Teknologi Sepuluh Nopember. Surabaya.
8. Herrena, A. and Titah, H.S. (2017). Fito Processing for Deconcentration of Rhodamin B Colors, Methylene Blue and Methyl Violet with Aquatic Plants *Eichhornia crassipes*. *Jurnal Teknik ITS*, 6 (2).
9. Lastdrager, J., Hanson, J. and Smeekens, S. (2014). Sugar Signal and The Control of Plant Growth and Development. *Journal of Experimental Botany*, 65(3): 799-807.
10. Al-Rosyid, L.M. (2019). Relationship Between BOD / COD Ratio to Octanol Partitions of Water in Organic Substances. *Tesis*. Institut Teknologi Sepuluh Nopember. Surabaya.

Reconstruction of Architectonic Transformation of the Grand Mosque of Sang Ciptarasa Cirebon, from the Pyramidal *Tajug* to the Hipped *Limasan* Roof

Rahadhian P. Herwindo

Architecture Department of Parahyangan Catholic University, Bandung, Indonesia

Received: February 24, 2019

Accepted: April 22, 2019

ABSTRACT

The shape of the Grand Mosque of Sang Ciptarasa (GMSC)'s roof differs from other ancient mosques, which are hip-roofed with multi-layers and a rectangular-shaped core plan. The roof shape of mosques in the early era of the development of Islam in Java basically uses the form of a *Tajug* pyramid-shaped roof that is stacked together. The hipped *Limasan* roof was not used for mosques common to the era. The analysis of this study has been carried out in a descriptive argumentative manner through architectonic and typo-morphological studies. In terms of interpretation, reconstruction of spatial patterns and scopes has been made. Based on the analysis of the Cirebon *babad* script, folklore, and analysis of the arrangement of foundation base patterns and their columns all indicate that GMSC once had a *Tajug* roof and then changed into the hipped *Limasan* roof. This change began in the 16th century after the fire. Reading the transformation of GMSC shows that in the 16th century there were initiatives for improvement or renewal but his enthusiasm remained in dialogue with what had been established before. The position of base foundation patterns show that GMSC in the past had a *Tajug* roof and subsequently changed into a hipped *Limasan* roof shape.

KEYWORDS: *Tajug, Limasan, Transformation, Reconstruction, Mosque*

1. INTRODUCTION

The present appearance of Grand Mosque of Sang Ciptarasa (GMSC) features a unique roof shape, namely a tiered hipped roof - *Limasan* roof with a rectangular core plan. The shape of the mosque roof in the early era of Islamic development basically employed the form of a tiered *Tajug* pyramid roof. In the Javanese traditional architectural typology, *Tajug* it is known as one of the roof typologies for mosques or sacred buildings. The shape of the *limasan* roof can be classified as very rarely or even never used for the roof of the mosque, because it might be identical to the roof for residential (secular) buildings. In traditional Javanese architecture the terms *Limasan* and *Joglo* are an embodiment of a roof whose elongated peak is not centered like the *Tajug* style. [1] The shape of the GMSC roof looks unique because it uses a hipped-shaped roof that is not widely used for mosques common to that particular era.



Fig.1: Grand Mosque-Sang Ciptarasa (tiered *Limasan*-hipped roof); Grand Mosque-Demak (tiered *Tajug*)[2]

This study aims to examine in greater depth the uniqueness of the mosque's roof typology when associated with its architectonic aspects. It can be clearly discerned that this type of roof should be supported only at the edges so that the column is not needed. The roof of this multi-layered is found in the context of traditional Balinese architecture, namely *Wantilan-Bale* and the traditional Javanese architecture in the form of a pavilion in the shape

of a *Limasan* roof that does not require a column in the middle of the building in a row. On the other hand, historical records show that GMSC had experienced a fire and was later rebuilt. Thus it is possible to have a redesign in the form of its architecture from the old form to the new form.

The mosque form at the beginning of the development of Islam, especially on Java and in Indonesia, even extending to Southeast Asia has a certain characteristic that is using a *Tajug* roof overlap in layers [3]. *Tajug* takes the term from the type of a pointed pyramid-shaped roof. In general, the stack arrangement is odd. Durmacay affirms *l'Origin fuberaire* derived from Javanese mosques and the role of these buildings in replacing mountain figures in the pre-Islamic tradition[4]. The shape of the pyramidal roof which is also a mountain is universally a sign of permanence. This can be discerned from the shape of the square plan giving the impression of stability and pyramids giving the impression of permanence[5]. The shape of this stacked roof is a legacy of the pre-Islamic architectural tradition[6], that is to say the Majapahit era (13th-15th Century). Majapahit era buildings can be identified in the enshrined relief images of this era and are also known on the island of Bali, termed *Wantilan*. Bali is an area that has inherited Majapahit culture.



Fig.2: *Wantilan* in Bali, Building in Hindu-Balinese Tradition [7] [8]

The shape of the *Tajug* building plan is square like the sacred buildings enshrined in the Majapahit era, so that it can be recognized that *Tajug* is indeed closely related to sacred buildings. *Wantilan* can be square or rectangular, and also have pyramidal roofs like *Tajug* or the *Limasan* style, although *Wantilan* relates to sacred functions as well. The architecture of the early mosque on Java consists essentially of a square plan and a centered *Tajug* roof, so that when we consider the form of GMSC built in the same era but lacking the square shape and *Tajug* features, our interest to study this phenomenon in greater depth is piqued. This *Tajug* centering building is also used in the tombs of Islamic heritage on Java, especially the tombs of *Wali*-guardians or kings. Square and multi-layering *Tajug* shapes were indeed used for sacred buildings in that era [9].



Fig.3: The Early/Ancient Indonesian Mosque - *Wali* Mosque Type – *Tajug* Roof: (left to right) Yogyakarta, Lombok, Jambi, Aceh [10]

2. RESEARCH METHODS

This research was conducted qualitatively with an architectonic, historical and empirical approach based on field heritage. Comparisons are also drawn with other buildings with similar functions and built in the same era to understand the relationship of spatial patterns, tectonics and forms such as the *Demak* Mosque and the *Panjunan* Red Mosque. The variables used in the analysis process are placement patterns of columns, walls and roofs in the context of spatial planning and mass and shape. The analysis of this study has been carried out in a descriptive argumentative manner through architectonic and typo morphological studies[9]. Interpretation has been made

interpretively, and reconstruction of spatial patterns and scopes will be conducted. In general, the research steps carried out are:

1. Reviewing and identifying matters relating to the architectural background of the Grand Mosque of Sang *Ciptarasa* (GMSC) or the Grand *Pakungwati* Mosque in Cirebon, for example covering their historical, cosmological, cultural, ritual, geographical background through the study of background literature, observations, data collection on the object of study (method of observation and interview).
2. Assessing the pattern of the spatial structure of Grand Mosque architecture on Java based on architectonic studies and the morphologies including the possibilities of transformation in them.
3. Comparing GMSC with other ancient mosque architectures such as the Grand Mosque of *Demak* and the Red Mosque of *Panjunan* and other *Wali* mosques which are expected to be built in the same era, namely the beginning of the development of Islam in Java.

This knowledge can underlie an understanding of the reconstruction of the GMSC spatial pattern based on the form of the figure/shape (especially the roof) so that it can be used as a basis for understanding the transformation or development of its architecture. This research is expected to enhance recognition of the changes that have taken place in the building of GMSC so that it is not only based on current interpretations such as the ones based on myths and so on, or interpretations associated with feminism and the like. This research can open up a new interpretation of GMSC's form based on the development of its spatial pattern based on architectonic features which involves the relationship of figures and their tectonic aspects.

3. RESULTS AND DISCUSSION

The form of the *Limasan* roof in the context of GMSC, at least according to some opinions, is associated with feminine characteristics. The GMSC with its hipped *Limasan* roof is called feminine (its elongated peak) thus pairing it with the Grand Mosque of *Demak* which has a *Tajug* pyramidal-masculine roof (whose peak is centered) [4]. This *Tajug* roof at its peak features a *Memolo* or decoration on the roof top like a shining crown, while the *Limasan* roof does not. GMSC and the Grand Mosque of *Demak* were built in a contemporaneous and contiguous period of time as so-called partners. The *Demak* Mosque was built in approximately 1477 AD while GMSC was built around 1480 AD, although there were many other opinions about GMSC's building year, such as in 1478 a year after the *Demak* Mosque was built. However, this feminine nature needs to be questioned or re-examined, and it must be granted that GMSC did indeed initially use a type of hipped roof, considering that this mosque had been burned in the past.

There are several analyses of the form of GMSC Architecture. GMSC based on its history in the past is also called the Grand Mosque of *Pakungwati* because it is considered to be a unit with the *Pakungwati* Palace [11]. The *Pakungwati* Palace was the Cirebon Palace before the *Kasepuhan* and *Kanoman* Palaces were built. The term feminism is in accordance with the name enshrined there, even though *Nyi Mas Pakungwati* on the other hand is believed to have died (*moksa*) in this mosque and is buried there. Apart from being associated with the feminine aspect of the shape of the roof with elongated peaks, it is also associated with architecture in the Sundanese [12] tradition. Sundanese architecture uses many buildings with elongated roofs

According to the analysis of Unang Sunarjo, the GMSC building was built by *Sunan Gunung Jati* with the help of *Sunan Kalijogo*, *Sunan Bonang*, *Sunan Drajat*, and *Sunan Kudus* with the architect *Raden Sepat* from the *Majapahit* Kingdom. Thus the building should be identical to other guardian mosques, especially the *Demak* Mosque. *Raden Sepat's* involvement shows that *Majapahit* architectural art can be recognized in this mosque, for instance in its ornament processing and other aspects. [13]

On the porch to the south near the GMSC pillar, there is a wooden carved inscription on a wooden pillar, with Arabic *pegon* letters that reads: "*dugi hinggini Masjid Agung Pakung Wati ing martabate Insan*" - "*Kamil babad pelesto ning ing rengkeppe masjid dentata dugi ing bumi hijrah Nabi Muhammad SAW min Shahri jumadil awwal minsyahri muharrom*", meaning: "until now the Great Mosque of *Pakungwati* as a specimen of perfect human history from the beginning to the end has been neatly arranged like this, which on this land coincides with the migration of the Prophet Muhammad, *Jumadil* beginning in the month of *Muharram* (9 months). This inscription can be related to the process of building this mosque. [13]

The development can be connected with the initial development, but on the other hand the next development can also be linked to the restoration. Based on the folklore of *Menjangan Wulung* [14] until the emergence of the *Pitu Adhan* and the *Babad Cirebon* it seems that this mosque had in the past been hit by a fire disaster. The inscription above can be interpreted differently, which is related to the process of repairing the mosque for nine months.

Based on the folklore and the *Babad* Cirebon, it can be concluded that GMSC has basically carried out renovations or improvements in the past.

Restoration or rebuilding can cause buildings to undergo changes, ending up not necessarily built like the original building. The community at that time was expected to learn from previous experience not to be repeated, for example the roof of the mosque was initially estimated as having been made from sago palm, then replaced with wood shingles. This restoration and rebuilding should be distinguished from the current restoration approach.

In 1549 the mosque was burned and subsequently repaired. This is contrary to the *Babad* Cirebon which states that the mosque caught fire in the era of the *Panembahan Ratu*. During the reign of *Panembahan Ratu I* (1568-1649) around the core building there was a porch. The south porch is called *Prabayaksa*, while the porch to the east consists of the foyer of *Panembahan Ratu I*; in 1679 *Sultan Sepuh I* with *Sultan Anom I* added a porch in front of the *Girilaya* portico so that on the east side there were three porches from different times. Furthermore, during the reign of *Sultan Sepuh XI* (1899-1942), with the help of J. Krijgman, a special foyer for a female congregation was added, called *pawestren*, located on the south side of the *Panembahan Ratu I*; the northernmost portico is also made together with this *pawestren*. [15]

The building of the Grand Mosque of *Sang Ciptarasa* (GMSC) is thought to show a change in the development of its construction. This building in the past should resemble the *Demak* Mosque with a *Tajug* roof. The GMSC building in the past in the form of a *Tajug* in layers such as the *Demak* Mosque was reinforced through the historical text KCR 04 [16]. According to KCR 04 and historical studies, it was thought in the past that there had been a fire in this mosque so that its form changed after being rebuilt or restored by the ruler at that time.

KCR 04 *Pucung* 02

The trial of the Cirebon *faqirs* was the burning of the GMSC on the top which was struck by lava fire coming from the south.

The above incident shows that there must have been a large fire at the mosque due to the launch Eruption lava stone in the south (Mount *Ciremai*?). Mount *Ciremai* as recorded in history once erupted in 1698 but quite possibly had erupted before. This eruption is thought to have caused the roof of GMSC to burn.

KCR 04 *Pucung* 10

They consulted to discuss the improvement of the Great Mosque, based on the agreement of the elders, then as a substitute for *Memolo*, the pyramid building would be made.

KCR 04 *Pucung* 11

But the shape of the pyramid as a substitute for *Memolo* will later be very different in shape to the results of *Memolo* in the *Waliyullah* era, the difference is very striking like the earth with the sky alone.

KCR 04 *Pucung* 12

Kanjeng Panembahan agrees with the substitute of *Memolo* to be transformed into a *Limasan*, even the mosque building was added with a porch or terrace surrounding the mosque.

KCR 04 *Pucung* 13

And on the door soft bricks are added so that they can be carved into the *mungal* and imitating parts in a beautiful carved lotus flower that grows without a lake.

KCR 04 *Pucung* 14

Also carving a heart without a banana that can (appear), that turned into *Bata Mungal Mangil Mungup*.

The text above shows that GMSC was originally built in the *Tajug* style like other mosques, but then natural disaster caused the roof to burn. The ruler subsequently tried to improve but did not use the *Tajug* roof but the hipped *Limasan* roof as can be observed until now. The shape of the hipped *Limasan* roof is different from the shape of a typical *Walisongo* mosque so that they are as different as chalk and cheese, from the centered *Tajug* roof to become *Limasan* which is not centered. During repairs or renovations, GMSC was then equipped with brick walls and *mihrab*. This phenomenon shows that in the past it was possible that the walls of the mosque were not made of brick. Bricks (*bata*) and the porch were new additions after the restoration carried out by the authorities at that time. The ruler in those days was thought to be *Panembahan Ratu*. The burning of this mosque is estimated to have occurred during the reign of *Panembahan Ratu*, so between 1568-1649.

To strengthen the proof that GMSC in the past the roof was pyramidal/*Tajug*, it could be assessed based on the pedestal pattern. Based on the position of *umpak* foundations it is quite possible that this mosque in the past had a *Tajug* roof. This can be proven by the distance between the columns in the position of columns $AB = CD = BD = AC$ in the same form as a square plan pattern. It can be assumed that ABCD are the main column (*saka guru*) like at the *Demak Mosque*. This pattern is the four main columns in the past that support the highest and most explicit *Tajug* roof. This roof is reminiscent of the shape of mosque roofs in general during that era, for example that of the *Demak Mosque*. The *Demak Mosque* was built at a time not far removed from GMSC so that the shape seems to be the same as the Grand Mosque of *Demak*.

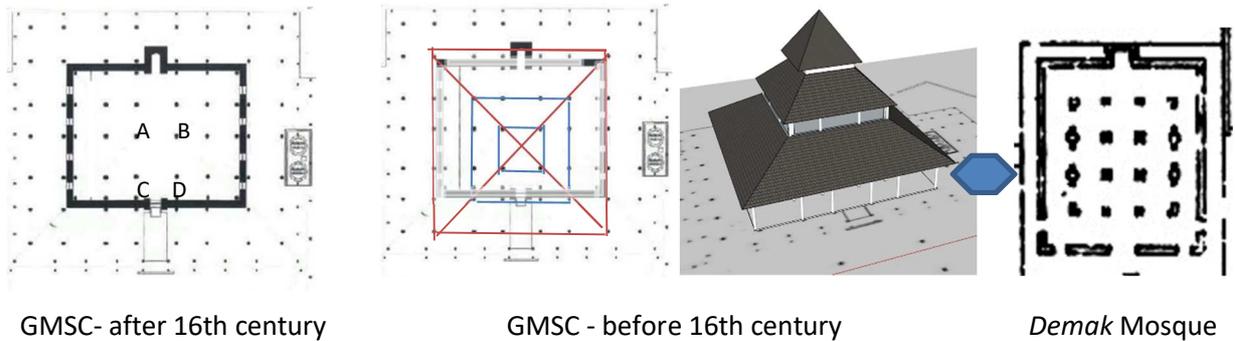


Fig.4: The Possibility the first shape of GMSC according to the *umpak* foundation position and before the brick wall was equipped later [17] [6]

The base of this swallow is not expected to be shifted from its position but the columns on it which are burned partially later are estimated to be reconnected with a newer column. In the mosque columns, there is a column connection. This connection indicates that there has been a rebuilding by maintaining the old one and then connecting the new one. As for the position of the foundation, it has indeed not changed. This could have been done to honor the old tradition of the *Wali* inheritance-styled Mosque or it could be for reasons of practicality and convenience, although later the roof shape was changed to a pyramidal one.

This roof change shows that the relationship between the columns and the roof does not reflect the roof tectonics commonly used for the hipped *Limasan*-shaped roofs. It can be seen that there is a position in the middle of the column that should not be necessary, given the construction of the *Limasan* roof is considerably supported by the edge columns. This shows that there must have been a transformation of forms from the pyramidal *Tajug* to the hipped *Limasan* but with an unchanging construction structure, making it look rather unique and experimental.

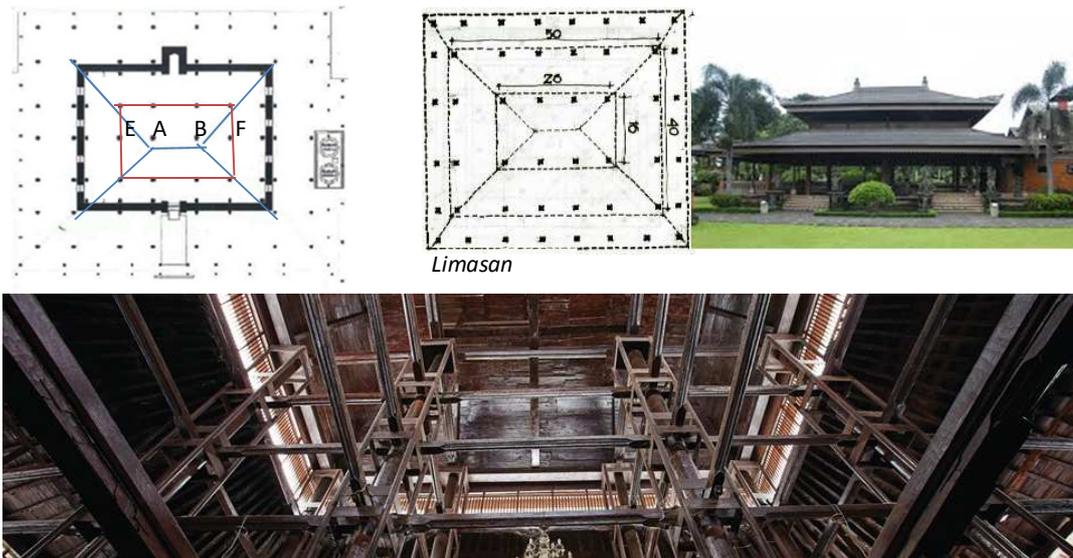


Fig.5: The column E,A,B,F in GMSC (left and below) are actually not needed to support the rooftop, if it follows the tectonic of *Limasan* roof (center-right) [17][18] [14][7]

The *Tajug* roof on the GMSC in the past was marked by the *Memolo* at its peak like other mosques. This *Tajug* roof is a roof centered with a pointed *Memolo* on top and the shape of the tiered *Memolo* like the one of Banten's Grand Mosque but quite unlike the *Memolo* observed at the Grand Mosque of *Demak*. This *Memolo* subsequently caught fire and was not replaced again. In addition, basically the shape of the roof of the mosque has changed from *Tajug* (*Memolo*) to *Limasan*.



Fig.6: The *Memolo* of Demak Mosque (left), *Memolo* of Banten Mosque (Center), roof GMSC (right) [9]

KCR 04 Durma 02

There is no terrace building that rotates to the right and left, also in front and behind it. Still limited to *Kutha*, with a *Memolo* made of tapered bronze.

KCR 04 Pucung 05

Then sped up the sharp *pataka* (*Memolo*) which had mixed with thick smoke into the sky, ...

KCR 04 Pucung 07

The one that was burning was the stump (*Memolo*) which was above, three steps stacked. Burned to dust.

The next GMSC construction is to follow the center of the *Tajug* roof and extend to the side to the very end of the pedestal foundation. This footing foundation is an old building boundary sign and it is estimated that there are columns surrounding the main column. After the roof was burned and restored so that it changed to the shape of the *Limasan* with the same construction and partial changes, then on the next construction then the surrounding terraces are added, as can be observed up to now.

The walls of this mosque were thought to have been made of wood in the past like other contemporary mosques. This wooden wall is a divider between the outer and inner boundaries or between areas that are sacred and profane. This wall looks attractive in the context of mosque architecture in Cirebon. When compared with mosques, which are about the same age in Cirebon as the *Panjunan*, it can be recognized that the mosque's facade wall was built not correlated with the arrangement of the columns in place, so that the wall becomes detached and there is no connection with the construction on it like a roof. This wall is more like the dividing wall of the curtain /partition or *gebyok* in Javanese architecture and does not function to support the construction above it, neither is it connected with the columns around it.

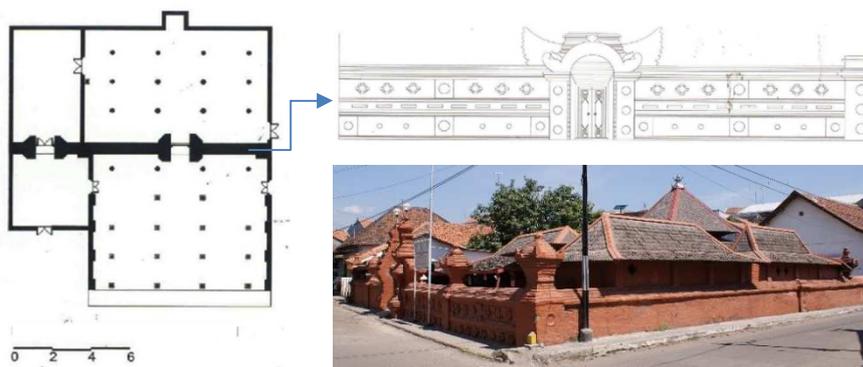


Fig.7: The *Panjunan* Mosque, plan and wall-partition [14] [17]

On the front floor there is a basin which is thought to have been a pool of water in the past. This pool is not deep and is generally built in the facade area. This pool is an area so that everyone entering the mosque must pass through this shallow pool while cleaning their feet. Thus, people who enter must clean their legs by way of ritual/sacred ablution. The existence of a pool basin in front of the door shows that in the past the door of the mosque's main mosque was only one, namely in the front, every person who entered would have waded through this shallow pool.

The building that is now known as the main door is only one in front but is reinforced with other smaller doors so that the number to be 9. This number can be interpreted as the number of the *Wali Songo*/Guardians of the Islamic Faith, namely 9 or the number of holes in the human body (*hawa songo*) associated with the concept of self-control, or otherwise as a number that is respected in the Indonesian tradition because it is considered the highest number.

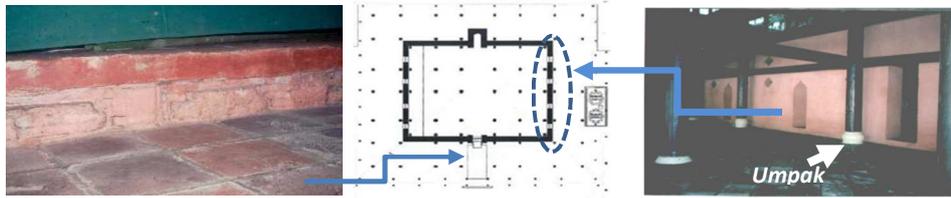


Fig.8: Basin, Doors, *Umpak* foundation in GMSC [17] [14]

The GMSC which is seen at the present time is the development of the next construction phase that began in the 16th century due to fire. Restoration in the next era until modern times follow the pattern of forms of improvement after this mosque had experienced a fire in the 16th century. Based on the structure of the *Umpak* foundation and the distance between the columns it is possible that initially this mosque indeed had a *Tajug* roof as well as a *Memolo*. Its *Memolo* is synonymous with the Grand Mosque of Banten. This roof then turns into a pyramid shape as it was rebuilt. The reason for this change into the pyramidal shape is not clearly explained, so it can be interpreted that other thoughts have occurred. According to KCR 04 *Pucung*: 12, *Kanjeng Panembahan* agreed that the replacement of the *Memolo* would be transformed into a *Limasan*, and even the mosque building was expanded with a porch or terrace surrounding the mosque. The shape of the rectangular hipped *Limasan* roof was then followed by the construction of a brick wall that follows a rectangular-shaped floor plan that strengthens the pattern of the roof-shaped space. It is not clearly explained why the form of the pyramid was approved, even though the sacred forms are identical with *Tajug*, and not the *Limasan* type. This phenomenon leads to the conclusion that the pyramid-shaped roof in that era was still considered common for sacred buildings, identical to the Balinese *Wantilan* which may also occur in the form of a *Limasan*.

On the other hand, the relationship between the columns and the roof is unusual, namely in the middle there is a lined column supporting *wuwungan* which has never been found in pyramid-shaped buildings. Older *Limasan* buildings such as *Wantilan* are never supported by columns. Thus, the restoration of GMSC in the 16th century was still maintaining the position of the base of the pedestals and columns even though the roof changed completely to the pyramidal shape. The arrangement of the overlapping roof was still maintained, even though it turned into a pyramid. Maintaining the position of the column and stacked roof was an attempt to honor the inheritance of the previous trustees. Maintaining the position of the pedestal foundation against the site and the pattern of a stacked roof appear to be very important compared to the figure of the body. Reading this transformation of GMSC shows that in the 16th century there were initiatives for improvement or renewal, but his enthusiasm remained in dialogue with what had preceded it, namely in the form of column positions and forms of overlapping. The position of the column and the shape of a stacked roof are considered to have played a very important role in the development of subsequent designs, although the body and shape of the roof underwent change.

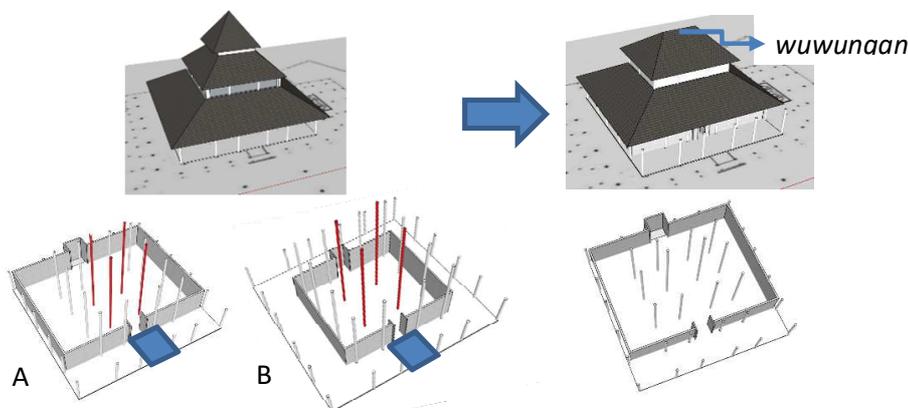


Fig.9: Architectonic Transformation at GMSC, tiered *Tajug* to *Limasan* and formation possibilities of the early wall (A or B) with basin before brick wall equipped later [17]

4. Conclusion

GMSC's development demonstrates the dynamism of design thinking in response to problems that arose at that time, being not rigid but flexible so that changes and additions are possible even though there are still elements that were obviously maintained. GMSC initially had a *Tajug* roof like other mosques, but changes into the *Limasan* shape showed a certain creativity in thought patterns or expanding ideas in that era. This phenomenon makes GMSC distinctive and markedly different in character from other mosques, such as the *Demak* and *Mataram* mosques, but still holding a dialogue with the past. The *Limasan* form is not easily interpreted directly with feminine nature. Grand Mosque of Sang Ciptarasa does indeed show an architectonic transformation, but the reason for this change from *Tajug* to *Limasan* is indeed still open to various further interpretations.

Acknowledgements

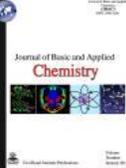
The author thanks to LPPM Parahyangan Catholic University (Unpar), and Faculty of Engineering, Architecture Department, Unpar, for their financial support to this research.

REFERENCES

- [1] Ismunandar R, Joglo, *Arsitektur Rumah Tradisional Jawa*, Semarang, Dahara Prize, 2009
- [2] Prajudi, Rahadhian, H, Meru, *Jurnal Tatanan*, Fakultas Teknik Jurusan Arsitektur Unpar, 2001
- [3] Frishman, Martin & Hasan-Uddin Khan, Eds, *The Mosque: History, Architectural Development & Regional Diversity*, Published by Thames & Hudson, 2002
- [4] Dumarcay, Jacques, *La Charpenterie des mosques Javanaises*, *Archipel* 30, Paris., 1985
- [5] Santosa, Revianto, *Atap Masjid dan Ruang*, Bandung, *Simposium Nasional Ekspresi Islami dalam Arsitektur di Nusantara*, 1997
- [6] Ismudiyanto & Parmono Atmadi, *Demak, Kudus, and Jepara Mosque: A Study of Architectural Syncretism*, Yogyakarta, Gadjah Mada University. 1987
- [7] <http://perwakilan.baliprov.go.id/anjungan-daerah-bali-tmii/wantilan/> accessed June 2019
- [8] <https://en.wikipedia.org/wiki/Wantilan>, accessed June 2019
- [9] Prajudi, Rahadhian, H, *Kajian Tipo-Morfologi Arsitektur Candi di Jawa*, Thesis, Arsitektur Institut Teknologi Bandung, Bandung, 1999.
- [10] Narliswandi dkk, *Masjid – Masjid Bersejarah di Indonesia*, Jakarta, PT. Potlot Nasional, 1994
- [11] Mandiri, Yanuar, *Ekspresi Majapahit dalam Ornamen Bangunan Masjid Sang Cipta Rasa Cirebon*, Prosiding Seminar Heritage IPLBI 2017 | A 117, 2017
- [12] Muffid, Mudofar, Bambang Supriadi, R.Siti Rukayah, *Konsep Arsitektur Jawa dan Sunda pada Masjid Agung Sang Ciptarasa Cirebon*, ISSN 0853 2877, Jurnal Modul vol 14 no 2 Juli-Desember, 2014
- [13] <http://sc.syekhnurjati.ac.id/esscamp/risetmhs/BAB214105110012.pdf>, accessed June 2019
- [14] Setiabudi Bambang, *Masjid Kuno Cirebon*, Ikatan Peneliti Lingkungan Binaan, 2015
- [15] Alamsyah, Suwardi, *Nilai Budaya Arsitektur Masjid Sang Ciptarasa Cirebon Provinsi Jawa Barat*, Patanjala Vol. 2, No. 2, Juni 2010: 172 – 190 Balai Pelestarian Sejarah dan Nilai Tradisional Bandung, 2010
- [16] Irianto, Bambang, *Sejarah Cirebon, Naskah Keraton Kacirebonan, Alih Aksara dan Bahasa Teks KCR 04*, Rumah Budaya Nusantara Pesambangan Jati Cirebon, 2013
- [17] Prajudi, Rahadhian H, *Penelitian Cirebon*, 2019
- [18] <https://alif.id/read/hamzah-sahal/masjid-agung-sang-cipta-rasa-monumen-penghormatan-pada-tradisi-b219272p/> accessed June 2019



Home Journals Instructions to Authors **Manuscript Submission** Join Us Contact Us

	Journal of Basic and Applied Scientific Research		Journal of Social Sciences and Humanity Studies
	Journal of Basic and Applied Chemistry		Journal of Basic Sciences and Applied Research
	Journal of Applied Environmental and Biological Sciences		Journal of Computer Sciences and Communication
	Journal of Pharmaceutical and Biomedical Sciences		Journal of Engineering and Higher Technology
	Journal of Agriculture and Food Technology		Current Economics and Management Research

The screenshot shows the website header with the TEXTROAD logo and navigation links. The main content area features the journal title and a search bar. A sidebar menu includes links to Journals, Instructions to Authors, Submit Article, Join Us, Contact Us, and Open Access. Below the menu are three boxes labeled Mission, Vision, and Goals, each containing a brief description of the journal's objectives and goals.

INSTRUCTION TO AUTHORS

Manuscript Submission:

Send your manuscript with attachment by mailing it to info@textroad.com, textroadjournals@gmail.com along with [covering letter](#).

Manuscript Preparation:

- * Title
- * Author names and addresses
- * Abstracts (Not more than 300 words)
- * Key words
- * Introduction
- * Materials and Methods
- * Results and Discussions
- * References (Use numbering in the text instead of full references).
Give full references at the end of the file
- * Photographs should be of high quality (Minimum 300-600 dpi)
- * Graphs should be in clearly visible form so that it may become easy to redraw
- * The manuscript must be submitted in MS-WORD file format.

INSTRUCTIONS TO AUTHORS

Submission

Submit manuscripts as e-mail attachment to the Editorial Office at:

textroadjournals@gmail.com or info@textroad.com along with [covering letter](#). A manuscript number will be mailed to the corresponding author same day or within 48 hours. The authors may also suggest two to four reviewers for the manuscript (JBASR may designate other reviewers). There is no page limit. The submitting author takes responsibility for the paper during submission and peer review.

Terms of Submission

Papers must be submitted on the understanding that they have not been published elsewhere (except in the form of an abstract or as part of a published lecture, review, or thesis) and are not currently under consideration by another journal. The submitting author is responsible for ensuring that the article's publication has been approved by all the other coauthors. All enquiries concerning the publication of accepted papers should be addressed to editor@textroad.com.

Review Process

All manuscripts are reviewed by an editor and members of the Editorial Board or qualified outside reviewers. Decisions will be made as rapidly as possible, and the journal strives to return reviewers' comments to authors within one or two weeks. The editorial board will re-review manuscripts that are accepted pending revision. It is the goal of the JBASR to publish manuscripts within 4 weeks after submission.

Style of Manuscripts

Manuscripts should be written in clear, concise and grammatically correct English (with 10 font size and Times New Roman font style) so that they are intelligible to the professional reader who is not a specialist in any particular field. Manuscripts that do not conform to these requirements and the following manuscript format may be returned to the author prior to review for correction. The entire manuscript, including references, should be typed single spaced on one side of the paper. All pages should be numbered consecutively in the bottom centre starting from the title page. The manuscript should be presented in the following order.

Title and Authorship Information

The title should be a brief phrase (capitalize first letter of each word in the title) describing the contents of the paper. The Title Page should include the authors' full names and affiliations, the name of the corresponding author along with phone, fax and E-mail information. Present addresses of authors should appear as a footnote.

Abstract

All manuscripts should not exceed 250-300 words and should describe the scope, hypothesis or rationale for the work and the main findings. Complete sentences, active verbs, and the abstract should be written in the past tense. Standard nomenclature should be used and abbreviations should be avoided. No literature should be cited.

Keywords

Key words (5-7 words) should be provided below the Abstract to assist with indexing of the article. These should not duplicate key words from the title.

Introduction

This section should include sufficient background information, provide a clear statement of the problem, the relevant literature on the subject, and the proposed approach or solution. The aims of the manuscript should be clearly stated. The introduction should not contain either findings or conclusions. It should be understandable to colleagues from a broad range of scientific disciplines.

Materials and Methods

This should be complete enough to provide sufficient detail to allow the work to be repeated by others. However, only truly new procedures should be described in detail; previously published procedures should be cited, and important modifications of published procedures should be mentioned briefly. Capitalize trade names and include the manufacturer's name and address. Subheadings should be used. Methods in general use need not be described in detail.

Results

Results should be presented in a logical sequence in the text, tables and figures; repetitive presentation of the same data in different forms should be avoided. The results should not contain material appropriate to the Discussion. It should be written in the past tense when describing findings in the authors' experiments. Results should be explained, but largely without referring to the literature.

Discussion

The discussion should consider the results in relation to any hypotheses advanced in the Introduction and place the study in the context of other work. Results and Discussion sections can be combined.

Conclusions

If an optional conclusion section is used, its content should not substantially duplicate the abstract.

Acknowledgment

The acknowledgments of people, grants, funds, etc should be brief.

References

Bibliographic references in the text appear like [1, 2, 5, 6], using square brace in superscript. References should be numbered consecutively, with style:

Journal paper:

1. Hadjibabaie, M., N. Rastkari, A.Rezaie and M. Abdollahi, 2005. The Adverse Drug Reaction in the Gastrointestinal Tract: An Overview. *Intl. J. Pharmacol.*, 1 (1): 1-8.

Books:

1. Daniel A. Potter, 2002. Destructive turfgrass insects: Biology, diagnosis and control. Wiley Canada Publishers, pp: 24-67.

Chapters in Book:

1. Bray R.A., 1994. The leucaena psyllid. In: Forage Tree Legumes in Tropical Agriculture (eds R.C. Gutteridge and H.M. Shelton) pp. 283–291. CAB International, Oxford.

Titles of journals should be given in full. 'In press' can only be used to cite manuscripts actually accepted for publication in a journal. Citations such as 'manuscript in preparation' or 'manuscript submitted' are not permitted. Data from such manuscripts can only be mentioned in the text as 'unpublished data'.

A Report:

1. Makarewicz, J.C., T. Lewis and P. Bertram, 1995. Epilimnetic phytoplankton and zooplankton biomass and species composition in Lake Michigan, 1983-1992. U.S. EPA Great Lakes National Program, Chicago, IL. EPA 905-R-95-009.

Conference Proceedings:

1. Stock, A., 2004. Signal Transduction in Bacteria. In the Proceedings of the 2004 Markey Scholars Conference, pp: 80-89.

A Thesis:

1. Strunk, J.L., 1991. The extraction of mercury from sediment and the geochemical partitioning of mercury in sediments from Lake Superior, M. S. thesis, Michigan State Univ., East Lansing, MI.

Tables and Equations

Tables and equations should not be submitted in a format exceeding the A4 page size (in portrait form). **All tables should be embedded within the manuscript, and must be captioned and numbered sequentially.** Each table should be on a separate page, numbered consecutively in Arabic numerals and supplied with a heading and a legend. Tables should be self-explanatory without reference to the text.

Figures / Illustrations / Photographs

Graphics should be supplied as high resolution (at least 300-600 dp.i.) electronic files. Digital images supplied only as low-resolution print-outs cannot be used. Graphs, diagrams, chromatograms, photos, etc. should be prepared as clear, original positives, suitable for reproduction. **All figures should be embedded within the manuscript, and must be captioned and numbered sequentially.**

Proofs

Proofs will be sent via e-mail as an Acrobat PDF file (e-mail attachment) and should be returned within 3 days of receipt. Page proofs are considered to be the final version of the manuscript. With the exception of typographical or minor clerical errors, no changes will be made in the manuscript at the proof stage.

Check List

We recommend that you ask a colleague to read over your paper prior to submission to ensure it is of a high standard and conforms to a high level of scientific writing.

Before submission of your manuscript, please check that:

- All references cited in the text are included in the reference section.
- All figures and tables are cited in the text.
- Figures are at least 300 d.p.i.
- The pages are numbered.