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Energy efficiency in aeration systems for aquaculture ponds: a comprehensive review

Efisiensi energi dalam sistem aerasi untuk kolam budidaya: sebuah reviu komprehensif

Jurnal Riset Akuakultur, 20(1), 2025, 1-25

Aeration is a critical component in aquaculture systems to ensure optimal dissolved oxygen levels for aquatic organisms. However, aeration is also one of the most energy-intensive processes. This review critically analyzes energy efficiency strategies in aeration systems, highlighting technological advances and sustainable implementation practices analyzed using a systematic literature review approach, with inclusion criteria based on relevance to energy use, oxygenation performance, and real-world applications. The study identifies and compares different types of aeration technologies, including paddle wheel aerators, diffused air systems, venturi injectors, and renewable energy aerators in terms of energy efficiency and oxygenation effectiveness. In addition, the study explores key factors that influence aeration efficiency, such as pond design, automation, and integration of renewable energy sources, such as solar and wind, to power the aeration system. This paper extends previous literature by proposing a comprehensive framework that integrates digital technologies (e.g., sensor-based control systems and automation) with renewable energy sources to optimize aeration efficiency. The review offers a holistic approach that combines the evaluation of individual technologies or energy sources. The findings show that sensor-based automation can reduce energy consumption by up to 40%, and the integration of renewable energy significantly lowers long-term operating costs. Real-world applications of these strategies in aquaculture operations are also discussed, demonstrating both economic and environmental benefits in simple terms.

KEYWORDS: aeration; aquaculture; automation technology; energy efficiency; renewable energy

Aerasi merupakan komponen penting dalam sistem akuakultur untuk memastikan kadar oksigen terlarut yang optimal bagi organisme akuatik. Akan tetapi, aerasi juga merupakan salah satu proses yang paling boros energi. Tinjauan ini menganalisis secara kritis strategi efisiensi energi dalam sistem aerasi, menyoroti kemajuan teknologi dan praktik implementasi berkelanjutan yang dianalisis menggunakan pendekatan tinjauan pustaka sistematis, dengan kriteria inklusi berdasarkan relevansi terhadap penggunaan energi, kinerja oksigenasi, dan penerapan di dunia nyata. Studi ini mengidentifikasi dan membandingkan berbagai jenis teknologi aerasi, termasuk aerator roda dayung, sistem udara terdifusi, injektor venturi, dan aerator energi terbarukan dalam hal efisiensi energi dan efektivitas oksigenasi. Selain itu, studi ini mengeksplorasi faktor-faktor utama yang memengaruhi efisiensi aerasi, seperti desain kolam, otomatisasi, dan integrasi sumber energi terbarukan, seperti tenaga surya dan angin, untuk memberi daya pada sistem aerasi. Makalah ini memperluas literatur sebelumnya dengan mengusulkan kerangka kerja komprehensif yang mengintegrasikan teknologi digital (misalnya, sistem kontrol berbasis sensor dan otomatisasi) dengan sumber energi terbarukan untuk mengoptimalkan efisiensi aerasi. Tinjauan ini menawarkan pendekatan holistik yang menggabungkan evaluasi teknologi individual atau sumber energi. Temuan tersebut menunjukkan bahwa otomatisasi berbasis sensor dapat mengurangi konsumsi energi hingga 40%, dan integrasi energi terbarukan secara signifikan menurunkan biaya operasi jangka panjang. Aplikasi nyata dari strategi ini dalam operasi akuakultur juga dibahas, yang menunjukkan manfaat ekonomi dan lingkungan secara sederhana.

KATA KUNCI: aerasi; akuakultur; efisiensi energi; energi terbarukan; teknologi otomatisasi

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Improved design and accuracy of real-time water quality and filtering systems for application in IoT-based aquaculture

Desain dan konstruksi alat penyaringan dan pemantauan kualitas air pada sistem budidaya perikanan berbasis IoT

Jurnal Riset Akuakultur, 20(1), 2025, 27-47

Maintaining optimal water quality is essential in fish farming, as fluctuations in key parameters, such as pH, turbidity, and dissolved compounds, can lead to stress, disease, and even fish death. This study aimed to design and develop an Internet of Things (IoT)-based water quality monitoring and filtration system that can operate in real-time to support the sustainability of aquaculture. This system integrated pH, turbidity, total dissolved solids (TDS), and ultrasonic sensors with Arduino Uno and ESP32 microcontrollers. Sensor data was transmitted in real-time to an Android application, which displayed it on an LCD, allowing users to monitor water quality and receive alerts when parameters deviated from optimal thresholds. The test results demonstrated a high level of sensor accuracy, specifically 96.51% for pH, 98.19% for TDS, and 97.03% for turbidity, as determined through comparisons with laboratory equipment, commercial devices, and manual measurements. The effectiveness of the filtration system was also proven to be significant: turbidity was reduced by an average of 58.87%, TDS decreased by 26.80%, and pH values became more stable within the optimal range for aquaculture with an improvement of 7.3%. This system was able to maintain the variation of the main water quality parameters within the ranges for raw and drinking water stipulated in Indonesian Government Regulation No. 22 of 2021 and Regulation of the Minister of Health No. 492 of 2010. This improved design is arguably more efficient than conventional methods because it reduces the need for labor and provides early warning of changes in water quality.

KEYWORDS: automatic monitoring; fish farming; IoT; water filtration; water quality

Menjaga kualitas air yang optimal sangat penting dalam budidaya ikan, karena fluktuasi parameter utama seperti pH, kekeruhan, dan kandungan zat terlarut dapat menyebabkan stres, penyakit, hingga kematian pada ikan. Penelitian ini bertujuan untuk merancang dan mengembangkan sistem pemantauan dan penyaringan kualitas air berbasis internet of things (IoT) yang dapat beroperasi secara real-time untuk mendukung keberlanjutan akuakultur. Sistem ini mengintegrasikan sensor pH, turbiditas, total dissolved solids (TDS), dan sensor ultrasonik dengan mikrokontroler Arduino Uno dan ESP32. Data sensor ditransmisikan secara real-time ke aplikasi Android dan ditampilkan melalui LCD, memungkinkan pengguna memantau kualitas air dan menerima peringatan ketika parameter menyimpang dari ambang batas optimal. Hasil pengujian menunjukkan tingkat akurasi sensor yang tinggi, yaitu 96,51% untuk pH, 98,19% untuk TDS, dan 97,03% untuk kekeruhan, berdasarkan perbandingan dengan alat laboratorium, perangkat komersial, dan pengukuran manual. Efektivitas sistem filtrasi juga terbukti signifikan: kekeruhan berkurang rata-rata 58,87%, TDS menurun sebesar 26,80%, dan nilai pH menjadi lebih stabil dalam kisaran optimal untuk akuakultur dengan perbaikan sebesar 7.3%. Sistem ini telah memenuhi ketentuan Peraturan Pemerintah No. 22 Tahun 2021 dan Peraturan Menteri Kesehatan No. 492 Tahun 2010 untuk kualitas air baku dan minum. Sistem ini terbukti lebih efisien dibanding metode konvensional karena mengurangi kebutuhan tenaga kerja dan memberikan peringatan dini terhadap perubahan kualitas air.

KATA KUNCI: budidaya perikanan; filtrasi air; IoT; kualitas air; pemantauan otomatis

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Growth performance of whiteleg shrimp (*Litopenaeus vannamei*) at different stocking densities in a polyculture system with sea grape (*Caulerpa* sp.)

*Performa pertumbuhan udang vaname (**Litopenaeus vannamei**) pada padat tebar yang berbeda dalam sistem polikultur dengan anggur laut (**Caulerpa** sp.)*

Jurnal Riset Akuakultur, 20(1), 2025, 49-62

This study evaluated the growth performance, survival rate, and water quality improvement in a polyculture system integrating whiteleg shrimp (*Litopenaeus vannamei*) and sea grapes (*Caulerpa* sp.) with different shrimp stocking densities. This study employed a completely randomized design with three treatments, each at three levels of shrimp densities (15, 30, and 45 individuals per tank with a capacity of 0.06 m^3), integrated with sea grape (50 g) for 60 days. During maintenance, shrimp were fed commercial feed, and no water changes were performed. The results showed that the highest shrimp growth and survival were obtained at a density of 15 individuals per tank, with growth rates of 6.54% day^{-1} and survival rates of 98% for the shrimp, resulting in optimal growth in *Caulerpa* sp. In contrast, a higher stocking density (45 individuals per tank) was associated with lower observed growth and survival rate of whiteleg shrimp throughout the culture period. Water quality showed favourable conditions for both, with pH levels (6.5–9.4), dissolved oxygen concentrations (5.0–8.2 mg $L^{-1)}$, and temperatures (26–38°C) within the optimal range. The polyculture system facilitated nutrient recycling, where shrimp waste was utilized by *Caulerpa* sp., effectively reducing nitrate and phosphate concentrations and preventing eutrophication in all treatments with increased stocking density. The conclusion of this study highlighted the potential of the polyculture system to improve ecological balance and productivity in aquaculture. Lower shrimp stocking densities resulted in high growth and survival, while integrating *Caulerpa* sp. contributed to environmental sustainability.

KEYWORDS: *Caulerpa* sp.; growth; *Litopenaeus vannamei*; polyculture

*Penelitian ini mengevaluasi performa pertumbuhan, tingkat kelangsungan hidup, dan perbaikan kualitas air dalam sistem polikultur yang mengintegrasikan udang vaname (**Litopenaeus vannamei**) dan anggur laut (**Caulerpa** sp.) dengan kepadatan tebar udang yang berbeda. Penelitian ini menggunakan rancangan acak lengkap dengan tiga perlakuan, yaitu tiga tingkat kepadatan udang (15, 30, dan 45 ekor per wadah berkapasitas 0,06 m^3), masing-masing diintegrasikan dengan anggur laut (50 g) selama 60 hari. Selama pemeliharaan, udang diberi pakan komersial dan tidak dilakukan pergantian air. Hasil penelitian menunjukkan bahwa pertumbuhan dan kelangsungan hidup udang tertinggi diperoleh pada kepadatan 15 ekor per wadah, masing-masing sebesar 6,54% per hari dan 98%, serta menghasilkan pertumbuhan **Caulerpa** sp. yang optimal. Sebaliknya, kepadatan tebar yang lebih tinggi (45 ekor per wadah) menghasilkan pertumbuhan dan tingkat kelangsungan hidup udang vaname yang lebih rendah selama masa pemeliharaan. Kualitas air menunjukkan kondisi yang mendukung untuk keduanya, dengan pH (6,5–9,4), oksigen terlarut (5,0–8,2 mg $L^{-}1$), dan suhu (26–38°C) berada dalam kisaran optimal. Sistem polikultur ini memfasilitasi daur ulang nutrien, di mana limbah udang dimanfaatkan oleh **Caulerpa** sp., secara efektif mengurangi konsentrasi nitrat dan fosfat serta mencegah eutrofikasi pada semua perlakuan, bahkan dengan peningkatan kepadatan tebar. Kesimpulan dari penelitian ini menyoroti potensi sistem polikultur dalam meningkatkan keseimbangan ekologis dan produktivitas di bidang akuakultur. Kepadatan tebar udang yang rendah menghasilkan pertumbuhan dan kelangsungan hidup yang tinggi, sementara integrasi dengan **Caulerpa** sp. berkontribusi terhadap keberlanjutan lingkungan.*

KATA KUNCI: Caulerpa sp.; Litopenaeus vannamei; pertumbuhan; polikultur

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Hubungan kelimpahan mikroplastik dengan kerusakan histopatologis pada insang dan usus udang vaname (*Litopenaeus vannamei*) yang dibudidayakan di tambak di Probolinggo, Jawa Timur, Indonesia

*Correlation between microplastic abundance and histopathological damage in gills and intestines of Whiteleg Shrimp (**Litopenaeus vannamei**) cultivated in ponds in Probolinggo, East Java, Indonesia*

Jurnal Riset Akuakultur, 20(1), 2025, 63-77

Peningkatan kontaminasi mikroplastik di lingkungan tambak menjadi ancaman serius bagi kesehatan udang vaname (*Litopenaeus vannamei*). Penelitian ini bertujuan untuk menganalisis hubungan antara kelimpahan mikroplastik pada insang dan usus dengan tingkat kerusakan histopatologis udang vaname yang dibudidayakan di tambak yang berlokasi di Probolinggo, Jawa Timur, Indonesia. Penelitian dilakukan secara deskriptif kuantitatif menggunakan analisis korelasi Spearman. Sampel udang diambil dari tiga lokasi tambak dan dianalisis secara histologis untuk menilai skor kerusakan jaringan. Hasil menunjukkan korelasi sangat kuat dan signifikan antara kelimpahan mikroplastik dengan skor kerusakan insang (r = 0,815; p-value = 0,007), degenerasi usus (r = 0,885; p-value = 0,002), nekrosis (r = 0,804; p-value = 0,009), dan inflamasi (r = 0,688; p-value = 0,041). Temuan ini menunjukkan bahwa mikroplastik berkontribusi besar terhadap kerusakan struktural organ respirasi dan pencernaan udang. Penelitian ini menegaskan pentingnya pengelolaan pencemaran mikroplastik dalam sistem budidaya berkelanjutan.

KATA KUNCI: histopatologi; insang; *Litopenaeus vannamei*; mikroplastik; usus

*The increasing presence of microplastic contamination in shrimp ponds poses a serious threat to the health of whiteleg shrimp (**Litopenaeus vannamei**). This study aimed to analyze the relationship between microplastic abundance in gills and intestines with the level of histopathological damage in whiteleg shrimp cultivated in ponds located in Probolinggo, East Java, Indonesia. A quantitative descriptive method was used with Spearman correlation analysis. Shrimp samples were collected from three pond locations and histologically examined to assess tissue damage scores. The results showed a very strong and significant correlation between microplastics abundance and gill damage (r = 0.815; p-value = 0.007), intestinal degeneration (r = 0.885; p-value = 0.002), necrosis (r = 0.804; p-value = 0.009), and inflammation (r = 0.688; p-value = 0.041). These findings indicated that microplastics significantly contribute to structural damage in the respiratory and digestive organs of shrimp. This study highlighted the importance of effectively managing microplastic pollution in sustainable aquaculture systems.*

*KEYWORDS: gills; histopathology; intestines; microplastic; **Litopenaeus vannamei***

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The influence of wonton (*Sterculia shillinglawii*) leaves meal supplementation on the growth and digestibility performances of tilapia (*Oreochromis niloticus*) juveniles

*Pengaruh suplementasi tepung daun Woton (**Sterculia shillinglawii**) terhadap kinerja pertumbuhan dan kecernaan juvenil ikan nila (**Oreochromis niloticus**)*

Jurnal Riset Akuakultur, 20(1), 2025, 79-87

This study aimed to evaluate the effect of Woton (*Sterculia shillinglawii*) leaves meal supplementation on the growth performance and digestibility of tilapia (*Oreochromis niloticus*) juveniles. The treatments consisted of Woton leaves meal at inclusion levels of 0% (A), 5% (B), 10% (C), 15% (D), and 20% (E), with each treatment replicated three times. The observed parameters included average daily growth (ADG), average body weight (ABW), growth rate (GR), specific growth rate (SGR), survival rate (SR), feed conversion ratio (FCR), and feed efficiency (FE), as well as protein digestibility and total digestibility. Analysis of variance showed no significant differences in ADG, ABW, GR, and SR among the treatments. However, Treatment B recorded a relatively higher SGR (2.73 ± 0.44% day^{-1}) compared to the other treatments ($P < 0.05$). The analysis of digestibility revealed significant differences. Treatment C (15% inclusion level) resulted in the highest protein digestibility (99.39 ± 0.02%) and total digestibility (99.37 ± 0.01%), while a lower FCR (1.76 ± 0.24) and a higher FE (57.59 ± 7.85%) were found in Treatment B ($P<0.05$). This study highlighted that despite Woton leaves meal improving fish digestibility and feed efficiency, its supplementation in fish feed should be limited to 5-10% due to the adverse effects of its flavonoid compounds.

KEYWORDS: digestibility; growth; tilapia; Woton leaves

*Penelitian ini bertujuan untuk mengevaluasi pengaruh suplementasi tepung daun Woton (**Sterculia shillinglawii**) terhadap kinerja pertumbuhan dan kecernaan juvenil ikan nila (Oreochromis niloticus). Perlakuan terdiri atas tepung daun Woton pada tingkat inklusi 0% (A), 5% (B), 10% (C), 15% (D), dan 20% (E), dengan setiap perlakuan diulang tiga kali. Parameter yang diamati meliputi rata-rata pertumbuhan harian (RPH), rata-rata bobot tubuh (RBT), laju pertumbuhan (LP), laju pertumbuhan spesifik (LPS), tingkat kelangsungan hidup (TKH), rasio konversi pakan (RKP), dan efisiensi pakan (EP) serta kecernaan protein dan kecernaan total. Analisis varians tidak menunjukkan perbedaan yang signifikan pada RPH, RBT, LP, dan TKH di antara perlakuan. Namun, Perlakuan B menunjukkan LPS yang relatif lebih tinggi (2,73 ± 0,44% hari^{-1}) dibanding dengan perlakuan lainnya ($P<0,05$). Analisis kecernaan mengungkapkan perbedaan yang signifikan. Perlakuan C (tingkat inklusi 15%) menghasilkan kecernaan protein tertinggi (99,39 ± 0,02%) dan kecernaan total tertinggi (99,37 ± 0,01%), sedangkan RKP yang lebih rendah (1,76 ± 0,24) dan EP yang lebih tinggi (57,59 ± 7,85%) ditemukan pada Perlakuan B ($P<0,05$). Penelitian ini menunjukkan bahwa meskipun tepung daun Woton meningkatkan kecernaan dan efisiensi pakan ikan, suplementasinya pada pakan ikan sebaiknya dibatasi hingga 5-10% karena dampak negatif senyawa flavonoid yang dikandungnya.*

KATA KUNCI: daun Woton; ikan nila; kecernaan; pertumbuhan

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Pengaruh penambahan serbuk kunyit dan temulawak pada media kultur terhadap peningkatan kualitas cacing sutera (*Tubifex* sp.)

*Enhancing silkworm (**Tubifex** sp.) quality through turmeric and Javanese turmeric powder supplementation in culture media*

Jurnal Riset Akuakultur, 20(1), 2025, 89-101

Cacing sutera (*Tubifex* sp.) merupakan organisme akuatik yang memiliki peran strategis dalam sektor akuakultur sebagai pakan alami bagi ikan. Kualitas organisme ini sangat memengaruhi efektivitas budidaya. Penelitian ini bertujuan untuk mengkaji pengaruh penambahan serbuk kunyit (*Curcuma longa*) dan temulawak (*Curcuma xanthorrhiza*) dalam pakan terhadap produktivitas dan kualitas *Tubifex* sp. Penelitian dilakukan secara eksperimental menggunakan rancangan acak lengkap (RAL) dengan empat perlakuan: P0 (tanpa tambahan), P1 (2,5 g kunyit + 7,5 g temulawak), P2 (5 g kunyit + 5 g temulawak), dan P3 (7,5 g kunyit + 2,5 g temulawak), masing-masing per 100 g pakan. Pemberian pakan dilakukan setiap 3 hari sebanyak 1140 g m^{-2} selama 21 hari. Data dianalisis menggunakan ANOVA dan uji Duncan. Hasil menunjukkan bahwa suplementasi serbuk kunyit dan temulawak secara signifikan meningkatkan pertumbuhan bobot dan produktivitas *Tubifex* sp., dengan P2 memberikan hasil terbaik (317,54 ± 13,16 g dan 2646,18 ± 109,74 g m^{-2} $siklus^{-1}$) ($P<0,05$). Penyerapan kurkumin tertinggi tercatat pada P2 sebesar 44,32 ± 11,30 mg kg^{-1} ($P<0,05$). Uji mikrobiologis menunjukkan bahwa semua perlakuan bebas dari kontaminasi *Salmonella* sp. dan *Escherichia coli*. Penelitian ini mengindikasikan bahwa penambahan serbuk kunyit dan temulawak dalam pakan dapat meningkatkan mutu dan keamanan *Tubifex* sp. dalam budidaya.

KATA KUNCI: biomassa; *Curcuma longa*; *Curcuma xanthorrhiza*; produktivitas; *Tubifex* sp.

*Culturing Silkworms (**Tubifex** sp.) as a highly nutritious natural feed for farmed fish has been limited due to reliance on wild supply and limitation on reliable growth medium. This study aimed to assess the effects of addition of turmeric (**Curcuma longa**) and Javanese turmeric (**Curcuma xanthorrhiza**) powders in culture media on the productivity and quality of **Tubifex** sp. The study was conducted experimentally using a completely randomized design (CRD) with four treatments: P0 (no addition), P1 (2.5 g turmeric + 7.5 g Javanese turmeric), P2 (5 g turmeric + 5 g Javanese turmeric), and P3 (7.5 g turmeric + 2.5 g Javanese turmeric), per 100 g of feed for each treatment. Feeding was done every 3 days at a dose of 1140 g m^{-2} for 21 days. Data were analyzed using ANOVA and Duncan's test. Results showed that turmeric and Javanese turmeric powders supplementation significantly increased **Tubifex** sp. weight growth and productivity, with P2 giving the best results (317.54 ± 13.16 g and 2646.18 ± 109.74 g m^{-2} $cycle^{-1}$) ($P<0.05$). The highest curcumin absorption was recorded in P2 at 44.32 ± 11.30 mg kg^{-1} ($P<0.05$). Microbiological tests showed that all treatments were free from **Salmonella** sp. and **Escherichia coli** contamination. This study indicated that addition of turmeric and Javanese turmeric powders in feed could improve the quality and safety of **Tubifex** sp. in aquaculture.*

*KEYWORDS: biomass; **Curcuma longa**; **Curcuma xanthorrhiza**; productivity; **Tubifex** sp.*

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AUTHOR GUIDELINES OF JURNAL RISET AKUAKULTUR FOR WRITING FORMAT AND PUBLICATION PROCESS

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ABSTRACT

Abstract is written in bahasa and English using 12-point Times New Roman single space with justified alignment. English abstract is followed by the English version of the title which is typed using bold capitalized each word letters. Abstract must not exceed than 250 words and contains the brief outline of the problem statement and aims of the study, brief methodology, the main findings or results, and conclusion.

KEYWORDS: author guidelines; Jurnal Riset Akuakultur; publication process; writing format

ABSTRAK: Panduan Format Penulisan Jurnal Riset Akuakultur (Terjemahan dari Judul Artikel yang ditulis dalam Bahasa Indonesia Maksimal 20 Kata)

Abstrak ditulis dalam bahasa Indonesia dan Inggris menggunakan font Times New Roman 12 spasi satu dengan rata kiri dan kanan. Abstrak bahasa Inggris diikuti dengan judul naskah versi bahasa Inggris yang diketik tebal dengan huruf pertama kapital pada setiap kata. Abstrak tidak boleh lebih dari 250 kata dan berisi ringkasan masalah dan tujuan penelitian, metodologi singkat, temuan utama atau hasil penelitian, dan kesimpulan.

KATA KUNCI: format penulisan; Jurnal Riset Akuakultur; petunjuk penulisan; proses publikasi

INTRODUCTION

Introduction must be concise and at least has several components including an adequate background related to the research, problem statement, some literature review from previous studies, the research gap, and the aims of the study. Introduction is written using double space line, single column, 12-point Times New Roman with justified alignment. Text citation of references uses author-date style according to APA 7th Edition and multiple references are listed in alphabetical order separated by semicolon among references to differentiate citations, e.g. (Smith & Jones, 2016; Williams, 2014). Use “and” when giving a citation in sentences and “&” for parentheses, e.g. Smith and Jones (2016) or (Smith & Jones, 2016).

MATERIALS AND METHODS

This section presents a clear and concise research procedures for others to be able to replicate the study. The use of subsections is allowed to explain some different continued-procedures. This section also provides ethical clearance statement for the research which applies an experiment on animals or human. The materials and equipment used must be mentioned with their specifications consisting of the trademark, supplier or manufacture name, and region or country. This section also covers a brief narration about data analysis. Methods that have been published should be summarized and completed with in-text-citation. Modified methods should be clearly described its modification from the previous cited methods. Use the international system of units (SI) or SI-derived units to express unit of measurements. Minus index is suggested being used rather than using slash (/), e.g.: mg L^{-1}, g L^{-1}, not mg/L or g/L. This section is typed in 12-point Times New Roman, double space line, a single column with justified alignment.

RESULTS AND DISCUSSION

Results and discussion must be combined in one section. The statement of the results can be summarized from the data appeared in the figures and tables. Discussion should explore the significance of the results or comparison to previous studies and represent the causal factors why and how the results were taken place, do not re-express the mentioned data in figures and tables in the form of sentences within results. Figures and tables can be placed in this section completed with cross-reference of the figures or tables stated in the text. This section is written in 12-point Times New Roman, double space line, a single column format with justified alignment.

Tables and figures must be placed within the main text, those can be placed in sections of materials and methods or results and discussion (if applicable). The preparation of tables can follow the guidance below:

1. Provide an editable form of tables, do not place any tables in the form of images.
2. The titles of tables should be consecutively numbered using Arabic numerals, please cite the tables in the text or give cross-reference of tables in the text.
3. The titles of tables are written in both in bahasa and English for the manuscript written

in bahasa, or only in English for the manuscript in English. Type the title using 12-point Times New Roman, single space with sentence case letters in justified alignment, and give hanging indent for the second and consecutive lines of the table title.

4. The body of the table is typed in 10-point Times New Roman, single space with left alignment, only column headings are typed in bold.
5. Please provide bahasa and English versions of any text in the body of the table for the manuscript submitted in bahasa, use italic font to type the English version of the text, while all the text in the table body of the manuscript submitted in English is only provided in English.
6. Use single horizontal lines to separate column heading and to indicate the end of the table, other horizontal lines are not needed. Vertical lines should not be used in the tables.
7. Capitalize only the first letter of the first word in each column and row entry.
8. All abbreviations and symbols or any statistical explanation and used literatures in the table body must be described in footnotes placed below the table and written in 10-point Times New Roman, single space in justified alignment.

An example of table format can be seen below.

Table 1. Average of survival rate, absolute weight growth, absolute length growth, and daily growth rate Asian redtail catfish fry fed different percentages of fermented sago dregs and anchovy head meal feed.

Treatments	*SR (%)*	*AWG (g)*	*ALG (cm)*	*DGR (% day^{-1})*
P1	56,67 ± 22,5	0,12 ± 0,01^{b}	1,47 ± 0,39	0,57 ± 0,06^{b}
P2	58,33 ± 10,4	0,11 ± 0,01^{b}	1,42 ± 0,54	0,56 ± 0,03^{b}
P3	75,00 ± 10,0	0,16 ± 0,01^{c}	1,54 ± 0,17	0,78 ± 0,06^{c}
P4	66,67 ± 25,6	0,07 ± 0,00^{a}	1,20 ± 0,07	0,32 ± 0,01^{a}

Note: Values with different superscript letters in the same column indicate significantly different results (P<0,05). P1 = Feeding with percentages of 6%, P2 = 8%, P3 =10 %, P4 = 12% from body weight of fish fry. SR = survival rate; AWG = absolute weight growth; ALG = absolute length growth; DGR = daily growth rate.

The preparation of figures should refer the guidance below:

1. Figures should be provided in either vector art formats (Illustrator, EPS, WMF, FreeHand, CorelDraw, PowerPoint, Excel, etc.) or bitmap formats (Photoshop, TIFF, GIF, JPEG, etc.). Bitmap images should be of 300 dpi resolution. Provide an editable form of charts, not as images.

2. The titles of figures should be consecutively numbered using Arabic numerals, please cite the figures in the text or give cross-reference of figures in the text.
3. The titles of figures are written in both in bahasa and English for the manuscript written in bahasa, or only in English for the manuscript in English. Type the title using 12-point Times New Roman, single space with sentence case letters in justified alignment, and give hanging indent for the second and consecutive lines of the table title. Place the figure title below the figure.
4. Please provide bahasa and English versions of any text in the body of the figure for the manuscript submitted in bahasa, use italic font to type the English version of the text, while all the text in the figure body of the manuscript submitted in English is only provided in English.
5. Capitalize only the first letter of the first word in any text contained in the figure body.
6. All abbreviations and symbols or any statistical explanation and used literatures in the figure body must be described in footnotes placed below the figure title and written in 10-point Times New Roman, single space in justified alignment.

An example of figure format is presented below.

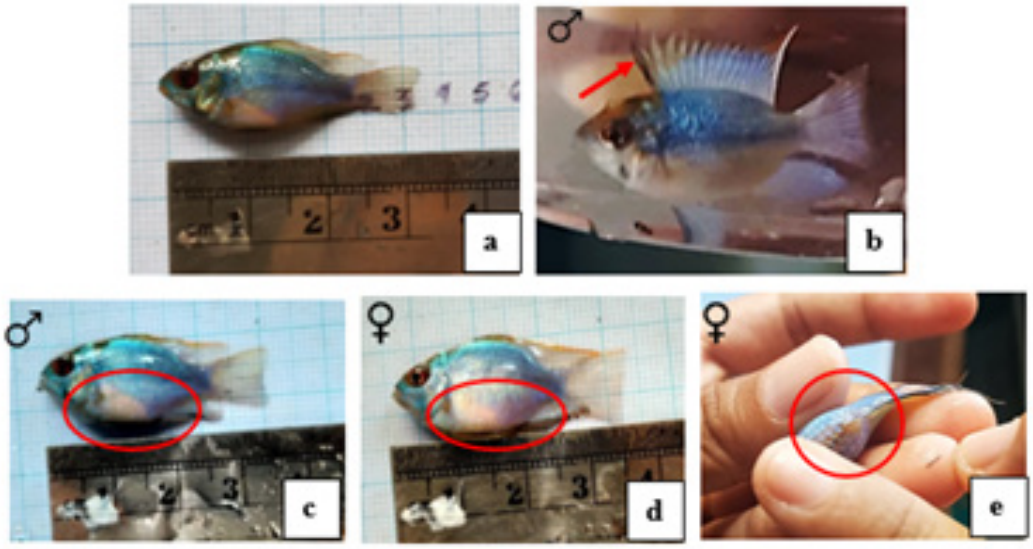

Figure 1. Visual observations of gonad matured ramirezi broodstock: (a) research start (b) ramirezi male at the end of the research with a black elongated front dorsal fin (c) ramirezi male with a bluer body and belly (d) ramirezi female with a pink belly (e) prominent and yellow urogenital.

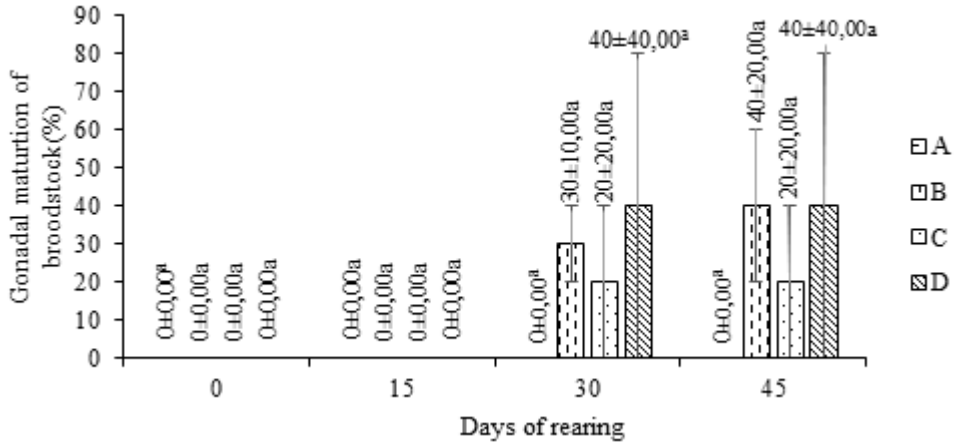

Figure 2. Accumulation percentage of gonadal mature ramirezi broodstock after treatments (combined ratio of artificial feed to bloodworms (*Chironomus* sp.): (A) 3:0, (B) 0:3, (C) 2:1, and (D) 1:2)) on day 0 to day 45

Note: The results presented are based on data normalization. Different superscripts in the same days of rearing indicate significantly differences at a confidence level of 95% ($P<0.05$).

CONCLUSION

Conclusions must summarize the results and answers the research questions or aims. Conclusions should be combined with the summary of the discussions which explains why or how the highlighted results obtained. This section is written in 12-point Times New Roman, double space line, a single column format with justified alignment.

ACKNOWLEDGMENTS

This section is used to acknowledge any institutions or individuals that provide funding sources or help during the study. The research which was funded by a research grant must mention the name of research grant and its detail such the funding organization and associated grant number (if applicable). This section is written in 12-point Times New Roman, double space line, a single column format with justified alignment.

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