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Preliminary Evaluation of Pellet and *Tubifex* Feed Treatments on *Pangasius* and Water Spinach Growth in a Bucket-Based Aquaponic System (Budikdamber)

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Abstract. Bucket-based aquaponics offers a low-cost option for integrated fish and vegetable production, but treatment-level observations require cautious interpretation. This 43-day preliminary study descriptively evaluated commercial pellets (P1), a 1:1 pellet–*Tubifex* combination (P2), and *Tubifex* (P3) in separate 80-L *Pangasius*–water spinach systems. Recorded fish length and weight gains were highest numerically in P3 (10.5 cm; 10.2 g), whereas P2 produced the largest water-spinach height, leaf count, and leaf width (28 cm; 36; 1.7 cm). Mean pH ranged from 7.85 to 7.89, while recorded temperatures were high (36.8–37.8 °C). Because each treatment was represented by one bucket, results were analyzed descriptively. The observations do not establish treatment superiority or feed efficiency; confirmatory research requires replicated systems, quantified feed intake, and comprehensive water-quality monitoring.

Keywords: Aquaponics, *Ipomoea aquatica*, *pangasius*, *tubifex*, urban farming

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1. Introduction

Aquaponics integrates aquatic animal culture and soilless plant production by recirculating water and nutrients. Fish feed is the principal external nutrient input in many coupled systems; nutrients are subsequently partitioned among fish biomass, dissolved metabolites, solids, microbial processes, and plant uptake. Recent system-level studies demonstrate that feed input, resource use, nutrient recovery, water quality, and system configuration jointly determine aquaponic performance [1-3,19-21].

Small bucket-based systems, locally known as budikdamber, are relevant for space-limited households, schools, and urban communities because they combine fish and vegetables in a compact, low-cost unit. The growing interest in decentralized food production makes it urgent to determine whether such simplified systems can generate interpretable fish–plant performance data under realistic tropical conditions. Their technical simplicity, however, does not remove the need to monitor system efficiency and environmental conditions. Feed use, production scale, water consumption, system balance, and economic performance are central considerations when evaluating aquaponic technologies [4,5,21,22].

Pangasius spp. are widely cultured in Southeast Asia, while water spinach (Ipomoea aquatica) is suitable for simple recirculating systems. Fish–plant compatibility depends on stocking density, temperature, pH, dissolved oxygen, nitrogen compounds, and hydraulic conditions [6-9]. These variables influence fish growth, microbial nutrient transformation, and nutrient availability to plants.

Tubifex is commonly used as a natural feed for freshwater juveniles because of its palatability and nutrient content. Controlled feeding studies have shown that live-feed regimes containing Tubifex can influence growth and survival in cultured fishes, including Pangasius larvae and Celebes rainbowfish [10,11]. Nevertheless, growth observations alone cannot establish physiological mechanisms, nutrient-conversion efficiency, or feed efficiency without direct biochemical, feed-utilization, and water-quality measurements.

Although aquaponic research has examined nutrient cycling, hydraulic loading, stocking, and commercial-scale configurations, direct evidence comparing commercial pellets, Tubifex, and their combination in a low-cost Pangasius–water spinach budikdamber configuration remains scarce [19-25]. In particular, it is unclear whether the numerical responses of fish and plants move in the same direction when the feed source differs in a single-bucket tropical system. Addressing this gap is timely because budikdamber is increasingly promoted as an accessible urban-food-production approach, while weak experimental control can lead to premature claims of feed superiority. Therefore, this study provides a preliminary descriptive evaluation of recorded fish growth, plant growth, temperature, and pH patterns under three feeding treatments. It does not test physiological responses, nutrient balance, or causal treatment superiority. The research objective was to document and compare the recorded response patterns of Pangasius juveniles and water spinach in three treatment-specific bucket systems and to identify the measurements and design improvements required for a confirmatory experiment.

2. Materials and Methods

2.1. Study setting and system configuration

The 43-day observation began on 2 October 2023 and was conducted on the sixth floor of the main building at Universitas PGRI Semarang, Indonesia. Three 80-L bucket-based aquaponic systems were prepared using net pots, rockwool, flannel wicks, and water-spinach seedlings. Each system was stocked with 62 *Pangasius sp.* juveniles selected at an approximate initial length of 5–7 cm.

Conditions intended to be held constant across the three systems were the study location and 43-day duration, nominal bucket volume (80 L), bucket and plant-support configuration (net pots, rockwool, and flannel wicks), initial fish number (62 juveniles per system), approximate initial fish-length range (5–7 cm), water-spinach planting material, twice-daily feeding schedule, and weekly water-replacement schedule. All buckets were maintained in the same sixth-floor setting. Ambient temperature and light were not actively controlled, and water-flow rate, dissolved oxygen, nitrogen compounds, and initial system-level biomass were not retained in the archived records; these factors must therefore be regarded as unmeasured sources of between-bucket variation.

2.2. Feed treatments and husbandry

Three feeding regimes were evaluated, with one regime assigned to each bucket. P1 consisted exclusively of the commercial pellet routinely used for Pangasius juveniles. P2 consisted of the same commercial pellet combined with live Tubifex, recorded in the archived protocol as a 1:1 mixture. P3 consisted exclusively of live Tubifex. These regimes represented a conventional formulated feed, a mixed formulated–natural feed, and a natural feed, respectively. Fish were fed twice daily, in the morning and afternoon, to apparent satiation. The archived records did not specify whether the P2 1:1

ratio was based on wet mass, dry mass, or volume; therefore, the ratio is reported only as recorded and is not treated as a quantitatively standardized nutrient ratio. Daily feed input and uneaten feed were not weighed. Water replacement was conducted weekly.

2.3. Measurements

Fish length and body mass were measured during the observation period. Plant height, number of leaves, and leaf width were also recorded. Water temperature and pH were monitored, and aggregate mean values were retained in the archived article. Dissolved oxygen, total ammonia nitrogen, nitrite, nitrate, electrical conductivity, and other nutrient-balance variables were not measured. Representative documentation of the measurement procedures is provided in Figure 1.

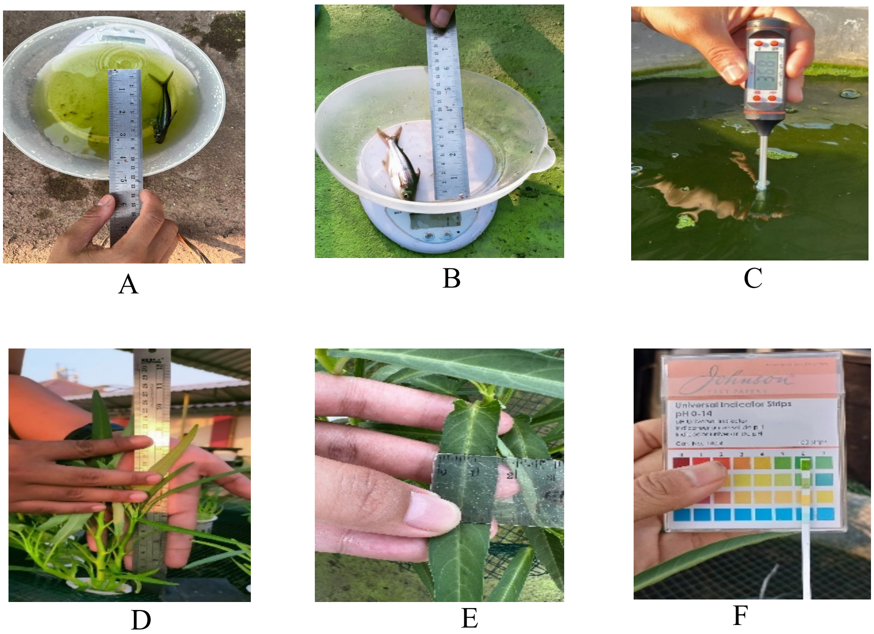

Figure 1. Representative documentation of the study procedures: (a) fish-length measurement; (b) fish length and body-mass measurement; (c) water-spinach height measurement; (d) leaf-width measurement; (e) water-temperature measurement; and (f) pH measurement using indicator strips.

Early mortality occurred in P1, after which fish were added to that bucket. Because the archived aggregate records contained inconsistent initial-count descriptions and did not preserve individual mortality dates, a valid treatment-specific survival rate could not be reconstructed. Survival was therefore excluded as an analyzed outcome.

2.4. Analytical approach

The feed treatment was applied to each bucket as a whole, and each treatment had one bucket. Fish and plants sharing a bucket were subsamples rather than independent system-level replicates. Consequently, no inferential statistical comparison was performed. Results are presented as archived aggregate descriptive values. Standard deviations, confidence intervals, post-hoc comparisons, and effect sizes are not reported because the underlying raw observations were not retained.

3. Results and Discussion

3.1. Recorded fish-growth patterns

The archived aggregate records showed larger fish length and weight gains in P2 and P3 than in P1 (Table 1). P3 had the largest numerical values, followed closely by P2. Natural feeds such as Tubifex may be readily consumed by freshwater juveniles, but growth responses also depend on feed quantity, nutrient composition, digestibility, temperature, dissolved oxygen, and stocking conditions [10,11,19,20]. Because none of these potential mechanisms was measured comprehensively here, the observations remain descriptive outcomes from single treatment-specific systems and should not be interpreted as statistically different treatment effects.

Table 1. Archived aggregate fish-growth observations after 43 days

System	Feed treatment	Mean length gain (cm)	Mean weight gain (g)
P1	Commercial pellet	8.4	6.4
P2	Pellet + *Tubifex* (recorded 1:1)	10.3	9.8
P3	*Tubifex*	10.5	10.2

Note: Values are archived aggregate means; dispersion statistics and independent bucket replicates were unavailable.

3.2. Recorded water-spinach growth patterns

The P2 system had the largest recorded plant height gain, leaf count, and leaf width (Table 2), whereas P3 had the smallest plant height and leaf count. Feed-derived nitrogen and minerals can support plant growth only after dissolution and microbial transformation, and plant performance is also shaped by hydraulic loading, pH, oxygen availability, crop-to-fish balance, and nutrient retention [20,23-25]. Because each feed treatment was confounded with one aquaponic system and these processes were not quantified, the patterns cannot distinguish a feed effect from other bucket-specific conditions.

Table 2. Archived aggregate water-spinach observations after 43 days

System	Feed treatment	Height gain (cm)	Leaf count	Leaf width (cm)
P1	Commercial pellet	27	32	0.8
P2	Pellet + *Tubifex* (recorded 1:1)	28	36	1.7
P3	*Tubifex*	23	25	0.7

Note: Values are archived aggregate observations and are not inferential treatment estimates.

3.3. Recorded temperature and pH

Mean pH was similar among the systems, ranging from 7.85 to 7.89 (Table 3). Recorded mean water temperatures ranged from 36.8 to 37.8 °C. These temperatures were higher than those maintained in recent replicated warm-water aquaponic feeding studies [12-15]. Without time-resolved raw measurements or an independent calibration record, the duration and biological consequences of the recorded thermal exposure cannot be evaluated.

Table 3. Archived aggregate water-quality observations

System	Feed treatment	Mean temperature (°C)	Mean pH
P1	Commercial pellet	37.6	7.89
P2	Pellet + *Tubifex* (recorded 1:1)	37.8	7.85
P3	*Tubifex*	36.8	7.85

Note: Dissolved oxygen, ammonia, nitrite, and nitrate were not measured.

3.4. Interpretation of the recorded patterns

Two contrasting descriptive patterns were recorded: P3 had the largest numerical fish length and weight gains, whereas P2 had the largest water-spinach measurements. This divergence is biologically plausible because the feed most readily used by fish is not necessarily the feed that produces the most favorable dissolved-nutrient profile for plants. Reviews and mass-balance studies emphasize that feed composition, mineralization, microbial transformations, solids management, hydraulic conditions, and the fish-to-plant ratio jointly determine nutrient availability [19-25]. Demonstrating nutrient conversion therefore requires quantified feed input, system-level fish biomass gain, nitrogen and phosphorus concentrations, plant biomass, and replicated aquaponic units [2,3,12-15,23]. The available observations consequently do not demonstrate that mixed feeding increased system efficiency.

The similar pH values suggest that aggregate acidity conditions were broadly comparable, although pH values near 7.9 may reduce the availability of some plant nutrients and reflect a compromise among fish, plants, and nitrifying microorganisms [19,20,22]. In contrast, the recorded temperatures were high. Temperature affects fish feeding, metabolic oxygen demand, ammonia toxicity, nitrification, and plant processes; these interactions make dissolved oxygen and nitrogen compounds indispensable for interpreting aquaponic performance [19], [20]. Recent experimental systems have combined repeated water-quality monitoring with independent treatment units to interpret fish and plant responses [12-16,23-25]. The absence of dissolved-oxygen and nitrogen-compound measurements in the present study prevents the observed fish and plant patterns from being attributed solely to feed treatment.

The numerical fish-growth pattern is broadly consistent with controlled studies showing that live Tubifex can support growth and survival in cultured fishes [10,11]. However, daily feed mass, proximate feed composition, and uneaten feed were not retained. Feed conversion ratio, protein efficiency ratio, feed efficiency, and protein retention therefore cannot be calculated retrospectively. Direct physiological claims were also removed because no blood, biochemical, digestive, immune, stress, or tissue-level indicators were measured.

Plant performance in aquaponics reflects the interaction of nutrient supply, water quality, microbial transformation, hydraulic loading, plant density, and crop requirements [20,23-25]. Studies using fish effluent have demonstrated that plant growth can be supported when water and nutrient conditions are adequately characterized [16,17], while water-spinach production can respond strongly to system loading and plant-to-fish ratios [25]. In the present study, the P2 plant observations are useful for hypothesis generation but do not establish a nutrient-recovery mechanism.

Within these constraints, the study provides an initial record from a low-cost Pangasius–water spinach budikdamber configuration. Such small-scale integrated systems remain relevant to resource-efficient and urban food production [17-19,21], but their performance should be validated using replicated system-level experiments and complete material-flow measurements. The present results are therefore best used to refine hypotheses and sampling protocols rather than to recommend one feed regime.

3.5. Limitations and future research

This study has substantial limitations. Each treatment was applied to only one bucket, so treatment and bucket effects were confounded. Raw individual observations and dispersion statistics were not retained. Fish were added to P1 after early mortality, preventing valid reconstruction of treatment-specific survival. Feed intake, uneaten feed, and feed composition were not quantified. Only temperature and pH were retained, whereas dissolved oxygen, ammonia, nitrite, nitrate, electrical conductivity, and nutrient balance were not measured.

Future research should randomly assign feed treatments to at least three independent aquaponic units per treatment, define the pellet–Tubifex ratio on a dry-mass basis, quantify feed intake and uneaten feed, and repeatedly monitor temperature, pH, dissolved oxygen, ammonia, nitrite, nitrate, and electrical conductivity. Hydraulic loading, aeration, light exposure, initial fish biomass, and plant density should also be standardized or recorded. System-level biomass gain, survival, specific growth rate, feed conversion ratio, protein efficiency ratio, plant biomass, and nutrient recovery should then be analyzed using the aquaponic unit as the experimental unit, consistent with replicated and mass-balance-oriented aquaponic studies [12-15], [20,23-25].

4. Conclusion

In the three observed bucket systems, P3 had the largest numerical fish length and weight gains, whereas P2 had the largest recorded water-spinach height, leaf count, and leaf width. Mean pH values were similar, while recorded temperatures were high. These findings describe individual system outcomes and do not establish feed-treatment superiority, physiological responses, feed efficiency, or nutrient-conversion efficiency. Confirmatory evaluation requires replicated systems and complete feed, water-quality, and nutrient-flow measurements.

Declaration of AI and AI assisted technologies in the writing process

During the preparation of this work, the authors used ChatGPT (OpenAI) to support English-language editing and improve the clarity of the manuscript. After using this tool, the authors reviewed and edited the content as needed and take full responsibility for the content of the publication.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Data Availability

Only the aggregate observations reported in the archived study article were available for this revision; the underlying individual-level dataset was not retained.

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