# A BIOINTEGRATED SYSTEM FOR IMPROVING PRODUCTION EFFICIENCY OF WATER RECIRCULATING AQUACULTURE

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## SYNOPSIS

This research was focused on addressing three questions: 1) reliability of conventional aquaponics water recirculation system; 2) feasibility of farming plant crops on a stacked planting unit (SPU), and 3) practicability of stacked aquaponics systems. *Portulaca* spp. was planted in three different solutions: distilled water, aquaculture effluent, and fertilized water (with commercial hydroponic fertilizer). After 40 days of growth, the plants in the fertilized water recorded 145% more biomass gain compared to plants in aquaculture effluent. Physiological development of plant was observed to be markedly superior in the fertilized water compared to the other treatments. Another experiment was conducted by investigating the efficiency of *Ipomea aquatica* in remediating aquaculture effluent. Plants with well developed roots had their roots submerged in aquaculture effluent for seven days and it was found that nitrate and phosphorus were reduced by 59% and 65%, respectively. The two experiments suggested that although phytoremediation is relatively reliable, a different approach in aquaponics recirculation strategy had to be adopted as the growth performance of plants is unsatisfactory. SPU is a structure with planting rows stacked atop each other in A-shaped structure. Sweet Basil (*Omicum basilicum*) and Pak Choy (*Brassica rapa*) were grown in the SPU and their biomass gain was recorded for each row. Basil represented a medium sized plant and Pak Choy represented a short plant. It was found that even for this two very different plants, they recorded an identical efficiency of 67% ± 1%. SPU accommodated 108% more plant in an area of land when compared with the conventional planting unit. It was found that the increased plant number per area in the SPU compensated for the non-ideal efficiency. Pak Choy yielded 2.77 kg/m$^2$ and Basil 1.51 kg/m$^2$ more than the conventional planting unit. It was also found that the RAS system used in this research would make a loss of RM4751 per year, but if it is joined to the SPUs, forming stacked aquaponics, the system as a whole, would return a profit.



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## *SINOPSIS*

*Penyelidikan ini tertumpu kepada tiga soalan utama. 1) kebolehpercayaan sistem edaran semula air konvesional aquaponiks; 2) kemungkinan penanaman tanaman pada 'stacked planting unit' (SPU), dan 3) kesesuaian sistem 'stacked' aquaponiks. Portulaca spp. ditanam dalam tiga larutan berbeza, air suling, efluen akuakultur, dan air yang dibajakan (dengan baja hidroponiks komersial). Selepas 40 hari, tumbuhan dalam air yang dibaja mencatat 145% lebih biomas berbanding dengan tumbuhan dalam efluen akuakultur. Tumbesaran fisiolozikal diperhatikan jauh lebih baik bagi tumbuhan yang berada di air yang dibaja berbanding dengan yang lain. Satu lagi eksperimen dijalankan dengan mengaji efisiensi Ipomea aquatica dalam remediasi efluen akuakultur. Tumbuhan yang akarnya tertumbuh dengan baik direndamkan di efluen akuakultur untuk tujuh hari dan didapati bahawa nitrat dan fosforus dikurangkan sebanyak 59% dan 65% masing-masing. Dua eksperimen ini mencadangkan bahawa walaupun fito-remediasi agak konsisten, suatu pendekatan berbeza perlu dibuat dalam strategi pengitaran akuaponiks kerana tumbesaran tumbuhan tidak memuaskan. SPU merupakan struktur dengan barisan menanam disusun di atas satu dengan yang lain dalam struktur berbentuk "A". Selasih Manis (Omicum basilicum) dan Pak Choy (Brassica rapa) ditanam di SPU dan tumbesaran biomass mereka dicatat untuk setiap baris. Basil mewakili tumbuhan saiz sederhana dan Pak Choy mewakili tumbuhan saiz pendek. Ia didapati bahawa untuk dua tumbuhan ini yang sangat berbeza, mereka tercatat efisiensi yang sama, iaitu 67% ± 1%. SPU boleh menampung 108% lebih tumbuhan di suatu kawasan tanah berbanding dengan unit knovensional. Ia didapati bahawa penambahan bilangan tumbuhan per kawasan di SPU memampasi efisiensi tidak sempurna itu. Pak Choy akan mengeluarkan 2.77kg/m2 dan Selasih 1.51kg/m2 lebih dari unit konvensional. Juga didapati bahawa sistem RAS yang digunakan dalam penyelidikan ini akan mengalami kerugian sebanyak RM4751 setahun, tetapi jika ia digabungkan dengan SPU, menjadi 'stacked' akuaponiks, sistem ini secara keseluruhan, akan memulangkan keuntungan.*



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