



GROWTH PERFORMANCE OF SUPER INTENSIVE *Litopenaeus vannamei* BFT CULTURE SYSTEM USING FISH MEAL ANALOG

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Rio Grande, Brazil

Table 24
FAO Fish Model: overall trends to 2022

	Base period	2022 scenarios			
	2010–2012	Baseline	Intermediate	Optimistic	Mixed
<i>(Million tonnes in live weight equivalent)</i>					
WORLD					
Total fishery production	153.940	181.070	188.093	194.800	194.792
Aquaculture	62.924	85.124	92.402	99.330	99.330
Capture	91.016	95.946	95.692	95.474	95.462
Fishmeal production (<i>product weight</i>)	6.103	7.021	7.358	7.679	7.734
Fish oil production (<i>product weight</i>)	0.980	1.079	1.087	1.094	1.088
Fish trade for human consumption	36.994	45.082	45.566	46.237	46.566
Fish supply for human consumption	131.741	160.514	167.397	173.969	174.032
Per capita apparent fish consumption (kg)	18.9	20.7	21.6	22.4	22.4

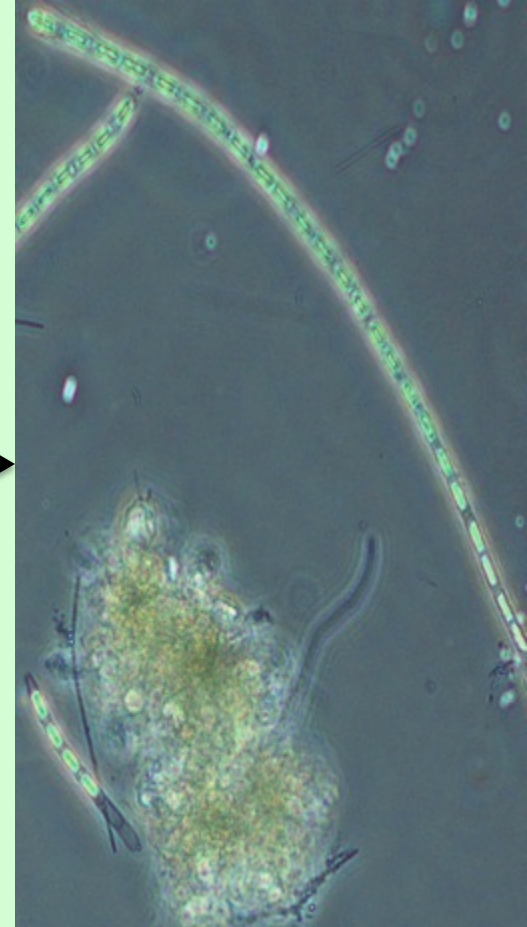
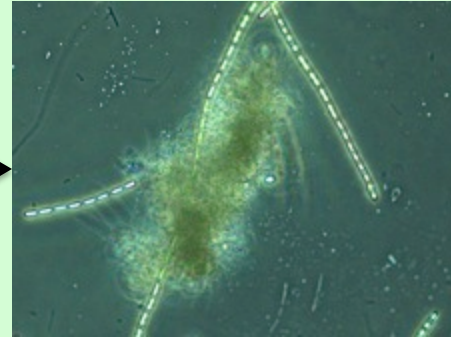


Aquaculture will increase about 50%, but fish oil and meal will increase about 15%.
How to do that???

Alternative meals for shrimp diet

Authors		Species	Replaced
Davis & Arnold, (2000)	Soybean meal and poultry by-product meal	<i>Litopenaeus vannamei</i>	80%
Forster et al. (2003)	Meat and bone meal	<i>Litopenaeus vannamei</i>	25 e 75%
Samocha; et al. (2004)	Soybean meal	<i>Litopenaeus vannamei</i>	100%
Amaya et al. (2007)	Poultry by-product meal	<i>Litopenaeus vannamei</i>	16%
Cruz-Suarez et al. (2007)	Poultry by-product meal	<i>Litopenaeus vannamei</i>	80%
Suarez et al. (2009)	Soy protein concentrate	<i>Litopenaeus vannamei</i>	80%
Bauer et al. (2012)	Biofloc meal	<i>Litopenaeus vannamei</i>	100%
Molina-Poveda et al. (2013)	Tremoço meal	<i>Litopenaeus vannamei</i>	50%
Tan et al. (2005)	Meat and bone meal	<i>Litopenaeus vannamei</i>	80%
Hernández et al. (2008)	Pork meal	<i>Litopenaeus vannamei</i>	>35%

Several researchers are confirming that bioflocs system can contribute to shrimp, nutrition, growth, survival, FCR, decrease protein content in the feeds, immunity and so one.



Avnimelech Ballester Abreu Baloi Arantes Schweitzer Bratvold Browdy Lawrence Crab Burford Verstraete Schryver Ebeling Furtado Gaona Timmons Suita Poersch Wasielesky Krummenauer Foes Hargreaves Lee Jung McIntosh Lara Emerenciano Peixoto Davis Soares Correa Kuhn Samocha Maicá MacGraw Moss Moss Ray Leffler Samocha Patnaik Scopel Viau Ballester Browdy Stokes Venero Lotz Arnold Coman Avnimelech Bratvold Burford Wasielesky Samocha Cohen Preston Ebeling Hari Verdegem Stokes McAbee Otoshi Schneider Avnimelech Tacon Gaxiola-Cortés Cuzon Seiffert Valenzuela Kuhn Silva Tacon Conquest Ray Decamp Atwood Stokes Tung Taw and so one

OBJECTIVE:

**ANALYSE THE USE OF "FISH MEAL
ANALOG" IN THE FEEDING OF
LITOPENAEUS VANNAMEI IN A BFT
CULTURE SYSTEM**

Two Studies

1. The use of FMA in feeding of *L. vannamei* growout (From 1 to 10 g) in and BFT system;
2. The use of FMA in feeding of *L. vannamei* growout (From 10 to 20 g) in and BFT system.

Location of Study

- ✓ Marine Station of Aquaculture
- ✓ Institute of Oceanography, Federal University of Rio Grande, RS, Brazil
- ✓ 9 Raceways 35 m²



Three types of Isoproteic and isoenergetic feed were produced (38% CP and 7.5% EE), with different replacement of Fishmeal by Fishmeal Analog.

T0	T50	T100
0% FMA	50% FMA	100% FMA
100% FM	50% FM	0% FM

Fishmeal Analog's ingredients
Meat Meal
Bone meal
Blood meal
Feather meal
Poultry by-product meal
Squid meal
Fish solubles
Fish oil
Lectin
Lysine
Hemoglobin
Cholesterol
Methionine
Tryptophan
Micro Minerals
Vitamins Premix
Amino Acids Premix

*Data provided by GUABI feeds - Centro-Oeste
Rações LTDA

Fishmeal analog's composition (%)	
Crude protein	47.4
Crude lipids	16.3
Linolenic acid	2.1
Phospholipids	3.5
Cholesterol	0.3
HUFA	1.7
Fibers	0.9
Ashes	16.2
Calcium	5.7
Total phosphorus	3.0
Total lysine	3.9
Total cysteine	0.9
Total methionine	1.4

*Data provided by GUABI feeds - Centro-Oeste
Rações LTDA

METHODS

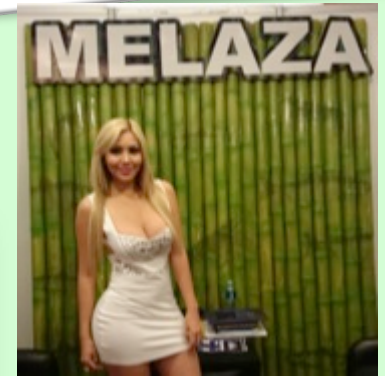
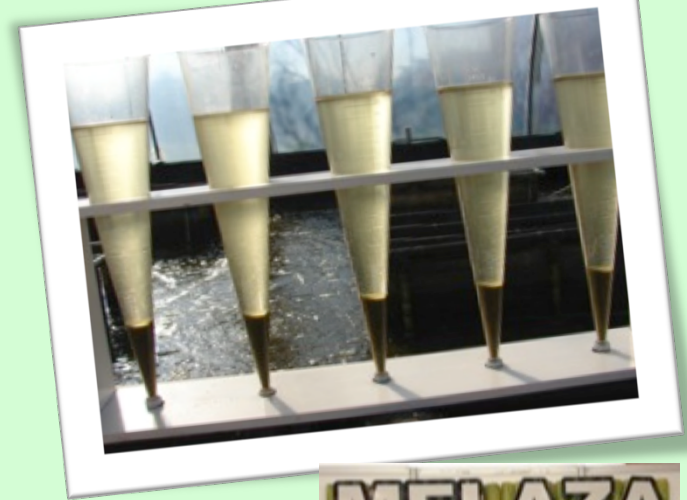
- ✓ Feeding rate was based on Jory et al. (2001)
- ✓ Belt feeder (12 hours)
- ✓ 10% of the feed was distributed in circular feeding trays



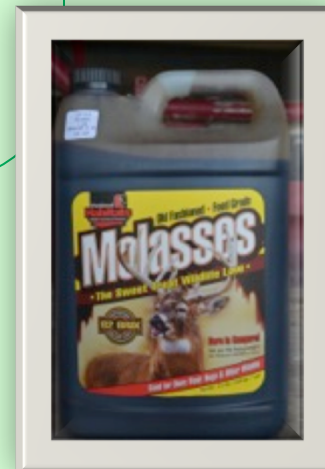
PRE-FERTILIZATION

- The measurement of TA-N was performed every day;
- Organic Fertilization (C:N) 6:1 - with molasses
- Fertilization when ammonia achieved 1 mg/L;

✓ Fertilization based on Avnimelech (1999) and Ebeling *et al.* (2006)



Molasses from
ECUADOR



Molasses from
USA

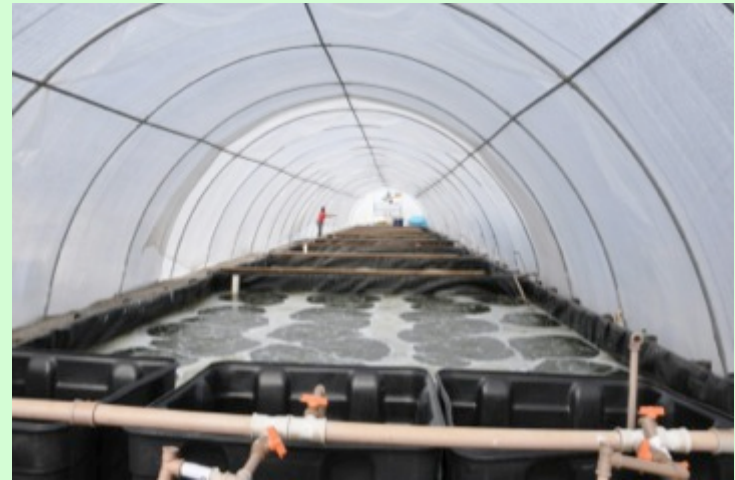
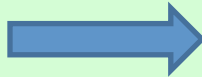
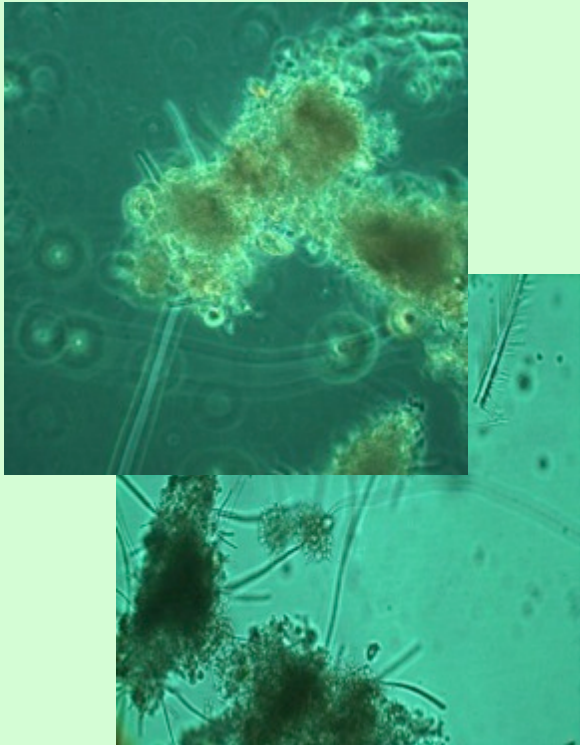


Molasses
from **BRAZIL**

Biofloc formation - Inoculum

METHODS

- 20 % of aged inoculum was pumped from nursery system for better nitrifying process (Krummenauer et al. 2013)

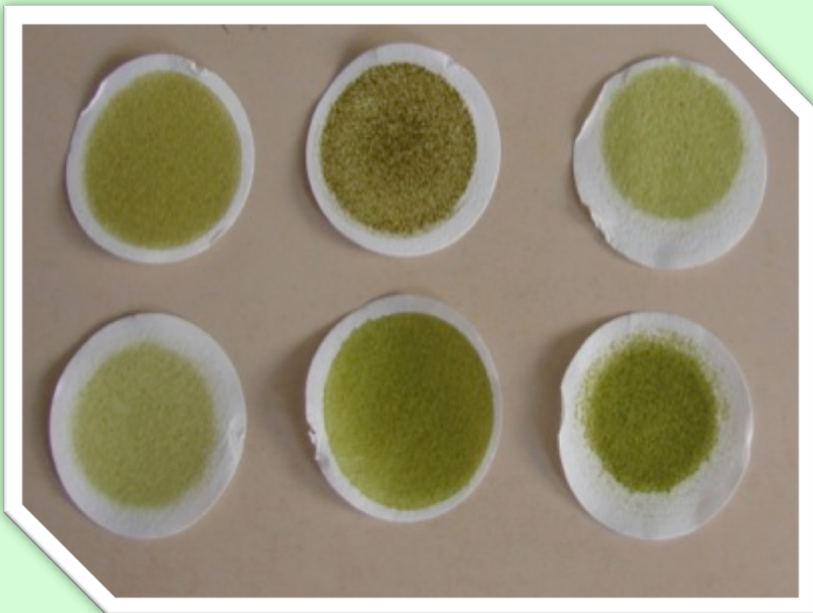


- ✓ pH, temperature, dissolved oxygen and salinity were measured daily
- ✓ Analysis of ammonia, nitrite and nitrate every three days;
- ✓ Shrimps were sampled weekly to check growth;
- ✓ Counting total number of shrimps in the end of the experiment to determine the survival;
- ✓ Results were analyzed by one-way ANOVA ($\alpha=0.05$)



Biofloc control:

- ✓ **Total Suspended Solids (TSS)**
 - ✓ **Bioflocs volume (Imhoff cones)**
- *(Three times / week)**

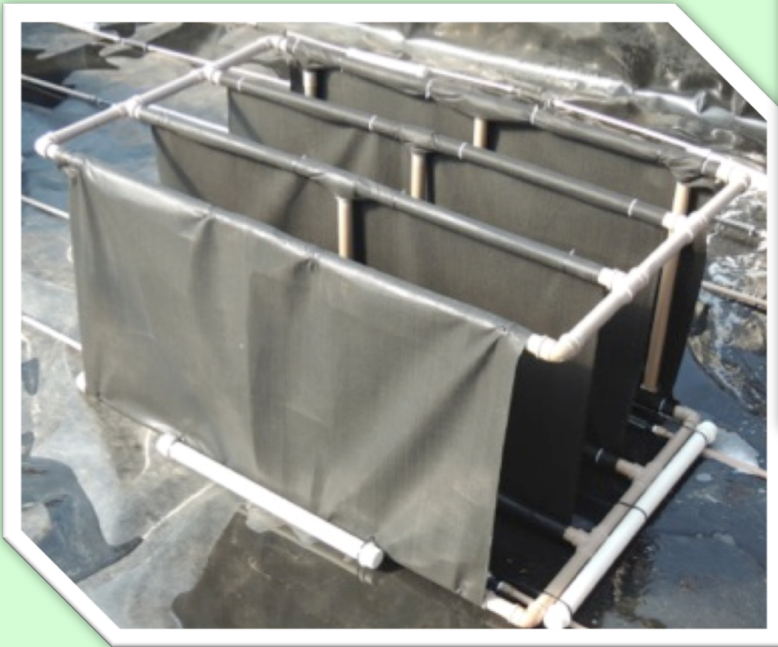


To control



ARTIFICIAL SUBSTRATE:

- ✓ 200% of surface area



MULTI-STRAIN COMMERCIAL PROBIOTIC**Water**

- ✓ 0.5 ppm /week
- ✓ Distribute the mixture in several locations around the tank.

Feed

- ✓ 3 g/kg diet
- ✓ Mix with the feed and let dry
- ✓ Feed was distributed in several locations around the tank.



Experiment 1

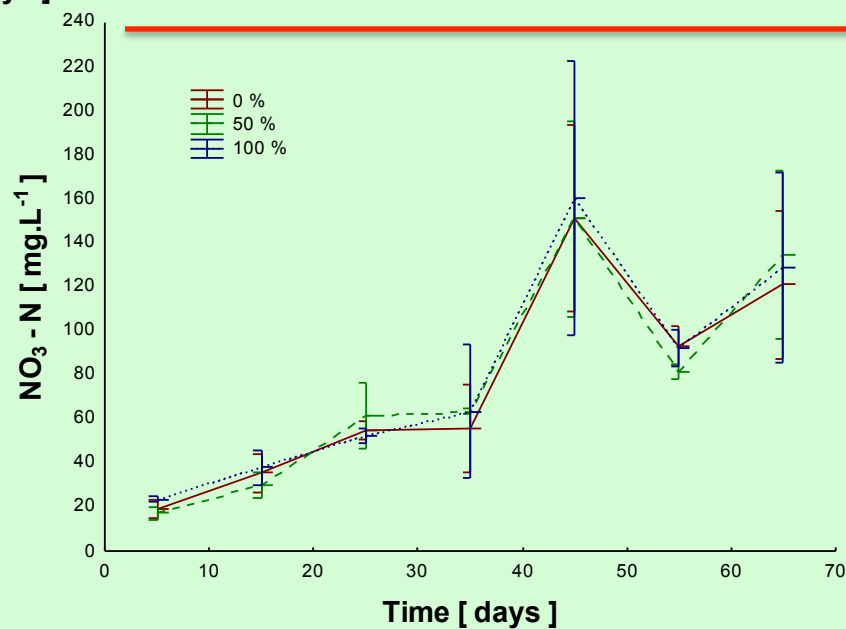
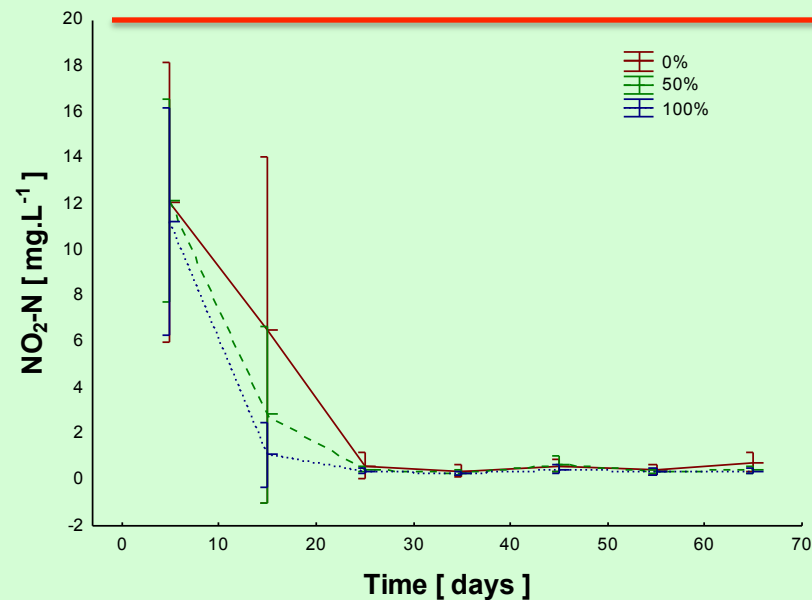
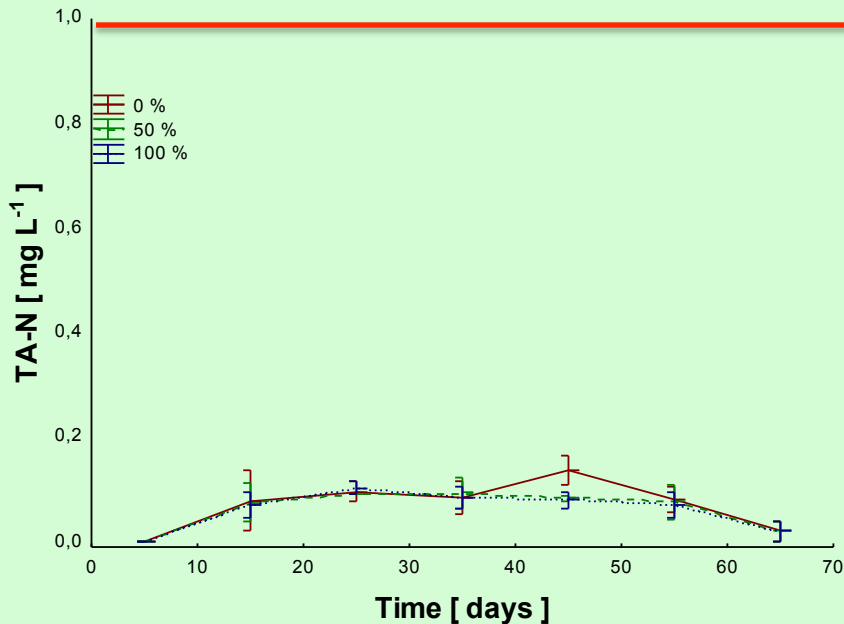
The use of FMA in feeding of *L. vannamei* growout (from nursed juveniles to 10 g) in and BFT system

-
- YOUR BEST PROBLEM IS A QUALITY PROBLEM
 ASSURE A MAXIMUM OF PERFORMANCE
 FOR YEARS OF TRUCKS & TRAILERS
- TRUCKS & TRAILERS
- THE GREEN METAL BOXES WITH A LID THAT IS
 EASILY OPENED AND TO PROTECT THE
 AS A REMINDER, OCCASIONALLY THE BOX
 THE QUALITY OF THE TRUCKS & TRAILERS
- 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021 2022 2023 2024 2025 2026 2027 2028 2029 2030 2031 2032 2033 2034 2035 2036 2037 2038 2039 2040 2041 2042 2043 2044 2045 2046 2047 2048 2049 2050 2051 2052 2053 2054 2055 2056 2057 2058 2059 2060 2061 2062 2063 2064 2065 2066 2067 2068 2069 2070 2071 2072 2073 2074 2075 2076 2077 2078 2079 2080 2081 2082 2083 2084 2085 2086 2087 2088 2089 2090 2091 2092 2093 2094 2095 2096 2097 2098 2099 2100 2101 2102 2103 2104 2105 2106 2107 2108 2109 2110 2111 2112 2113 2114 2115 2116 2117 2118 2119 2120 2121 2122 2123 2124 2125 2126 2127 2128 2129 2130 2131 2132 2133 2134 2135 2136 2137 2138 2139 2140 2141 2142 2143 2144 2145 2146 2147 2148 2149 2150 2151 2152 2153 2154 2155 2156 2157 2158 2159 2160 2161 2162 2163 2164 2165 2166 2167 2168 2169 2170 2171 2172 2173 2174 2175 2176 2177 2178 2179 2180 2181 2182 2183 2184 2185 2186 2187 2188 2189 2190 2191 2192 2193 2194 2195 2196 2197 2198 2199 2200 2201 2202 2203 2204 2205 2206 2207 2208 2209 2210 2211 2212 2213 2214 2215 2216 2217 2218 2219 2220 2221 2222 2223 2224 2225 2226 2227 2228 2229 2230 2231 2232 2233 2234 2235 2236 2237 2238 2239 2240 2241 2242 2243 2244 2245 2246 2247 2248 2249 2250 2251 2252 2253 2254 2255 2256 2257 2258 2259 2260 2261 2262 2263 2264 2265 2266 2267 2268 2269 2270 2271 2272 2273 2274 2275 2276 2277 2278 2279 2280 2281 2282 2283 2284 2285 2286 2287 2288 2289 2290 2291 2292 2293 2294 2295 2296 2297 2298 2299 2300 2301 2302 2303 2304 2305 2306 2307 2308 2309 2310 2311 2312 2313 2314 2315 2316 2317 2318 2319 2320 2321 2322 2323 2324 2325 2326 2327 2328 2329 2330 2331 2332 2333 2334 2335 2336 2337 2338 2339 2340 2341 2342 2343 2344 2345 2346 2347 2348 2349 2350 2351 2352 2353 2354 2355 2356 2357 2358 2359 2360 2361 2362 2363 2364 2365 2366 2367 2368 2369 2370 2371 2372 2373 2374 2375 2376 2377 2378 2379 2380 2381 2382 2383 2384 2385 2386 2387 2388 2389 2390 2391 2392 2393 2394 2395 2396 2397 2398 2399 2400 2401 2402 2403 2404 2405 2406 2407 2408 2409 2410 2411 2412 2413 2414 2415 2416 2417 2418 2419 2420 2421 2422 2423 2424 2425 2426 2427 2428 2429 2430 2431 2432 2433 2434 2435 2436 2437 2438 2439 2440 2441 2442 2443 2444 2445 2446 2447 2448 2449 2450 2451 2452 2453 2454 2455 2456 2457 2458 2459 2460 2461 2462 2463 2464 2465 2466 2467 2468 2469 2470 2471 2472 2473 2474 2475 2476 2477 2478 2479 2480 2481 2482 2483 2484 2485 2486 2487 2488 2489 2490 2491 2492 2493 2494 2495 2496 2497 2498 2499 2500 2501 2502 2503 2504 2505 2506 2507 2508 2509 2510 2511 2512 2513 2514 2515 2516 2517 2518 2519 2520 2521 2522 2523 2524 2525 2526 2527 2528 2529 2530 2531 2532 2533 2534 2535 2536 2537 2538 2539 2540 2541 2542 2543 2544 2545 2546 2547 2548 2549 2550 2551 2552 2553 2554 2555 2556 2557 2558 2559 2560 2561 2562 2563 2564 2565 2566 2567 2568 2569 2570 2571 2572 2573 2574 2575 2576 2577 2578 2579 2580 2581 2582 2583 2584 2585 2586 2587 2588 2589 2590 2591 2592 2593 2594 2595 2596 2597 2598 2599 2600 2601 2602 2603 2604 2605 2606 2607 2608 2609 2610 2611 2612 2613 2614 2615 2616 2617 2618 2619 2620 2621 2622 2623 2624 2625 2626 2627 2628 2629 2630 2631 2632 2633 2634 2635 2636 2637 2638 2639 2640 2641 2642 2643 2644 2645 2646 2647 2648 2649 2650 2651 2652 2653 2654 2655 2656 2657 2658 2659 2660 2661 2662 2663 2664 2665 2666 2667 2668 2669 2670 2671 2672 2673 2674 2675 2676 2677 2678 2679 2680 2681 2682 2683 2684 2685 2686 2687 2688 2689 2690 2691 2692 2693 2694 2695 2696 2697 2698 2699 2700 2701 2702 2703 2704 2705 2706 2707 2708 2709 2710 2711 2712 2713 2714 2715 2716 2717 2718 2719 2720 2721 2722 2723 2724 2725 2726 2727 2728 2729 2730 2731 2732 2733 2734 2735 2736 2737 2738 2739 2740 2741 2742 2743 2744 2745 2746 2747 2748 2749 2750 2751 2752 2753 2754 2755 2756 2757 2758 2759 2760 2761 2762 2763 2764 2765 2766 2767 2768 27

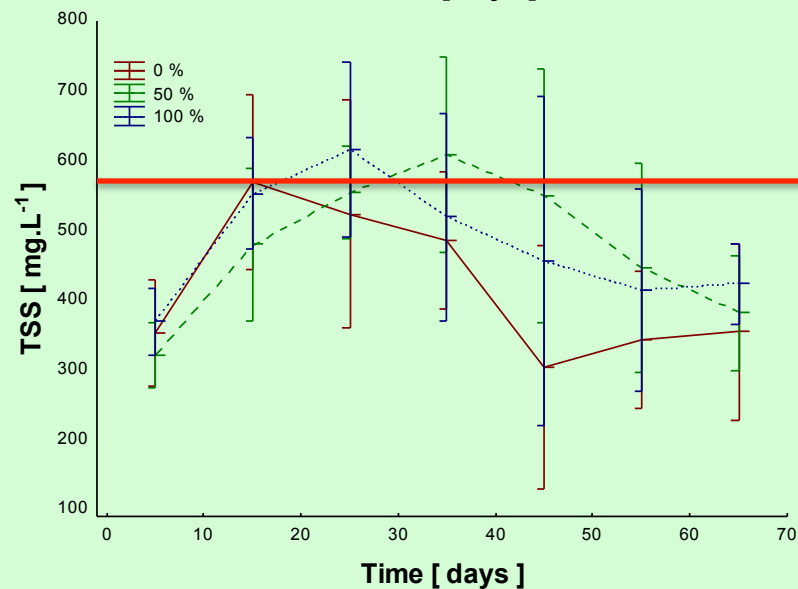
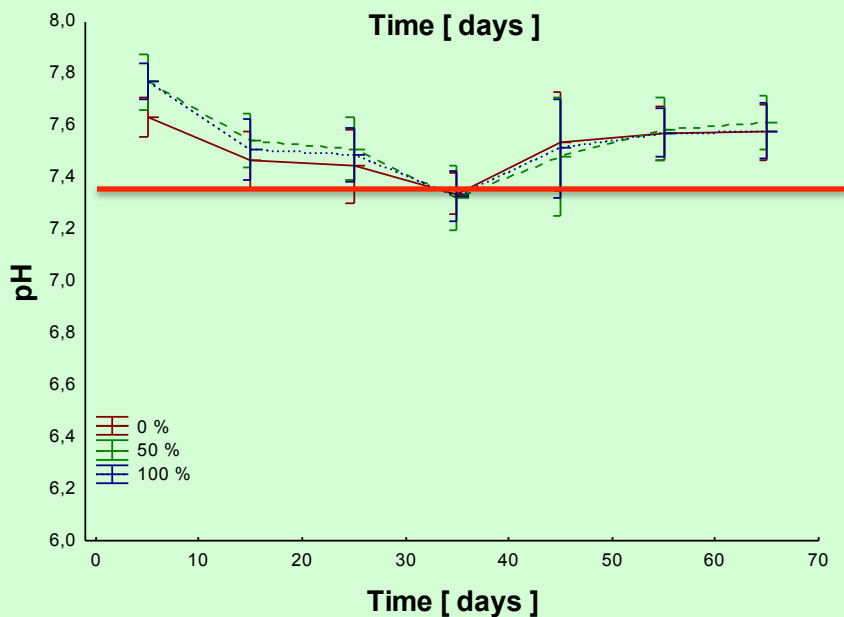
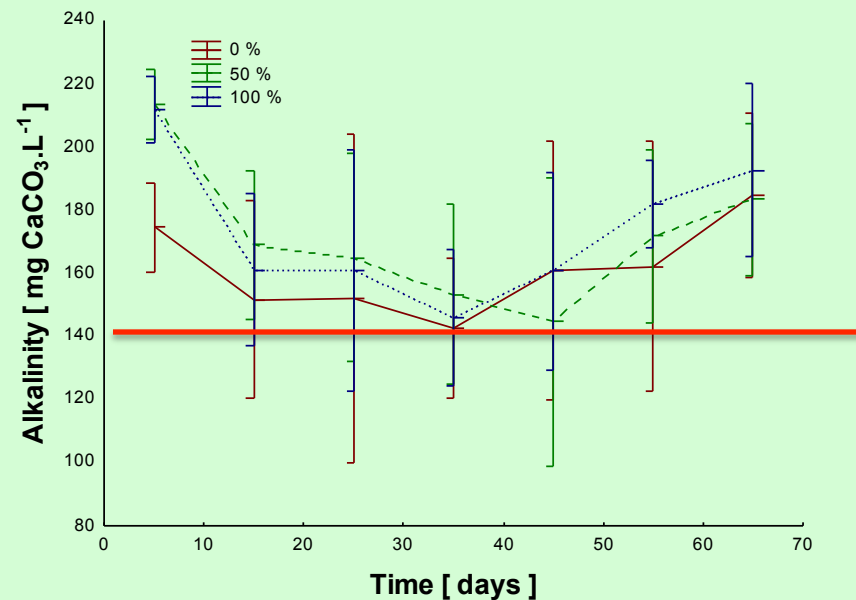
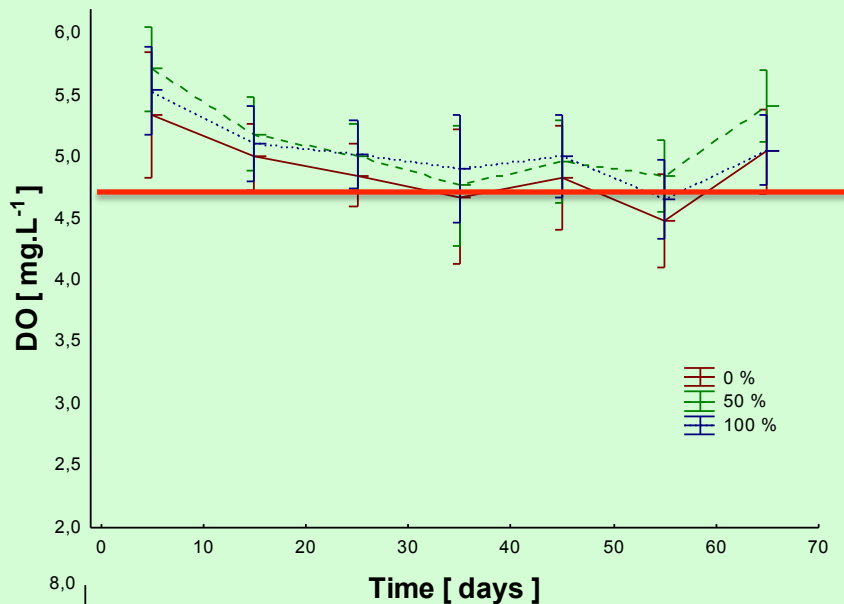
- ✓ **Treatments:**
- ✓ **TO - 0% FMA: Diet with 0% replacement of fishmeal by fishmeal analog;**
- ✓ **T50 - 50% FMA: Diet with 50% replacement of fishmeal by fishmeal analog;**
- ✓ **T 100 -100% FMA: Diet with 100% replacement of fishmeal by fishmeal analog**



Ammonia, Nitrite and Nitrate



DO, Alkalinity, pH and TSS

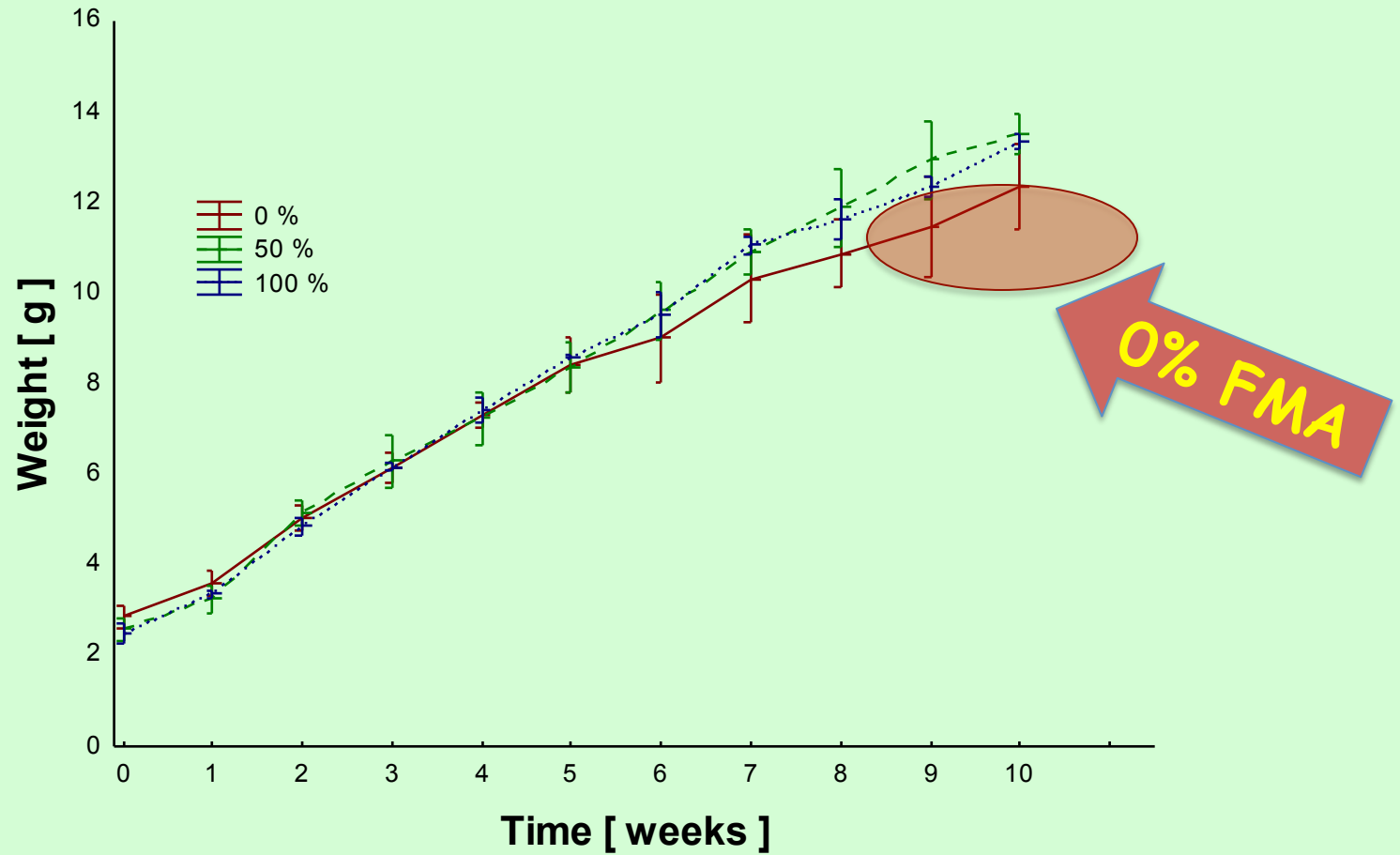


Water Quality parameters monitored during experimental period. Results shown as mean $\pm$ standard deviation.

Parameters	0 % FMA	50 % FMA	100 % FMA
DO (mg.L ⁻¹)	4.89 $\pm$ 0.53	5.13 $\pm$ 0.45	5.04 $\pm$ 0.44
pH	7.51 $\pm$ 0.16	7.55 $\pm$ 0.16	7.54 $\pm$ 0.14
Salinity	23.04 $\pm$ 0.58	23.19 $\pm$ 0.48	23.63 $\pm$ 0.54
Alkalinity (mg CaCO ₃ .L ⁻¹)	161.0 $\pm$ 34.56	170.60 $\pm$ 25.83	173.17 $\pm$ 21.61
TA-N (mg.L ⁻¹)	0.07 $\pm$ 0.02	0.07 $\pm$ 0.02	0.07 $\pm$ 0.01
NO ₂ ⁻ -N (mg.L ⁻¹)	3.02 $\pm$ 2.07	2.45 $\pm$ 1.15	2.03 $\pm$ 0.90
NO ₃ -N (mg.L ⁻¹)	83.27 $\pm$ 16.71	83.89 $\pm$ 11.91	87.46 $\pm$ 19.88
PO ₄ -P (mg.L ⁻¹)	2.80 $\pm$ 0.45	2.94 $\pm$ 0.63	3.03 $\pm$ 0.58
Settleable solids (ml.L ⁻¹)	18.8 $\pm$ 4.90	25.1 $\pm$ 8.00	26.4 $\pm$ 8.70
TSS (mg.L ⁻¹)	427.00 $\pm$ 122.75	477.06 $\pm$ 103.12	486.01 $\pm$ 110.94
Turbidity (NTU)	165.50 $\pm$ 52.65	207.82 $\pm$ 44.76	200.21 $\pm$ 52.54

(P>0.05)

Growth



Zootechnical parameters of *L. vannamei* fed with diet including different replacement levels of fishmeal analog (FMA) in biofloc system. Results shown as mean $\pm$ standard deviation.

Parameters	0 % FMA	50 % FMA	100 % FMA
Initial weight (g)	2.64 $\pm$ 0.77	2.64 $\pm$ 0.77	2.64 $\pm$ 0.77
Final weight (g)	12.19 $\pm$ 2.98	13.51 $\pm$ 2.92	13.34 $\pm$ 3.49
Initial biomass (kg/tank)	36,96	36,96	36,96
Final biomass (kg/tank)	153.93 $\pm$ 4.55	158.72 $\pm$ 4.99	149.29 $\pm$ 2.72
Produced biomass (kg/tank)	116,97 $\pm$ 4.55	121,76 $\pm$ 4.99	112,33 $\pm$ 4.72
Final Yield (kg.m ⁻²)	4.40 $\pm$ 0.13	4.53 $\pm$ 0.14	4.26 $\pm$ 0.18
WGR (g.week ⁻¹)	1.08 $\pm$ 0.10	1.11 $\pm$ 0.19	1.10 $\pm$ 0.14
Survival (%)	86.83 $\pm$ 7.68	82.17 $\pm$ 3.75	81.97 $\pm$ 4.79
FCR	1.47 $\pm$ 0.06	1.37 $\pm$ 0.06	1.50 $\pm$ 0.10

$P > 0.05$

Experiment 2

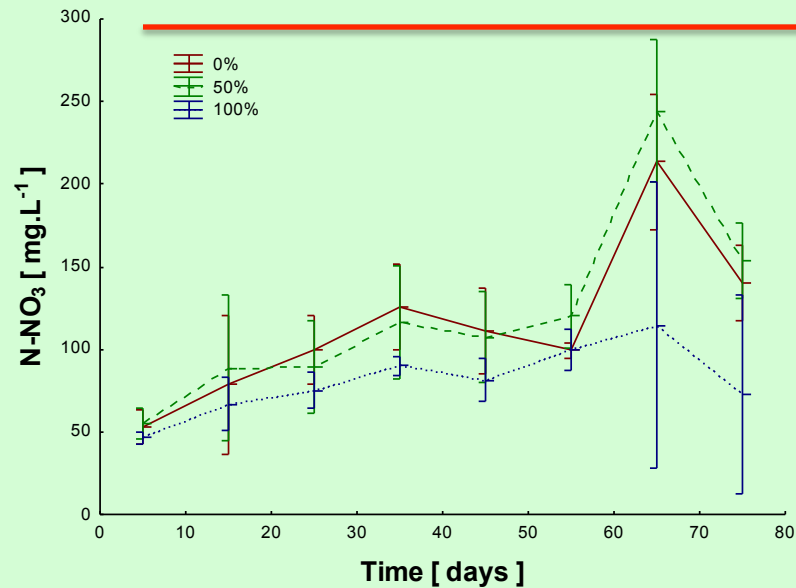
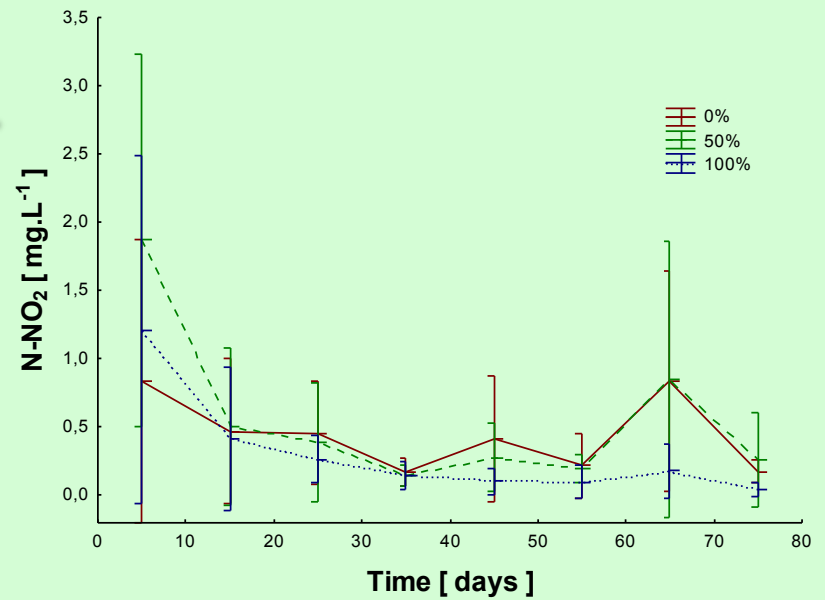
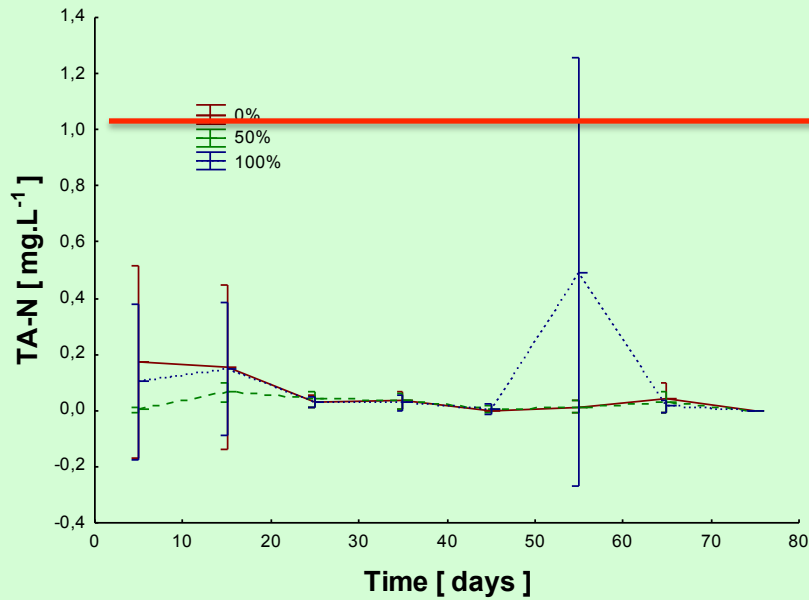
The use of FMA in feeding of *L. vannamei*
Grow out (From 10 to 20 g) in and BFT
system

METHODS

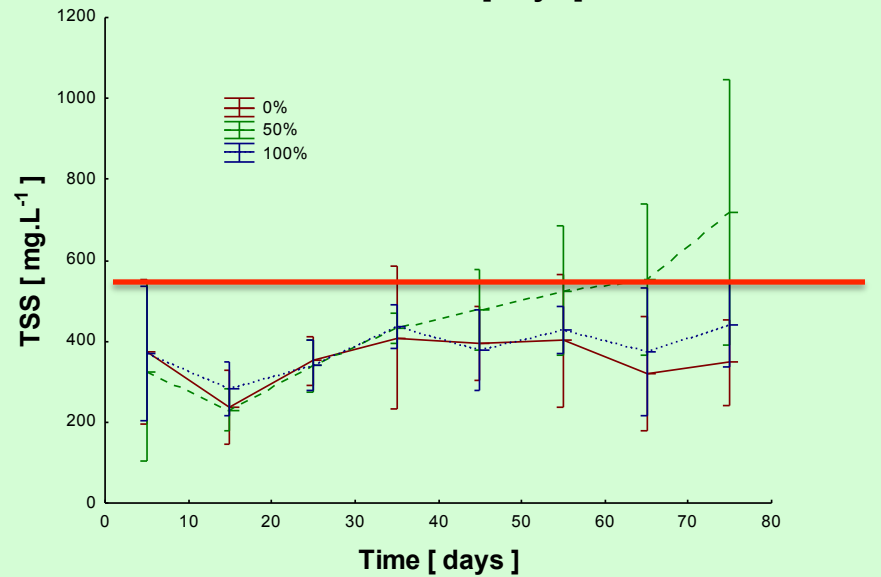
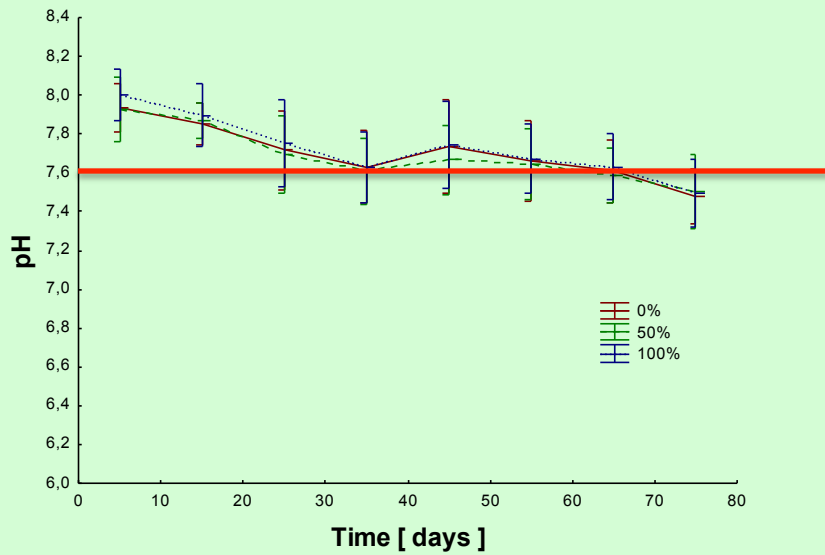
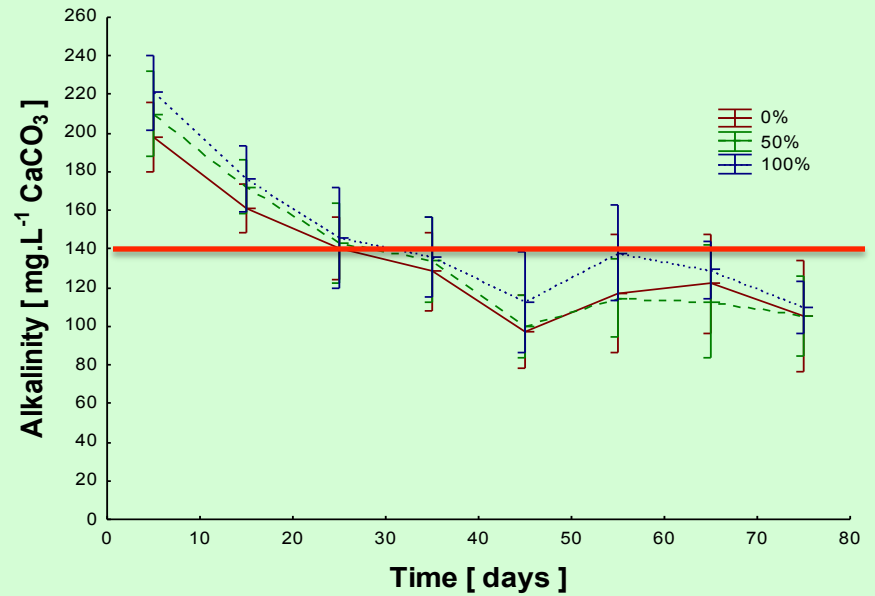
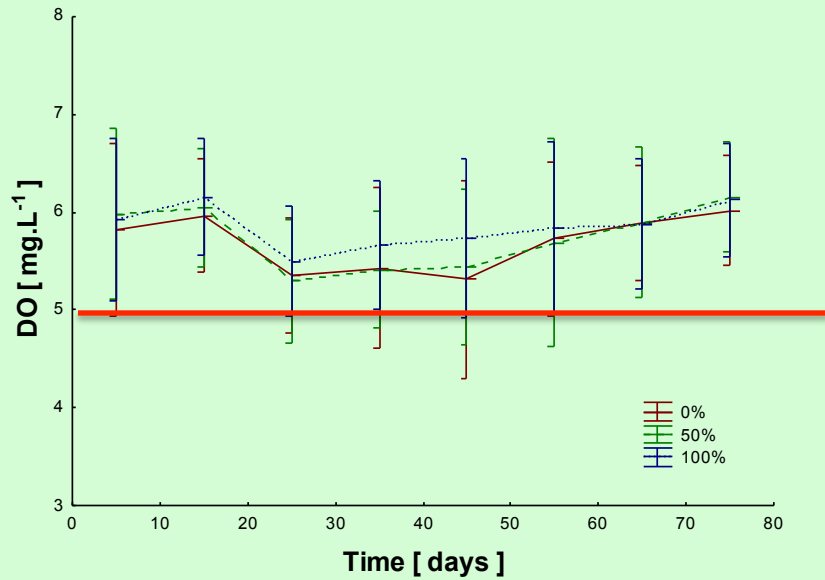
- ✓ Nine 35.000 L lined greenhouse enclosed raceways
- ✓ Initial weight: 9.25 ± 1.24 g
- ✓ (shrimps from growout)
- ✓ Stocking density: 200 shrimps/m² or /m³
- ✓ Period: 77 days
- ✓ Same methodology of first study and the same water



Ammonia, Nitrite and Nitrate



DO, Alkalinity, pH and TSS

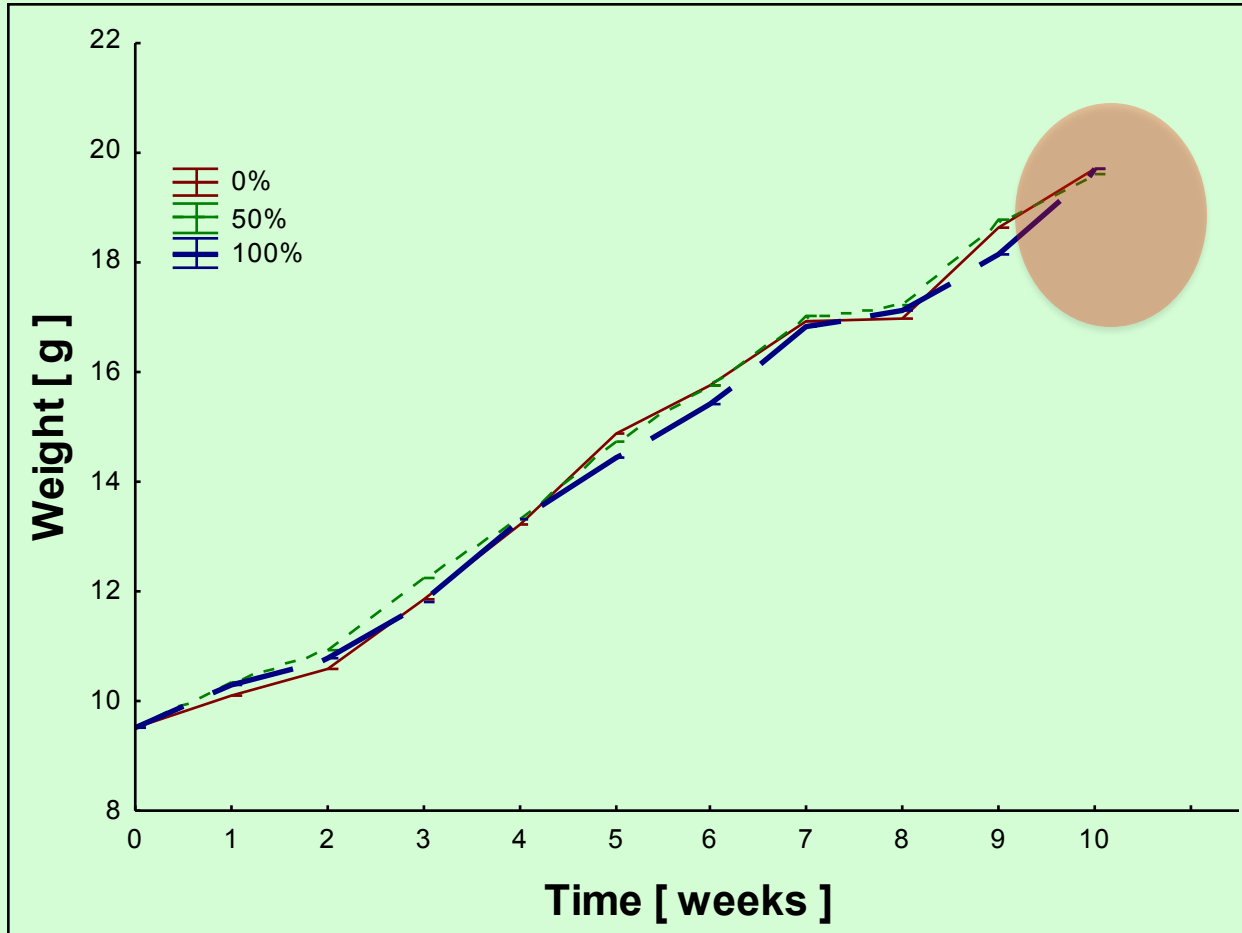


Water Quality parameters monitored during experimental period. Results shown as mean $\pm$ standard deviation.

	T0%	T50%	T100%
Temperature (°C)	27.5 $\pm$ 2.1	27.3 $\pm$ 2.3	27.5 $\pm$ 1.9
DO (mg.L ⁻¹)	5.67 $\pm$ 0.79	5.71 $\pm$ 0.75	5.84 $\pm$ 0.72
pH	7.70 $\pm$ 0.31	7.70 $\pm$ 0.20	7.75 $\pm$ 0.22
Salinity	18.20 $\pm$ 0.54	18.17 $\pm$ 0.81	17.43 $\pm$ 0.99
Alkalinity (mg.L ⁻¹ CaCO ₃)	138.87 $\pm$ 37.16	142.27 $\pm$ 43.07	153.44 $\pm$ 42.43
TAN (mg.L ⁻¹)	0.087 $\pm$ 0.2	0.054 $\pm$ 0.1	0.124 $\pm$ 0.3
NO ₂ -N (mg.L ⁻¹)	0.48 $\pm$ 0.57	0.33 $\pm$ 0.54	0.60 $\pm$ 0.80
NO ₃ -N (mg.L ⁻¹)	108.97 $\pm$ 57.26	114.43 $\pm$ 66.90	80.98 $\pm$ 39.30
PO ₄ -P (mg.L ⁻¹)	2.56 $\pm$ 1.13	2.34 $\pm$ 0.85	2.03 $\pm$ 0.63
SS (mL.L ⁻¹)	20.50 $\pm$ 14.70	40.28 $\pm$ 35.91	28.62 $\pm$ 19.2
TSS (mg.L ⁻¹)	343.13 $\pm$ 141.26	430.83 $\pm$ 204.46	361.70 $\pm$ 121.03
VSS (mg.L ⁻¹)	0.050 $\pm$ 0.1	0.067 $\pm$ 0.1	0.074 $\pm$ 0.1
Turbidity (NTU)	206.06 $\pm$ 78.04	305.61 $\pm$ 198.29	217.27 $\pm$ 95.41

(P>0.05)

Growth



Zootechnical parameters of of *L. vannamei* fed with diet including different replacement levels of fishmeal analog (FMA) in biofloc system. Results shown as mean $\pm$ standanrd deviation.

	0%	50%	100%
Inicial Weight (g)	9.25 $\pm$ 1.24	9.25 $\pm$ 1.24	9.25 $\pm$ 1.24
Final Weight (g)	19.47 $\pm$ 4,63	18.73 $\pm$ 4.10	18.59 $\pm$ 3.90
Inicial Biomass (kg)	64.75	64.75	64.75
Final Biomass (kg)	125.16 $\pm$ 5.21	125.22 $\pm$ 6.53	127.40 $\pm$ 3.39
Produced Biomass (kg)	60.41 $\pm$ 5.21	64.7 $\pm$ 6.53	62.65 $\pm$ 3.39
Inicial Productivity (kg.m ⁻²)	1.85	1.85	1.85
Final Productivity (kg.m ⁻²)	3.58 $\pm$ 0.15	3.58 $\pm$ 0.19	3.64 $\pm$ 0.10
Weekly Growth (g)	0.93 $\pm$ 0.09	0.86 $\pm$ 0.12	0.85 $\pm$ 0.11
Survival (%)	92.11 $\pm$ 8.15	95.58 $\pm$ 2.93	97.60 $\pm$ 3.40
FCR	1.95 $\pm$ 0.16	1.93 $\pm$ 0.18	1.70 $\pm$ 0.34

P>0.05

Conclusions

- ✓ Results confirm that biofloc present in BFT system can supply important nutrients not included in the feeds;
- ✓ It is possible to replace 100% of fishmeal with FMA in shrimp feeds, in BFT system.

Next Steps

- ✓ Elucidate how biofloc can contribute in shrimp nutrition when FMA is used;
- ✓ Low protein in FMA feeds;
- ✓ Low the cost of FMA.

ACKNOWLEDGEMENTS



D'AGUABI!

