BIOFLOC TECHNOLOGY APPLIED TO REAR SHRIMP *Litopenaeus stylirostris* BROODSTOCK: AN INTEGRATED AND DEVELOPMENT RESEARCH PROJECT IN NEW CALEDONIA AND FRENCH POLYNESIA.

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Introduction

Shrimp farming in New Caledonia and Tahiti face fluctuating quality of broodstock which prevent sustainable production of larvae in quantity and quality. The traditional extensive rearing method of broodstock in outdoor earthen ponds raises several issues: poor water quality control and biosecurity. Therefore it is fundamental to modify the broodstock culture strategy in order to achieve an easier water quality management and maximal biosecurity. Biofloc technology (BFT) offers easier water quality management, higher natural productivity, higher level of biosecurity, and could be a good alternative.

Since 2011 a R&D program started under the supervision of IFREMER in New Caledonia and French Polynesia in order to study and develop biofloc technology for rearing shrimp *L. stylirostris* broodstock.

The main results of our research on the subject are summarized below :

Results

The biofloc aggregates in suspension (microorganisms and detritus) represent a significant food source for growth and reproduction:

- N and C stable isotopes analysis show that 60% of the food of juvenile shrimp came from the natural productivity (Table1).
- Natural productivity is continuously available as food source unlike artificial diet available only during the meal: in such condition shrimps eat all the time hence stimulating their digestive enzymes (Photo1, Table 2).
- Natural productivity is a source of essential fatty acids that accumulate in digestive glande and eggs (Table 3)
- Biofloc aggregates are a natural source of dietary bacterias which can act as probiotics and stimulate inate immunity (i.e. oxidative stress defenses) and digestive activity of the shrimps.

Broodstock shrimps reared in biofloc have better health and reproductive performances

- Shrimps reared in biofloc exibited a better antioxidant defenses status and an stimulated immunity.
- Survivals during reproduction period were improved for broodstock reared in biofloc.
- Shrimps broodstock reared in biofloc laid more frequently and more eggs in once (Figure 1, Table 4))

Eggs from broodstock reared in biofloc showed higher antioxydant status and concentration of HUFA essential fatty acids; they hatch into healthier and stronger larvae

- Eggs from broodstock raised in biofloc accumulate glutathione and essential lipids (table 4)
- The larvae from BFT females had a significantly higher survival rate compared to larvae from females reared in clearwater, respectively 70% (n=4) and 45% (n=4) (Table 4).

Photo 1 : BFT Culture of *L. stylirostris* in BFT. Box : comparison of water from clear water and BFT cultures.

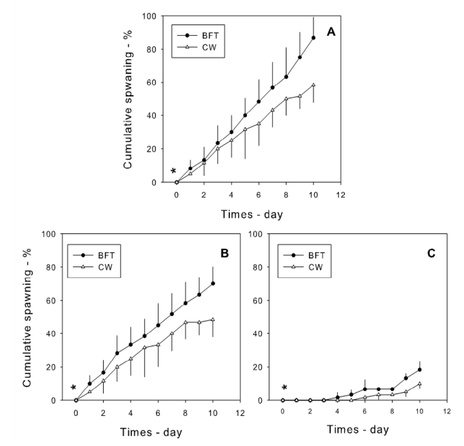

Figure 1 : Evolution of cumulative spawning rates for 100 females per treatment (Clear water and BFT rearing), including all spawns (A) and according to spawning rank 1 (B) and spawning rank 2 (C).

Table 1 : Isotopic value (δ13C and δ15N) and Carbon and nitrogen pourcentage in the two nutritional sources.

	Treatment	$\delta^{13}C$ (‰)	$\delta^{15}N$ (‰)	C (%)	N (%)	C/N
Natural productivty	F	^{a}-19.53 ± 0.33	^{a}10.02 ± 1.35	^{a}20.44 ± 2.42	^{a}3.04 ± 0.60	6.72 ± 0.82
	FF	^{a}-19.74 ± 0.30	^{a}10.21 ± 0.58	^{a}20.60 ± 2.21	^{a}3.25 ± 0.56	6.34 ± 0.48
Pellet	FF and CW	^{b}-24.50± 0.04	^{b}1.41 ± 0.05	^{b}41.08 ± 6.04	^{b}6.04 ± 0.08	6.80 ± 0.06
S		***	***	***	***	n.s

Table 2 : Means values of α-amylase and trypsin relative expression levels and specific enzymatic activities for clear water (CW) BFT without adding artificial diet (F) and BFT+artificial diet (FF)

	Enzyme	CW	F	FF	pvalue
Relative expression level	α amylase	^{a}1,59 ± 0,60	^{a}1,71 ± 0,63	^{b}2,64 ± 0,77	***
	trypsin	^{a}0,85 ± 0,45	^{a}0,90 ± 0,73	^{b}1,46 ± 0,84	*
Specific enzymatic activities	α amylase	^{a}10,09 ± 4,92	^{b}19,27 ± 9,38	^{b}19,32 ± 4,08	***
(U.mg of protein^{-1})	trypsin	^{a}2,78 ± 1,55	^{b}7,99 ± 2,85	^{b}7,32 ± 1,65	***

Table 3 : Total lipid (mg/dry organ or eggs) and class lipid composition in biofloc, digestive gland and eggs according treatments (CW = clear water, BFT = biofloc)

	Biofloc	Digestive gland		S	Eggs		S
		CW	BFT		CW	BFT	
Total lipid	6.91 ± 0.88	15.08 ± 2.84	22.90 ± 4.17	*	23.97 ± 1.68	26.66 ± 0.81	*
Neutral lipids	0.63 ± 0.10	3.03 ± 1.34	7.75 ± 1.72	*	7.39 ± 6.17	8.02 ± 0.60	n.s
Phospholipids	4.91 ± 0.42	10.67 ± 1.85	10.81 ± 1.75	n.s	4.30 ± 3.23	10.76 ± 3.28	*
Fatty acid - Neutral lipids	0.20 ± 0.04	1.38 ± 1.15	5.10 ± 1.72	*	5.95 ± 4.99	6.11 ± 0.98	n.s
Fatty acid - Phospholipids	1.94 ± 0.12	5.72 ± 1.68	7.13 ± 2.33	n.s	2.86 ± 0.33	6.58 ± 2.43	*

Table 4 : Total spawning number, eggs produced based on 75 females per treatment (Clear Water vs BFT) and larval survival (zoe 2 and PL 1)

	CW	BFT	
Total spawning number	35.00 ± 4.04	52.00 ± 5.51	*
Total eggs number x10^{7}	0.61 ± 0.07	1.05 ± 0.11	*
Larval survival Zoe_2	70.06 ± 13.79	87.99 ± 23.80	ns
Larval survival PL_1 stage	45.48 ± 7.67	68.73 ± 12.60	*

Conclusion

The contribution of natural productivity of biofloc in the nutrition of the shrimps is important in quantitative and qualitative terms. Biofloc is source of further dietary lipids that can act as energetic substrate, but also as source of phospholipids and essential fatty acids necessary to sustain reproduction, embryonic and larval development. The improvement of the reproduction of the broodstock reared in BFT also leads to an improvement of the quality of the larvae. This last result is explained by the improvement of anti-radical status and nutritional status of both shrimp broodstock and their offspring.

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