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Jannatul Ferdous Binti
Assistant Teacher, Pakurikanda Govt. Primary School, Rajbari Sadar, Rajbari, Bangladesh

Corresponding Author:
Jannatul Ferdous Binti
Assistant Teacher, Pakurikanda Govt. Primary School, Rajbari Sadar, Rajbari, Bangladesh

Biofloc aquaculture system: Bangladesh perspective

Jannatul Ferdous Binti

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Abstract
Biofloc system is rapidly developing globally in recent days. This technology has tremendous ability to maintain water quality conditions; provides surplus food, nutrition and healthcare; increases production, profitability and hence ensures biosecurity and sustainability and also reduces the costs along with including better technology in farming. In this aspect biofloc aquaculture system can be a better way than the traditional aquaculture in Bangladesh. This review is discussed global aquaculture fishes and crustaceans cultured in biofloc system and its prospects in Bangladesh. This review shows, some global aquaculture candidates including tilapia, carps, catfishes, perch, prawn and shrimp have been successfully cultured in biofloc system in tropical and subtropical region. These global species along with other indigenous aquaculture candidates have enormous potentiality to be implicated in biofloc system. These species can be used to contribute in enhancing aquaculture production, support aquaculture value chain actors for income generation and subsistence. The implication of biofloc system in this country may have recognized a new pathway moving towards traditional system to modern intensive aquaculture system. Therefore, this review suggests research, development and extension program of biofloc system for brood-stock development, nursery operation and grow-out production in Bangladesh.

Keywords: Zero-exchange biofloc system, carbon sources, C: N ratio, microbial based system, Aquaculture sustainability, Bangladesh aquaculture

1. Introduction

Aquaculture is a rapidly growing food production sector; provides food, nutrition, income and subsistence; a total of 19.3 million people are engaged globally in 2016 (FAO 2018) [27]. This sector had provided 80.3 million tonnes food fish, which occupied of 47% to total production in 2016. A decade ago, in 2007, aquaculture production was 49.94 million tonnes, it had contributed 36% of food fish production. The annual growth rate of this sector is accounted of 5.8 for 2001-2016. Per capita fish consumption has been increased day by day, it reached peak about 20.5 Kg in 2017 while it was 9 Kg in 1961. The global demand of aquaculture commodity has been increased owing to huge global population (7.8 billion) including Bangladesh (170 million). Therefore, the expansion and intensification of aquaculture system is highly required, while this sector has been challenged by some particular limitations of natural resources such as land, water and some environmental causes. So expansion and intensification of aquaculture industry is attributed by three fundamentals. Firstly, aquaculture system must be enhanced production by use of minimal water and land (Avnimelech, 2009) [9]. Secondly, aquaculture system will not cause any harm to the environment. Finally, aquaculture system will ensure a reasonable ratio of cost/benefit to support income generation as well as subsistence. These three prerequisites of aquaculture system could be helpful to increase production and profitability and also could ensure sustainability.

To fulfill animal protein demand fish play a vital role in Bangladeshi food menu; more than 60% of animal protein source has been provided by fish (Belton *et al*., 2011) [19]. According to DoF (2018) [23], Bangladesh is one of the top fish producing countries in the world, which produced about 4.27 million tonnes of fish in 2017-2018. These fish are from inland capture fisheries and aquaculture as well as marine fisheries; which have contributed about 28.45% (1.21 million tonnes), 56.24% (2.40 million tonnes) and 15.31% (0.06 million tonnes) in total production respectively; where aquaculture play crucial role in this country in terms of food, nutrition and subsistence.

Biofloc system is considered as an environment friendly "blue revolution" in aquaculture (Emerenciano *et al*., 2017) [36]. This technology prerequisites by adjustment of appropriate carbon and nitrogen ratios (C: N ratio of 10-20) (Avnimelech, 2009) [9]. Carbon source supplementation is stimulated to enhance heterotrophic micro-organisms growth, which removes nitrogenous toxicants, provides surplus live foods, nutrition and healthcare to culture animal (Ahmad *et al*., 2017) [1]. This system is synonymously known as microbial protein generation system (Avnimelech *et al*., 1989) [12], active-sludge or suspended bacterial-based system, suspended-growth system, zero-exchange autotrophic heterotrophic system (Wasielesky *et al*., 2006) [20], microbial floc system (Avnimelech 2007; Ballester *et al*., 2010) [10, 15]. This system has improved animal performance, augment productivity hence farm biosecurity and sustainability are ensured. It has been successfully carried out in indoor, outdoor and earthen pond for fishes and crustaceans broodstock nursery and grow-out production (Braga *et al*., 2015; Ekasari *et al*., 2015, 2016; Cardona *et al*., 2016) [20, 24]. This system can be integrated with aquaponics (Pinho *et al*., 2017) [36]. Therefore, this review has discussed the prospects of biofloc aquaculture system in Bangladesh.

Materials and Methods

The information used in this review were sourced from the available articles on biofloc aquaculture system. Google Scholar, ResearchGate, Springer Link have been used to search published articles. Due to scarcity of information, I had to limit the literature search from 2000-2019, in the above mentioned search engines. Some information are also collected from books related to biofloc system. To get relevant articles I used keywords such as biofloc system, aquaculture sustainability, Bangladesh aquaculture, carbon sources, C: N ratio, fish or prawn/shrimp culture in biofloc system, microbial control etc. I selected around 120 papers for this review. I read through the articles name and abstract, then sorted out the relevant papers to be reviewed and downloaded them for further study.

For this review I prepared some data criteria, after the selection of papers.

Here are the criteria which I prepared for this review:

- Global biofloc aquaculture status.
- Aquaculture production in traditional and biofloc system.

These information of biofloc system have been summarized and presented in Table 1 and 2.

Results and Discussion

The application of appropriate ratio of carbon sources in biofloc aquaculture system is perquisite. To date, different types of carbon sources have been used for fish, crustacean, and echinoderm culture in biofloc system (Table 1) and most of these carbon sources are available in Bangladesh.

Some carp species (*Cyprinus carpio*, Hypophthalmichthys molitrix, Aristichtys nobilis, Labeo rohita, Carassius auratus gibelio etc.) have been greatly attained higher growth performance in biofloc system globally (Table 1). Most of these carps are available and cultured in polyculture system with tilapia and pangas in earthen pond throughout Bangladesh (Belton *et al*., 2011; Islam and Yasmin, 2017) [19, 5]. According to DoF (2018) [23], major carps (Catla, Labeo and Cirrhinus) and exotic carps (Ctenopharyngodon idella, *Cyprinus carpio*, *Hypophthalmichthys molitrix*, *Hypophthalmichthys nobilis*, *Puntius gonionotus* etc.) contributed about 19.79 and 10.62% of fish total production in Bangladesh. Therefore, these carp species may have been implicated in biofloc system in this country.

Tilapia culture is now booming in Bangladesh, it is widely raised in earthen pond, cage and rice-fish system (Barman and Little, 2006; Alam *et al*., 2019; Rahman *et al*., 2019) [17, 3, 37]. This fish has contributed about 10.62% of total production, while Bangladesh possessed 4th placed in the world and 3rd in Asia (DoF 2018) [23]. Recently, tilapia has been gained imperative attention in biofloc system globally owing tremendous success earthen pond and indoor system (Table 2). The implication of biofloc system in Bangladesh aquaculture may have huge opportunities for hatcheries, nurseries and grow-out production. It can be helpful to enhance production and profitability among value chain actors including small holders.

Table 1: Global biofloc aquaculture status

Carbon source	Culture species	Country	C: N ratio	SR (%)	Final weight (g)		FCR		References
					BFT	Con	BFT	Con	
Acetate	*Macrobrachium rosenbergii*	Belgium	10	25					Crab *et al*., (2010) [12]
Brown sugar		Brazil	12	76.81	49	55	2.25	1.82	Ballester *et al*., (2017) [16]
Corn flour/starch (S)	*Cyprinus carpio*	Iran	20	97.3	51.7	46.7	1.3	1.6	Bakhshi *et al*., (2018) [14]
	Hypophthalmichthys molitrix	China	19	98.41	232.82	163.21			Zhao *et al*., (2014) [42]
	Aristichtys nobilis	China	23	100	240.17	159.76			Zhao *et al*., (2014) [42]
	Oreochromis niloticus	Brazil	20	99.57			1.39		Pasco *et al*., (2018)
	Labeo rohita	India	12.5				1.76	3.08	Ahmad *et al*., (2016) [1]
	Liza carinata	Egypt	10	99.59	21.40	20.92	0.86	1.38	Khalil *et al*., (2016)
	Litopenaeus vannamei	Iran	15	88.20	1.69	1.48	1.28	1.52	Khanjani *et al*., (2017)
Dextrose	*L. vannamei*	Brazil	20	82.70	7.19				Serra *et al*., (2015)
Glycerol	*M. rosenbergii*	Belgium	10	60					Crab *et al*., (2010) [12]
	Lemon fin barb hybrid	Malaysia	15	100	3.85	3.04	2.07	2.64	Dauda *et al*., (2018)
	Clarias gariepinus			83.33	2.88	2.78	1.47	1.62	
Glucose (G)	*Mugil cephalus*	Spain	19	81.1	1.66	3.31			Vinatea *et al*., (2018)
	Tinca tinca			91.6	3.28	4.14			
	Pimephales promelas	USA	12	95	2.19	2.18	3.37	1.93	Park *et al*., (2017)
	O. niloticus	China	15		15.08	13.04	1.5	1.25	Liu *et al*., (2018)
	M. rosenbergii	Belgium	10	70					Crab *et al*., (2010) [12]
	Apostichopus japonicus	China	15	Glucose is suitable					Chen *et al*., (2018)
Molasses	*C. carpio*	Iran	20	92.0	49.9	46.7	1.4	1.6	Bakhshi *et al*., (2018) [14]
	O. niloticus	Mexico	10	94.75	254.31	280.89	1.01	1.02	Pérez-Fuentes *et al*., (2016)

									[34]
	Carassius auratus gibelio	China	15	100	51.15				Zhang *et al*., (2018) [41]
	Pangasius pangasius	Indonesia	20	97.5	49.81		0.63		Sukardi *et al*., (2019)
	Scatophagus argus	Vietnam	15	79.2	34.9	23.5	1.64	3.46	Khanh *et al*., (2018) [38]
	Anabas testudineus	Indonesia	20	Three times higher profit ensured					Izmaniar *et al*., (2018)
	Ictalurus punctatus	USA	20	99.9	598.8				Green, (2015) [28]
	L. vannamei	Brazil	20	92.71	0.44		1.76		Peixoto *et al*., (2018)
	P. monodon	India	10	73.3	7.8	6.1	1.1	3.5	Kumar *et al*., (2017)
	M. rosenbergii	Mexico	20	85.31	15.18	12.57	2.27	2.74	(Pérez-Fuentes *et al*., (2013) [34]
	Farfantepenaeus duorarum	Mexico	20	63.2	13.3	13.9			Emerenciano *et al*., (2013)
PKE	*L. vannamei*	India	15	88.67	4.99	3.55	1.61	1.86	Syamala *et al*., (2017)
Sugar	*C. carpio*	Iran	20	97.3	49.6	46.7	1.4	1.6	Bakhshi *et al*., (2018) [14]
	O. niloticus	Brazil		80.35	353.26	409.84	1.89	1.61	de Lima *et al*., (2018)
Sucrose	*Marsupenaeus japonicas*	China	20	65.7	11.33	9.98	1.67	1.8	Zhao *et al*., (2012) [41]
Tapioca	*C. gariepinus*	Indonesia	10	96.67	3.9	4.09	0.92	0.97	Fauji *et al*., (2018) [25]
	L. vannamei	India	20	85.6	7.25	5.97			Rajkumar *et al*., (2016)
Rice bran	*L. vannamei*	Indonesia	15	85	7.36	7.14	1.56	1.67	Ekasari *et al*., (2014) [24]
Rice flour	*P. Monodon*	India	10	86.7	8.5	6.1	2.3	3.5	Kumar *et al*., (2017)
Wheat bran	*L. rohita*	India	12.5	Good growth with minimum FCR					Ahmad *et al*., (2016) [1]
Wheat flour (WF)		India	10	100	97.36	80.66	3.66	4.58	Mahanand *et al*., (2013)
	O. niloticus	UK	11.6	100	140.72		3.51		Azim and Little, (2008) [8]
	Penaeus semisulcatus	Egypt	20	88.4	19.8	15.1	1.21	3.1	Megahed, (2010)
	L. vannamei	Iran	15	86.41	1.64	1.48	1.29	1.52	Khanjani *et al*., (2017)
M+S+WF				90	1.71		1.22		
WB+G	*Procambarus clarkii*	China	>15	66.88	17.16	15.79			Li *et al*., (2019) [42]
M+WB	*F. brasiliensis*	Brazil	20	81.5	0.21				Emerenciano *et al*., (2012)

Catfish aquaculture is very popular in Bangladesh particularly Pangas. This fish has been constituted 10.60% of total production (DoF 2018) [23]. Recently, several indigenous catfishes (*Heteropneustes fossilis*, *Clarias batrachus*, *Mystus cavasius*, *Ompok pabda*) are illustrated considering attention among farmers due to their high demand and market values (Ahmed *et al*., 2010; Hossain *et al*., 1998; Rahman, 2014) [2, 30, 37]. These catfishes including Pangas have traditionally been cultured in earthen pond, but these have immense prospects in indoor aquaculture. The breakthrough of several catfishes (*Clarias gariepinus*, *Pangasius pangasius*, *Ictalurus punctatus*) have been achieved in biofloc system (Table 1). Thus, our indigenous catfishes and Pangas can be tested in pond and indoor biofloc system.

There are some aquaculture species such as *A. testudineus*, *L. carinata*, *M. cephalus*, *P. promelas* and *T. tinca* have been drawn considerable attention in biofloc system (Table 1). It is worthy to mention that Fathead minnows (*P. promelas*) is sold as baitfish in USA, this important commercial fish is cultured in BFT with high stocking density (4-8 individuals million hac^{-1}) in pond. This research can inspire and enable small fish culture in biofloc system in Bangladesh. Traditionally, our people are preferred to consume the small fishes. Thus, biofloc studies of small fishes might boost up production and meet high demand.

Table 2: Aquaculture production in traditional and biofloc system

Country	Species	Production (ton/ha)	Culture system	Duration (year/day)	References
Bangladesh	Prawn/shrimp	0.98	Traditional	20017-18	DoF (2018) [23]
	Pond fish production	4.85			
	Tilapia	6.09	Monoculture		Ferdoushi *et al*., (2019) [27]
		5.15	Polyculture		
		3.94	Monoculture	90	Khan *et al*., (2013)
		7.36-8.96			Alam *et al*., (2012) [4]
	Carp-sis	3.15	Polyculture	180	Mondal *et al*., (2018) [33]
Israel	Tilapia	55-76	Biofloc	51	Avnimelech *et al*., (1994) [11]
UK	Tilapia	21-30	Biofloc	84	Azim and Little, (2008) [13]
Bangladesh	Giant prawn	0.44-0.58	Biofloc	120	Asaduzzaman *et al*., (2008) [8]
India	*Penaeus monodon*	0.44-0.64	Biofloc	94	Hari *et al*., (2006)

In Bangladesh application of biofloc syatem can augment the production and profitability of fish and crustacean (Table 1 & 2). This system can ensure good water quality condition, proliferate live foods (phytoplankton, zooplankton, benthos), increase production, minimize FCR and maximize protein efficiency ratios, enhance disease resistance and immunity and reduce culture duration. Therefore, more research, development and extension of biofloc system are recommended for ensuring profitability and sustainability of the growing aquaculture sector in Bangladesh.

Conclusion

Biofloc system could be used as a useful indicator for the improvement of aquaculture production in Bangladesh. This system could provide higher productivity through reducing culture duration and land use with lesser environmental impact. This review recommends more research to identify the suitable local carbon sources, carbon to nitrogen ratios, appropriate protein in feeds with feeding frequency for fish and crustaceans. These researches should also be determined the subsequent effects on quality of water, proximate composition, growth performance, immunity, disease resistance and stress conditions. These research implications in aquaculture sector could be beneficial for income generation and resilience to climate change conditions, which archives sustainable development goal of this country.

References

1. Ahmad I, Rani AB, Verma AK, Maqsood M. Biofloc technology: an emerging avenue in aquatic animal healthcare and nutrition. Aquaculture Int. 2017;25(3):1215-1226.
2. Ahmed N, Alam MF, Hasan MR. The economics of sutchi catfish (*Pangasianodon hypophthalmus*) aquaculture under three different farming systems in rural Bangladesh. Aquaculture Res. 2010;41(11):1668-1682.
3. Alam MA, Guttormsen AG, Roll KH. Production risk and technical efficiency of tilapia aquaculture in Bangladesh. Mar Resour Econ. 2019;34(2):123-141.
4. Alam MF, Khan MA, Huq AA. Technical efficiency in tilapia farming of Bangladesh: A stochastic frontier production approach. Aquaculture Int. 2012;20(4):619-634.
5. Asaduzzaman M, Rahman MM, Azim ME, Islam MA, Wahab MA, Verdegem MCJ, *et al*. Effects of C/N ratio and substrate addition on natural food communities in freshwater prawn monoculture ponds. Aquaculture. 2010;306(1-4):127-136.
6. Asaduzzaman M, Salam MA, Wahab MA, Kunda M, Rahman MB. Effects of control of C/N ratio by low-cost carbohydrate addition on water quality and pond ecology in freshwater prawn Macrobrachium rosenbergii post-larvae nursing system. Bangladesh J Fish Res. 2006;10(2):121-30.
7. Asaduzzaman M, Wahab MA, Verdegem MCJ, Adhikary RK, Rahman SMS, Azim ME, *et al*. Effects of carbohydrate source for maintaining a high C ratio and fish-driven re-suspension on pond ecology and production in periphyton-based freshwater prawn culture systems. Aquaculture. 2010;301(1-4):37-46.
8. Asaduzzaman M, Wahab MA, Verdegem MCJ, Huque S, Salam MA, Azim ME. C/N ratio control and substrate addition for periphyton development jointly enhance freshwater prawn Macrobrachium rosenbergii production in ponds. Aquaculture. 2008;280(1-4):117-123.
9. Avnimelech Y. Biofloc technology: A practical guide book. World Aquaculture Society; c2009.
10. Avnimelech Y. Feeding with microbial flocs by tilapia in minimal discharge bio-flocs technology ponds. Aquaculture. 2007;264(1-4):140-147.
11. Avnimelech Y, Kochva M, Diab S. Development of controlled intensive aquaculture systems with a limited water exchange and adjusted carbon to nitrogen ratio. Israeli J Aquaculture-Bamidgeh. 1994;46(3):119-131.
12. Avnimelech Y, Mokady S, Schroeder GL. Circulated ponds as efficient bioreactors for single cell protein production. Israeli J Aquaculture. 1989;41(2):58-66.
13. Azim ME, Little DC. The biofloc technology (BFT) in indoor tanks: water quality, biofloc composition, and growth and welfare of Nile tilapia (*Oreochromis niloticus*). Aquaculture. 2008;283(1-4):29-35.
14. Bakhshi F, Najdegerami EH, Manaffar R, Tukmechi A, Farah KR. Use of different carbon sources for the biofloc system during the grow-out culture of common carp (*Cyprinus carpio* L.) fingerlings. Aquaculture. 2018;484:259-67.
15. Ballester ELC, Abreu PC, Cavalli RO, Emerenciano M, De Abreu L, Wasielesky Jr W. Effect of practical diets with different protein levels on the performance of Farfantepenaeus paulensis juveniles nursed in a zero exchange suspended microbial flocs intensive system. Aquaculture Nutr. 2010;16(2):163-172.
16. Ballester ELC, Marzarotto SA, Silva de Castro C, Frozza A, Pastore I, Abreu PC. Productive performance of juvenile freshwater prawns Macrobrachium rosenbergii in biofloc system. Aquaculture Res. 2017;48(9):4748-55.
17. Barman BK, Little DC. Nile tilapia (*Oreochromis niloticus*) seed production in irrigated rice-fields in Northwest Bangladesh: An approach appropriate for poorer farmers? Aquaculture. 2006;261(1):72-79.
18. BBS. Yearbook of Agricultural Statistics-2017. Bangladesh Bureau of Statistics, Ministry of Planning, Bangladesh; c2018.
19. Belton B, Karim M, Thilsted S, Collis W, Phillips M. Review of aquaculture and fish consumption in Bangladesh. Aquaculture and Fish Consumption in Bangladesh. The WorldFish Center; c2011:71.
20. Braga A, Lopes DL, Magalhaes V, Poersch LH, Wasielesky W. Use of biofloc technology during the pre-maturation period of Litopenaeus vannamei males: effect of feeds with different protein levels on the spermatophore and sperm quality. Aquaculture Res. 2015;46(8):1965-73.
21. Cardona E, Lorgeoux B, Chim L, Goguenheim J, Le Delliou H, Cahu C. Biofloc contribution to antioxidant defence status, lipid nutrition and reproductive performance of broodstock of the shrimp Litopenaeus stylirostris: consequences for the quality of eggs and larvae. Aquaculture. 2016;452:252-262.
22. Crab R, Lambert A, Defoirdt T, Bossier P, Verstraete W. The application of bioflocs technology to protect brine shrimp (*Artemia franciscana*) from pathogenic Vibrio harveyi. J Appl Microbiol. 2010;109(5):1643-1649.
23. DoF. Yearbook of Fisheries Statistics of Bangladesh, 2017-18. Department of Fisheries, Bangladesh: Ministry of Fisheries; c2018:129.
24. Ekasari J, Rivandi DR, Firdausi AP, Surawidjaja EH, Zairin Jr M, Bossier P, De Schryver P. Biofloc technology positively affects Nile tilapia (*Oreochromis niloticus*) larvae performance. Aquaculture. 2015;441:72-7.
25. Fauji H, Budiardi T, Ekasari J. Growth performance and robustness of African Catfish Clarias gariepinus (Burchell) in biofloc-based nursery production with different stocking densities. Aquaculture Res. 2018;49(3):1339-46.
26. FAO. The State of World Fisheries and Aquaculture 2018- Meeting the sustainable development goals. Food and Agriculture Organization of the United Nations, Rome; c2018.
27. Ferdoushi Z, Patwary ZP, Ara Y, Rana M. Economic analysis of tilapia farming in some selected areas of Dinajpur District: A comparison between monoculture and polyculture. J Bangladesh Agril Univ. 2019;17(1):117-21.
28. Green BW. Performance of a temperate-zone channel catfish biofloc technology production system during winter. Aquacultural Eng. 2015;64:60-7.
29. Hossain MA, Paul L. Low-cost diet for monoculture of

giant freshwater prawn (Macrobrachium rosenbergii de Man) in Bangladesh. Aquaculture Res. 2007;38(3):232-8.

30. Hossain MAR, Hasan MR. An assessment of impacts from shrimp aquaculture in Bangladesh and prospects for improvement. FAO Fisheries and Aquaculture Technical Paper No. 618; c2017:96.
31. Khan S, Hossain MS, Hossain MM. Production and economics of GIFT strain of tilapia (*Oreochromis niloticus*) in small seasonal ponds. Prog Agric. 2008;19(1):97-104.
32. Lima ECRD, Souza RLD, Girao PJM, Braga IFM, Correia EDS. Culture of Nile tilapia in a biofloc system with different sources of carbon. Rev Ciênc Agronômica. 2018;49(3):458-66.
33. Mondal S, Wahab MA, Barman BK, Mer M, Hossain M. Impact on environment intervention of carps-sis polyculture in north-west of Bangladesh. [Publication details needed for completion].
34. Pérez-Fuentes JA, Hernández-Vergara MP, Pérez-Rostro CI, Fogel I. C
35. ratios affect nitrogen removal and production of Nile tilapia *Oreochromis niloticus* raised in a biofloc system under high density cultivation. Aquaculture. 2016;452:247-51.
36. Pinho SM, Molinari D, de Mello GL, Fitzsimmons KM, Emerenciano MGC. Effluent from a biofloc technology (BFT) tilapia culture on the aquaponics production of different lettuce varieties. Ecol Eng. 2017;103:146-53.
37. Rahman MT, Nielsen R, Khan MA. Agglomeration externalities and technical efficiency: An empirical application to the pond aquaculture of Pangas and Tilapia in Bangladesh. Aquaculture Econ Manag. 2019;23(2):158-87.
38. Van Khanh L, Hai TN, Phuong NT, Son VN. Effects of different C
39. ratios on growth and survival of spotted scat (Scatophagus argus) in the biofloc system. [Publication details needed for completion].
40. Verma AK, Rani AB, Rathore G, Saharan N, Gora AH. Growth, non-specific immunity and disease resistance of Labeo rohita against Aeromonas hydrophila in biofloc systems using different carbon sources. Aquaculture. 2016;457:61-67.
41. Zhao P, Huang J, Wang XH, Song XL, Yang CH, Zhang XG, Wang GC. The application of bioflocs technology in high-intensive, zero exchange farming systems of Marsupenaeus japonicus. Aquaculture. 2012;354:97-106.
42. Zhao Z, Xu Q, Luo L, Li J, Wang L. Effect of feed C/N ratio promoted bioflocs on water quality and production performance of bottom and filter feeder carp in minimum-water exchanged pond polyculture system. Aquaculture. 2014;434:442-8.