Agricultural Sciences, 2024, 15, 71-81
https://www.scirp.org/journal/as
ISSN Online: 2156-8561
ISSN Print: 2156-8553

Effect of Different Feeds on Growth and Survival of the Sergestid Shrimp *Acetes vulgaris* Hansen, 1919 (Decapoda: Sergestidae)

Alongkorn Phudhom[1], Karnjana Hrimpeng[2], Wansuk Senanan[3], Nongnud Tangkrock-Olan[1,3]*

[1]Graduate Program in Environmental Science, Faculty of Science, Burapha University, Chonburi, Thailand
[2]Department of Microbiology Science, Faculty of Science, Burapha University, Chonburi, Thailand
[3]Department of Aquatic Science, Faculty of Science, Burapha University, Chonburi, Thailand
Email: *korn2alongkorn@gmail.com

How to cite this paper: Phudhom, A., Hrimpeng, K., Senanan, W. and Tangkrock-Olan, N. (2024) Effect of Different Feeds on Growth and Survival of the Sergestid Shrimp *Acetes vulgaris* Hansen, 1919 (Decapoda: Sergestidae). *Agricultural Sciences*, **15**, 71-81.
https://doi.org/10.4236/as.2024.151005

Received: November 29, 2023
Accepted: January 14, 2024
Published: January 17, 2024

Abstract

The sergestid shrimp *Acetes vulgaris* has long been an important fishery species in estuaries and coastal waters along the Pang-Rad River, Rayong province, Thailand. In nature, this shrimp feeds on a wide range of food items, such as phytoplankton, zooplankton, algae, plant matter, debris, sand, and mud. The objective of this study was to compare different feeds on growth and survival of *A. vulgaris* reared in fiberglass tanks containing 70 m^3 of seawater salinity 25 ppt over a period of 70 days. Individual shrimps were fed with four different types of feeds *i.e.*, newly hatched *Artemia* (Ar), rotifer (Ro), newly hatched *Artemia* + rotifer (ArRo) and shrimp larvae commercial feed (SF). Results suggested that specific growth rates (both for body weight and body length) of shrimps reared with SF were not significantly different with treatment feed with Ar, ArRo and Ro ($p \geq 0.05$). The survival rate of *A. vulgaris* did not vary significantly ($p \geq 0.05$) among the Ar, Ro and ArRo treatments. However, the highest survival rate of shrimp (81.78% ± 3.08%) was observed in SF treatment and the percentage of survival rate was significantly different with treatment feed with Ar, Ro and ArRo ($p \leq 0.05$). The findings reflected the ability of *Acetes* shrimps to consume diverse food types including both live feed and pelleted feed. Insights obtained from this research suggested that artificial feed can be as efficient as live feeds. This new knowledge is a needed addition to a currently lacking knowledge base for aquaculture of this *Acetes* species.

Keywords

Acetes vulgaris, Sergestid Shrimp, Food, Growth, Survival

1. Introduction

The shrimps of the genus *Acetes* (Crustacea, Decapoda, Sergestidae) are small planktonic shrimps [1] with an average length of 10 - 40 mm and average weight of 0.2 - 0.5 g [2]. Recently, 14 species of *Acetes* have been recognized and distributed worldwide [3]. The *Acetes* shrimps live mainly in the estuaries and coastal water of the tropical and subtropical regions of the world [4] [5]. In nature, *Acetes* shrimps are the link between phytoplankton, zooplankton, and animals at higher trophic levels [6]. They are commercially important organism in Asian countries [7] and East African waters [8]. In 2021, the annual catches of *Acetes* in Thailand were 25,800 tons [9].

The species *Acetes vulgaris* Hansen, 1919 occurs in estuaries and shallow coastal waters along the Gulf of Thailand and the Andaman Sea [10]. They are brackish and able to survive in salinity of 30 ppt or less, during certain seasons of the year [11]. They feed on a wide range of food items [12]. They eat several things like phytoplankton, zooplankton, algae, plant matter, debris, sand and mud [13] [14] [15] [16]. They are the most common species found along the coastal area of Rayong Province in Thailand [10]. This species is one of the most important commercial shrimp resources in Thailand and other countries in Asia [17]. In Thailand *A. vulgaris* is commercially exploited from July to September, using push nets [18]. The main uses of this shrimp are as fermented food, locally known as "Kapi" and as a dried product. It has also been used to feed larvae and adults of penaeid shrimps in aquaculture industry and laboratory [12].

In comparison with the knowledge of distribution, taxonomy, ecology, and biology [19] [20] [21] little is known about the effect of different types of feeds on growth and survival of *Acetes* species. Since quality food and proper nutrition are key to the success of commercial shrimp culture, probably including *Acetes* species. Until now, there has been no study concerned about feeding of *Acetes* shrimps in Thailand. Thus, the objective of the present study is to investigate differences in growth and survival rates of *A. vulgaris* with respect to different feeds. The results of these studies could help to understand feeding ecology, aquaculture, and probably could also help to understand sustainable management of the *Acetes* shrimp resources in the near future.

2. Materials and Methods

2.1. Source of Shrimps and Experimental Design

A. vulgaris were collected from the estuarine areas of the Pang-Rad River (12˚41'49.9"N; 101˚47'10.8"E), Rayong Province. Shrimps were caught using an umbrella dip net shrimp with fine mesh size 2 × 2 mm. during the period of August to September 2018. The shrimps were transported in oxygenated polythene bag to the laboratory. Before experimentation, shrimps were reared in 2000 L concrete tank filled with seawater at 25 ppt under constant aeration and were acclimated for one week at ambient temperature of 27˚C - 29˚C. Shrimps were fed with newly hatched *Artemia* nauplii as a satiation feed three times daily (08.00 a.m., 01.00 p.m. and 06.00 p.m.). Fecal matter and uneaten feed in tanks were siphoned every day.

After one week of acclimation, 1800 shrimps of similar size (average initial weight of 27.25 ± 6.54 mg and length of 20.90 ± 2.06 mm) were randomly distributed into a closed recirculating aquaculture system equipped with twelve 100 m3 fiberglass tanks containing 70 m^3 of seawater salinity 25 ppt (**Figure 1**). Each fiberglass tank contained 150 shrimps with three replicate tanks per experimental treatments. Four different types of feeds *i.e.*, newly hatched *Artemia* (Ar), rotifer *Brachionus rotundiformis* (Ro), newly hatched *Artemia* + rotifer (ArRo) and shrimp larvae commercial feed (SF) were applied to treatments I, II, III and IV respectively. The particle size of SF was 250 - 500 µ with nutritional profile as shown in **Table 1** (Lansy-Shrimp PL (INVE®, Phichit, Thailand). Shrimps were fed daily ad libitum three times a day (08.00 a.m., 01.00 p.m. and 06.00 p.m.) with four different feeds. The experimental time lasted 70 days (10 weeks).

2.2. Water Quality

Water quality including temperature, salinity, dissolved oxygen, pH, alkaline,

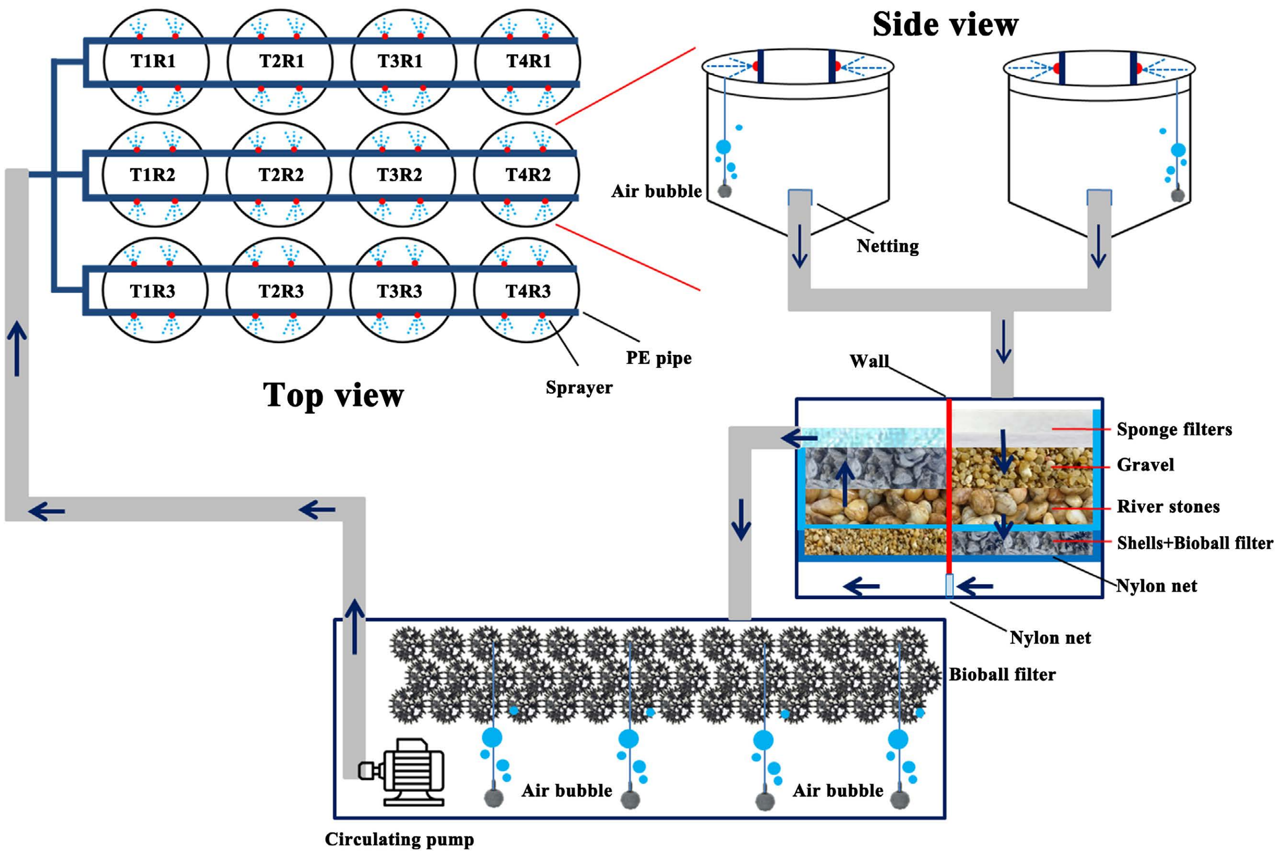

Figure 1. Diagram showing a closed recirculating aquaculture system equipped with twelve 100 m^3 fiberglass tanks (T = treatment, R = replicate), (T1 = Ar, T2 = Ro, T3 = ArRo, T4 = SF).

Table 1. Nutritional profile of the shrimp larvae commercial feed (SF) according to manufactures (Lansy-Shrimp PL (INVE®, Phichit, Thailand).

Ingredient	Approximate amount
Protein	≥48.0%
Fat	≥9.0%
Ash	≤2.5%
Moisture	≤9.0%

ammonia, nitrite and nitrate of each treatment was controlled right weekly before and during the cultivated period. Temperature, salinity and dissolved oxygen were determined directly by digital water analysis instrument (Multi-probe, YSI Pro 2010); while pH was measured using pH meter (Horiba Model: pH-22). Alkalinity was measured titrimetrically; while Nitrite was measured using spectrophotometer (Thermo Scientific, Genesys 20).

2.3. Data Collection and Calculation

Twenty individual shrimps were randomly collected to determine growth performance parameters immediately before being arranged in the tanks and every fortnight during the experimental period. At each sampling, each organism was gently blotted dry and weighed individually using four digital balances Sartorius, AX224). Simultaneously the length was measured from the rostrum tip to the telson end using a digital vernier caliper.

At the end of experiment, the total number, weight and length of shrimps in each experimental tank were determined. The daily weight gains, daily length gains, specific growth rate (body weight), specific growth rate (body length) and the survival rates were calculated using the following equations [22]:

Weight gain (WG) (mg) = Final weight (mg) − Initial weight (mg)

Length gain (LG) (mm) = Final length (mm) − Initial length (mm)

Daily weight gain (mg day^{-1}) = (Final weight − Initial weight)/Culturing days

Daily length gain (mm day^{-1}) = (Final length − Initial length)/Culturing days

$$\text{Specific growth rate} = \frac{(\text{Ln final weight} - \text{Ln initial weight})}{\text{Culturing days}} \times 100$$

(body weight) (% day^{-1})

$$\text{Specific growth rate} = \frac{(\text{Ln final length} - \text{Ln initial length})}{\text{Culturing days}} \times 100$$

(body length) (% day^{-1})

$$\text{Survival rate}(\%) = \frac{\text{Final shrimp number}}{\text{Initial shrimp number}} \times 100$$

2.4. Statistical Analysis

One-way analysis of variance (ANOVA) was conducted on all data, followed by

Tukey's multiple range tests to identified significant differences between the mean values (significance level of $p \leq 0.05$) using the Statistical Package for the Social Science (SPSS) software for Windows version 19.0.

3. Results and Discussion

3.1. Water Quality

Water quality in each experimental tank deteriorated due to the accumulation of fecal matter and the decomposition of uneaten food. Thus, a daily water change of 30% of the total water volume had been done. Changing water was done by using a siphon with a strainer at the intake end. Regular siphoning of sediments at the bottom of culture tanks was done 3 times a week.

The values of water quality parameters, including temperature, salinity, dissolved oxygen, pH, alkaline, ammonia, nitrite, and nitrate are presented in **Table 2**. All water quality parameters in all experimental tanks fluctuated within the suitable range for the whole period of culture and were within the optimal range for shrimp culture [23] [24].

3.2. Body Weight Gains

Data in **Figure 2** show that the mean weight of *A. vulgaris* increased with culturing time in all treatments. After 70 days, the mean weight of shrimps increased from the initial weight (27.25 ± 6.54 mg) to 70.37 ± 18.41, 54.37 ± 16.03, 69.49 ± 24.94 and 61.58 ± 18.82 mg in treatment feed with *Artemia* (Ar), Rotifer (Ro), *Artemia* + Rotifer (ArRo) and Shrimp larvae commercial feed (SF) respectively.

The mean final weight of shrimps ranged between 54.37 ± 16.03 mg to 70.37 ± 18.41 mg, with the highest in Ar treatment and lowest in Ro treatment. Shrimps reared with Ro had the lowest weight and were not significantly different with treatment feed with SF ($p \geq 0.05$) but significantly different with treatment feed with Ar, and ArRo ($p \leq 0.05$). The mean final weight of shrimps reared with SF was not significantly different with treatment feed with Ar, ArRo and Ro ($p \geq 0.05$).

Table 2. Mean water quality parameters analyzed in different feeds treatments during 70 days of rearing *A. vulgaris*.

Parameters	Mean ± SD	Minimum	Maximum
Temp (˚C)	29.92 ± 0.48	28.7	31.0
Salinity (ppt)	25.43 ± 0.24	25.00	25.90
Dissolved oxygen ($mg \cdot L^{-1}$)	5.18 ± 0.28	4.80	6.10
pH	7.75 ± 0.09	7.55	8.03
Alkaline ($mg \cdot L^{-1}$)	119.00 ± 19.17	85.00	153.00
Ammonia ($mg \cdot L^{-1}$)	0.1568 ± 0.1840	0.0064	0.5899
Nitrite ($mg \cdot L^{-1}$)	0.0386 ± 0.0332	0.0064	0.1036
Nitrate ($mg \cdot L^{-1}$)	1.8539 ± 0.4515	1.2521	2.6328

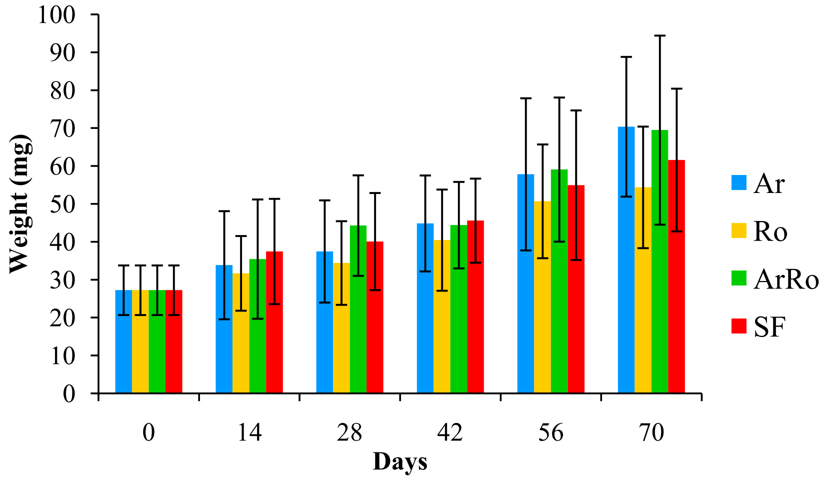

Figure 2. Mean weight of *A. vulgaris* in different feeds during periods of culture. *Artemia* (Ar), Rotifer (Ro), *Artemia* + Rotifer (ArRo) and Shrimp larvae commercial feed (SF).

Similar results were found for the weight gains, daily weight gains and specific growth rate that shrimps reared with Ro had the lowest weight gain and daily weight gain and were not significantly different with treatment feed with SF ($p \geq 0.05$) but significantly different with treatment feed with Ar and ArRo ($p \leq 0.05$). The weight gains daily weight gain and specific growth rate of shrimps reared with SF were not significantly different with treatment feed with Ar, ArRo and Ro ($p \geq 0.05$). (**Table 3**)

3.3. Body Length Gains

Data in **Figure 3** show that the mean length of *A. vulgaris* increased with culturing time in all treatments. After 70 days, the mean length of shrimps increased from the initial length (20.90 ± 2.06 mm) to 27.49 ± 2.13, 26.41 ± 2.72, 27.90 ± 4.34 and 27.01 ± 2.92 mm in treatment feed with *Artemia* (Ar), Rotifer (Ro), *Artemia* + Rotifer (ArRo) and Shrimp larvae commercial feed (SF) respectively.

The mean final length of shrimps ranged between 26.41 ± 2.72 mm to 27.90 ± 4.34 mm, with the highest in ArRo treatment and lowest in Ro treatment. Shrimps reared with Rotifer (Ro) had the lowest length and were significantly different with treatment feed with Ar, ArRo and SF ($p \leq 0.05$). The mean final length of shrimps reared with SF was not significantly different with treatment feed with Ar and ArRo ($p \geq 0.05$).

Similar results were found for the length gains, daily length gains and specific growth rate (body length) that shrimps reared with Ro had the lowest length gain, daily length gain and specific growth rate (body length) and were significantly different with treatment feed with Ar, ArRo and SF ($p \leq 0.05$). The length gains and daily length gain and specific growth rate (body length) of shrimps reared with SF were not significantly different with treatment feed with Ar, ArRo and Ro ($p \geq 0.05$) (**Table 4**).

Table 3. Mean initial weight, final weight, weight gain, daily weight gain and specific growth rate (body weight) of *A. vulgaris* reared with different feeds within 70 days.

Treatment	Initial weight (mg)	Final weight (mg)	Weight gain (%)	Daily weight gain (mg day^{-1})	Specific growth rate (% day^{-1})
Ar	27.25 ± 6.54	70.37 ± 18.41^{a}	43.12 ± 18.41^{a}	0.6161 ± 0.2631^{a}	4.17 ± 0.28^{a}
Ro	27.25 ± 6.54	54.37 ± 16.03^{b}	27.12 ± 16.03^{b}	0.3875 ± 0.2290^{b}	3.90 ± 0.26^{b}
ArRo	27.25 ± 6.54	69.49 ± 24.94^{a}	42.24 ± 24.94^{a}	0.6035 ± 0.3563^{a}	4.11 ± 0.39^{a}
SF	27.25 ± 6.54	61.58 ± 18.82^{ab}	34.33 ± 18.83^{ab}	0.4904 ± 0.2689^{ab}	4.01 ± 0.29^{ab}

Values are presented as mean ± SD of three replicates. Different superscripts in the same column show significant difference ($p \le 0.05$).

Table 4. Effect of different food on the final weight, weight grain, daily weight gain, daily length grain, specific growth rate and survival rate of *Acetes vulgaris* during 70 days rearing.

Treatment	Initial length (mm)	Final length (mm)	Length gain (%)	Daily Length Gain (mm day^{-1})	Specific Growth Rate (% day^{-1})
Ar	20.90 ± 2.06	27.49 ± 2.13^{a}	6.59 ± 2.13^{a}	0.0941 ± 0.0304^{a}	3.26 ± 0.07^{a}
Ro	20.90 ± 2.06	26.41 ± 2.72^{b}	5.51 ± 2.72^{b}	0.0787 ± 0.0389^{b}	3.22 ± 0.09^{b}
ArRo	20.90 ± 2.06	27.90 ± 4.34^{a}	6.99 ± 4.33^{a}	0.0999 ± 0.0619^{a}	3.27 ± 0.15^{a}
SF	20.90 ± 2.06	27.10 ± 2.92^{a}	6.11 ± 2.92^{a}	0.0873 ± 0.0417^{a}	3.24 ± 0.11^{a}

Values are presented as mean ± SD of three replicates. Different superscripts in the same column show significant difference ($p \le 0.05$).

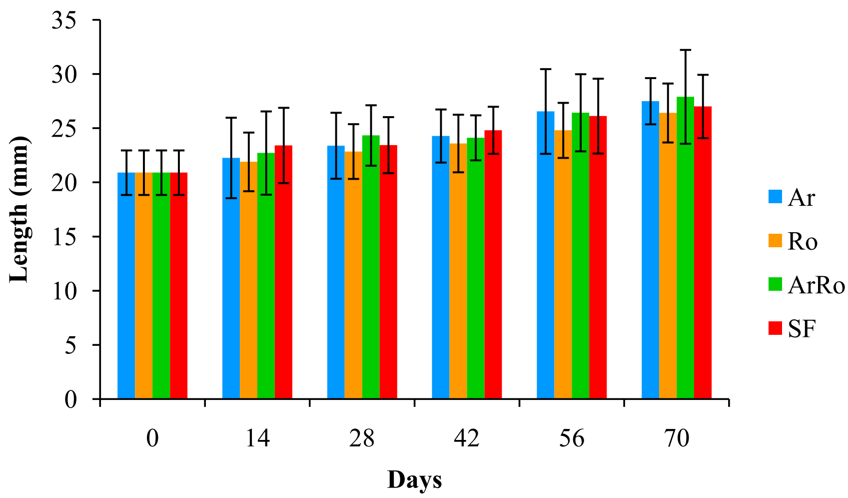

Figure 3. Mean length of *A. vulgaris* in different feeds during periods of culture. *Artemia* (Ar), Rotifer (Ro), *Artemia* + Rotifer (ArRo) and Shrimp larvae commercial feed (SF).

3.4. Survival Rates

The survival rate of *A. vulgaris* after 70 days of culture with different feeds ranged from 75.78 ± 3.36 to 81.78 ± 3.08, with the highest value in SF treatment and the lowest value in Ro treatment (Table 5). The survival rate of shrimp in SF treatment was significantly different with treatment feed with Ar, Ro and ArRo

Table 5. Mean survival rates (%) of *A. vulgaris* cultured in different foods for 70 days rearing.

Treatment	Day 70	Survival rate (%)
Ar	116.00 ± 5.29[a]	77.34 ± 3.53[a]
Ro	113.67 ± 5.03[a]	75.78 ± 3.36[a]
ArRo	114.33 ± 6.03[a]	76.23 ± 4.02[a]
SF	122.67 ± 4.62[b]	81.78 ± 3.08[b]

Values are presented as mean ± SD of three replicates. Different superscripts in the same column show significant difference ($p \le 0.05$).

($p \le 0.05$). But the differences were not significant among the Ar, Ro and ArRo treatments ($p \ge 0.05$).

[25] reported effects of different food on survival of *A. sibogae australis* by comparing feeding shrimp with natural detritus and newly hatched *Artemia* and found that specimens fed natural detritus lived shorter (3 - 17 days) than those fed *Artemia* nauplii (11 - 64 days). *Artemia* is a beneficial to the growth and survival rated of pelagic shrimp (*Neomysis intermedia*, *Metamysidopsis elongate*, *Lucifer chacei*, *Sergia lucens* and *Sergestes similis*) and it is also an important feed for the caridean shrimp (*Palaemon serratus*) [25]. The effect of different food on growth and survival rate of *A. vulgaris* in this study also revealed that *Acetes* shrimps has ability to eat a variety of foods and can eat food of various sizes since they can eat rotifer, *Artemia* and shrimp larvae commercial feed.

Specific growth rates (both for body weight and body length) of shrimps reared with SF were not significantly different with treatment feed with Ar, ArRo and Ro ($p \ge 0.05$). This is postulated that *Acetes* shrimps can eat both live feeds and formulated feeds and being an omnivore species. This is likely to [26] studied food and feeding habit of Taiwan mauxia shrimp *Acetes intermedius* in the coastal waters of Southwestern Taiwan region and concluded that *Acetes* is an omnivore species, feeding on a wide range of food items [12]. In their natural habitat, they eat several things like phytoplankton, zooplankton, algae, plant matter, debris, sand and mud [13] [14] [15] [16].

Typically, larvae stages of marine species are fed live feeds such as algae, zooplankton, rotifers and *Artemia*. In this study, rotifer and *Artemia* were used as live feed as well as pellet feed. The nutritional composition of different feeds used in this experiment was found to have different nutritional values. Newly hatched *Artemia* contain 57.26% protein, 16.21% fat and 6.67% carbohydrate) [27] (*Brachionus* rotifer contains 59.0% protein, 13.0% fat and 3.1% highly unsaturated fatty acid) [28] (Shrimp larvae commercial feed used in this study contains 48.0% protein, 9.0% fat, 2.5% ash and 9% moisture (Lansy-Shrimp PL (INVE®, Phichit, Thailand). Although live feeds provide an excellent source of nutrition, several limitations are associated with their use. Rotifers require considerable expenditures in time and effort to maintain, and live artemia nauplii suffer from inconsistent supply [29]. Thus, shrimp larvae commercial feed is probably the most benefit convenience for a commercial culture of *Acetes* species in the future.

4. Conclusion

The sergestid shrimp *Acetes vulgaris* has ability to consume both live feeds and pellet feed. SF gave the highest survival rates ($p \leq 0.05$) and the specific growth rates were not significantly different with treatment feed with Ar, ArRo and Ro ($p \geq 0.05$) The findings reflected the ability of *Acetes* shrimps to consume divers food types including both live feed and pelleted feed. Insights obtained from this research suggested that artificial feed can be as efficient as live feeds. This new knowledge is a needed addition to a currently lacking knowledge base for aquaculture of this *Acetes* species.

Acknowledgements

We would like to thank the Biodiversity-based economy development office (BEDO) (grant number 3/2562) for supporting this research project.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

References

[1] Wong, B.Y., Ong, H.K. and Khoo, G. (2015) Length-Weight Relationships of Acetes spp. Sampled along the West Coast of Peninsular Malaysia. *Sains Malaysiana*, **44**, 379-386. https://doi.org/10.17576/jsm-2015-4403-09

[2] Omori, M. (1975) The Systematic, Biogeography and Fishery of Epipelagic Shrimps of the Genus *Acetes* (Crustacea, Decapoda, Sergestidae). *Bulletin of the Ocean Research Institute*, *University of Tokyo*, **7**, 1-91.

[3] Musel, J., Anuar, A., Mohamad, S., Mustaoa, N., Hassan, M.H., Rajali, H. and Anuar, A. (2019) Morphometric Relationship and the Spawning Season of *Acetes intermedius* from the Coast of Miri Sarawak, Northwestern Borneo. *Bioflux*, **12**, 457-471.

[4] Hanamura, Y. (1999) Occurrence of *Acetes sibogae* Hansen (Crustacea: Decapoda: Sergestidae) in Western Australia, with Notes on the Northern Australian Population. *Records of the Western Australian Museum*, **19**, 465-468.

[5] Aziz, D., Siraj, S.S., Amin, S.M.N. and Harmin, S.A. (2010) Population Characterization of Planktonic Shrimp, *Acetes japonicus* (Decapoda: Sergestidae) Using RAPD Technique. *Journal of Biological Sciences*, **10**, 355-361. https://doi.org/10.3923/jbs.2010.355.361

[6] Santos, A.P.F., Simoes, A.M., Bochini, G.L., Costa, C.H. and Costa, R.C.D. (2015) Population Parameters and the Relationships between Environmental Factors and Abundance of the *Acetes americanus* Shrimp (Dendrobranchiata: Sergestidae) near a Coastal Upwelling Region of Brazil. *Brazilian Journal of Oceanography*, **63**, 229-238. https://doi.org/10.1590/S1679-87592015086206303

[7] Mantiri, R.O.S.E., Ohtsuka, S. and Sawamoto, S. (2012) Fisheries on Mesopodopsis (Mysida: Mysidae) and Acetes (Decapoda: Sergestidae) in Indonesia. *Kuroshio Science*, **5**, 137-146.

[8] Kim, J.N., Choi, J.H., Lee, J.H. and Kim, J.I. (2013) New Records of Three Sergestid Shrimps (Crustacea: Decapoda: Penaeidea) from the Koren Waters of the Yellow Sea. *Fisheries and Aquatic Sciences*, **16**, 199-205. https://doi.org/10.5657/FAS.2013.0199

[9] Department of Fisheries (2022) Fisheries Statistics of Thailand 2021. Ministry of Agriculture and Co-Operatives, Bangkok, 92 p.

[10] Naiyanetr, P. (2007) Checklist of *Crustacean fauna* in Thailand (Decapoda, Stomatopoda, Anostraca, Myodocopa and Isopoda). Office of Natural Resources and Environmental Policy and Planning, Bangkok.

[11] Amin, S.M.N., Arshad, A., Siraj, S.S. and Sidik, B.J. (2009) Population Structure, Growth, Mortality and Yield per Recruit of Sergestid Shrimp, *Acetes japonicus* (Decapoda: Sergestidae) from Coastal Waters of Malacca, Peninsular Malaysia. *Indian Journal of Marin Sciences*, **38**, 57-68. https://doi.org/10.3923/jas.2009.801.814

[12] Oh, S.Y., Arshad, A., Japar, S.B., Azwady, A.A.N. and Amin, S.M.N. (2011) Diet Composition of Sergestid Shrimp *Acetes serrulatus* from the Coastal Waters of Kukup, Johor, Malaysia. *Journal of Fisheries and Aquatic Science*, **6**, 809-815. https://doi.org/10.3923/jfas.2011.809.815

[13] Xiao, Y. and Greenwood, J.G. (1992) Distribution and Behavior of *Acetes sibogae* (Decapoda, Crustacea) in an Estuary in Relation to Tidal and Diehl Environmental Changes. *Plankton Research*, **14**, 393-407. https://doi.org/10.1093/plankt/14.3.393

[14] Deshmukh, V.D. (2002) Biology of *Acetes indicus* Milne Edwards in Bombay Waters. *Indian Journal of Fisheries*, **49**, 379-388.

[15] Collins, P.A. and Wiliner, V. (2003) Feeding of *Acetes paraguayensis* (Nobili) (Decapoda: Sergestidae) from the Parana River, Argentina. *Hydrobiologia*, **493**, 1-6. https://doi.org/10.1023/A:1025474614248

[16] Amani, A.A., Amin, S.M.N. and Arshad, A. (2011) Stomach Contents of Sergestid Shrimp *Acetes japonicas* from the Estuary of Tanjung Dawai Peninsular Malaysia. *Journal of Fisheries and Aquatic Science*, **6**, 771-779. https://doi.org/10.3923/jfas.2011.771.779

[17] Saengkaew, S., Rittiboon, S., Buatip, S., Chavavongsa, C. and Chuchote, W. (2023) Species Composition and Distribution of Acetes in Tuyong Canal, Thepha District, Songkhla Province, Thailand. *Natural and Life Sciences Communications*, **22**, 1-10. https://doi.org/10.12982/NLSC.2023.013

[18] Charoenjit, K., Hrimpeng, K., Pilantanapak, A., Damrongrojwattana, P., Tangkrock-Olan, N. and Buranapratheprat, A. (2015) Geospatial-Based Study for the Impacting of Climate and Rapid Ecosystem Changes on Abundance and Biodiversity of Paste Shrimp along the Eastern Coast of Thailand. Research Report, Burapha University, Saen Suk, 109 p.

[19] Amin, S.M.N., Arshad, A., Bujang, J.S. and Siraj, S.S. (2009) Age Structure, Growth, Mortality and Yield-per-Recruit of Sergestid Shrimp, *Acetes indicus* (Decapoda: Sergestidae) from Waters of Malacca, Penninsular Malaysia. *Journal of Applied Sciences*, **9**, 801-814. https://doi.org/10.3923/jas.2009.801.814

[20] Amin, S.M.N., Arshad, A., Siraj, S.S., Sidik, B.J. and Bujang, J.S. (2011) Update on the Species Composition and Distribution of Sergestid Shrimps (Acetes spp.) in Malaysian Waters. *Journal of Fisheries and Aquatic Science*, **6**, 761-770.

https://doi.org/10.3923/jfas.2011.761.770

[21] Metillo, E.B. (2011) Feeding Ecology of *Acetes intermedius* Omori 1975 (Crustacea, Decapoda, Setgestidae) in Iligan Bay, the Philippines. *Zoological Studies*, **50**, 725-736.

[22] Sukri, S.A.M., Saad, C.R., Kamarudin, M.S. and Yasin, I.S.M. (2016) Effect of Different Levels of Chlorella Meal on Growth and Survival of Freshwater Prawns *Macrobrachium rosenbergii* Juvenile. *Songklanakarin Journal Science Technology*, **38**, 641-644.

[23] Furtado, P.S., Campos, B.R., Serra, F.P.M., Klosterhoff, M., Romano, L.A. and Wasielesky Jr, W. (2015) Effect of Nitrate Toxicity in the Pacific White Shrimp, *Litopenaeus vannamei*, Reared with Biofloc Technology (BTF). *Aquaculture International*, **23**, 315-327. https://doi.org/10.1007/s10499-014-9817-z

[24] Zhao, M., Yao, D., Li, S., Zhang, Y. and Aweya, J.J. (2020) Effects of Ammonia on Shrimp Physiology and Immunity: A Review. *Reviews in Aquaculture*, **12**, 2194-2211. https://doi.org/10.1111/raq.12429

[25] Ikeda, T. and Raymont, J.K.B. (1989) Preliminary Studies on the Intermoult Period and Growth of the Pelagic Shrimp *Acetes sibogae australis* from a Tropical Sea. *Bulletin of Plankton Society of Japan*, **36**, 11-18.

[26] Chiou, W.D., Hwang, J.J., Cheng, L.Z. and Chen, C.T. (2005) Food and Feeding Habit of Taiwan Mauxia Shrimp *Acetes intermedius* in the Coastal Waters of Southwestern Taiwan Region. *Fisheries Science*, **71**, 361-366. https://doi.org/10.1111/j.1444-2906.2005.00988.x

[27] Lopalco, P.S., Lobasso, R.M.A., Lopes-dos-Santos, Stappen, G.V. and Corcelli, A. (2019) Lipid Profile Changes during the Development of *Artemia franciscana* from Cysts to the First Two Naupliar Stages. *Frontiers in Physiology*, **9**, Article No. 1872. https://doi.org/10.3389/fphys.2018.01872

[28] Das, P.S.C., Mandal, C., Bhagabati, S.K., Akhtar, M.S. and Singh, S.K. (2014) Important Live Food Organisms and Their Role in Aquaculture. *Frontiers in Aquaculture*, **5**, 69-86.

[29] Wouters, R. and Fegan, D.F. (2004) Larval Shrimp Nutrition, a Review. Global Aquaculture Advocate, 1/8.