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RESEARCH PAPER

Evaluation of Nutritional Profiles of Wild Mixed Zooplankton in Sulur and Ukkadam Lakes of Coimbatore, South India

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Abstract

The nutritional profiles of wild mixed zooplankton (WMZ) and laboratory cultured *Artemia* nauplii were compared in the present study. WMZ samples were collected from Sulur lake and Ukkadam lake, Coimbatore, Tamil Nadu, South India. The WMZ from both lakes and *Artemia* nauplii were utilized for the estimation of biochemical constituents (protein, carbohydrate, lipid, moisture and ash), profiles of amino acids, and fatty acids. Results showed that the total protein content was found to be significantly ($P<0.05$) higher in WMZ collected from Ukkadam lake, followed by Sulur lake when compared to *Artemia* whereas, the total carbohydrate and lipid contents were found to be significantly ($P<0.05$) higher in *Artemia* nauplii than WMZ. While, there was insignificant ($P>0.05$) difference found in ash and moisture contents in all live feeds evaluated. Profile of amino acids and saturated fatty acids were significantly elevated ($P<0.05$) in WMZ when compared to *Artemia*. While, in the case of unsaturated fatty acids showed significant ($P<0.05$) elevations in WMZ of Ukkadam lake followed by Sulur lake and *Artemia*. The present results revealed that the WMZ has more desirable dietary nutritional characteristics as larval diets than traditional live feed *Artemia* nauplii.

Keywords: Nutritional composition, zooplankton, *Artemia*, live feed.

Introduction

Zooplankton is the main group of living organisms among the aquatic environment, which is serving as a vital source for food web in aquatic ecosystems. Among the zooplankton, cladocera and copepoda plays a key role in the freshwater food chains and food web. Zooplankton is rich in essential amino acids and fatty acids for serves as a sufficient primary source of nutrition required by fish and prawn larvae (Kanazawa, Teshima, & Ono, 1979). Zooplankton forms ideal food usually in the larval stages of prawns and in early larval stages of fishes (Neelakandan, Rafiuddin, Ratish Menon, & Kusuma, 1988). Thus “live feed” (zooplankton) serves as “living capsules” of nutrition (Tiwari, 1986) and their nutritional status can be further enhanced by using “bio-enrichment” so that the nutritional status of fishes, prawns and shrimps feeding on them could be increased. They play as most important role as a diet of some invertebrates and vertebrate organisms. The zooplankton growth in nature may depend on the quality of water and the food available as the phytoplankton community changes. According to Farkas and Herodek (1964), the fatty acid composition of zooplankton proved to be different and it modified differently by the changes of water temperature. They transfer energy from microalgae to higher trophic levels by being eaten as a food through various aquatic organisms (Goldman & Horne, 1983; Ahlgren, Lundstedt, Brett, & Forsberg, 1990; Harris, Wiebe, Lens, Skjoldal, & Huntley, 2000; Farhadian, Kolivand, Khoshdarehgy, Dorch, & Soofiani, 2013). These organisms contain a valuable source of lipid and fatty acids, protein and amino acids, vitamins, and enzymes (Pillay, 1990; Izquierdo, Socorro, Arantzamendi, and Hernandez-Cruz, 2000; Evjemo, Reitan, & Olsen, 2001).

Biochemical studies have shown that zooplankton are rich in protein, lipid, essential amino acids and essential fatty acids which can provide the better augmented growth, immune stimulation, pigment enhancement, and physiological regulations, it leads to better reproduction of brood-stock prawns and fishes (Watanabe, Kitajima, & Fujita, 1983; Altaff & Chandran, 1989; Safiullah, 2001). The functional status of the digestive system of larval stages with regard to the digestibility of feed need to be assessed by the successful larval rearing of prawn and fish. Many authors have reported the utilization of copepods from wild and cultured sources for higher

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yields of prawns in ponds (Anderson, Parker, & Lawrence, 1987; D'Abramo & Sheen, 1991; Collins, 1999). Wild mixed freshwater zooplankton has high levels of saturated fatty acids in addition to the moderate level of n-3 and n-6 highly unsaturated fatty acids (Domaizon, Desvilettes, Debroas, & Bourdier, 2000). Better survival, growth, biochemical profile and amino acid composition has been reported in the post larvae of *Macrobrachium rosenbergii* fed on mixture of copepods *Sinodiaptomus* (*Rhinedia ptomus*) *indicus* and *Mesocyclops aspericornis* than those fed on individual copepods or *Artemia* nauplii (Amanl & Altaff, 2004).

The elevated growth of finfish and shellfish fed to mixed cladocera diets was noticed due to the supply of essential nutrients and digestive enzymes for enhanced digestibility and assimilation. The higher nutritional value of live feed organisms can comparatively swim up to 5 - 6 hrs in water before sinking to the bottom and die, there also extending its availability for larval consumption (Hoff & Snell, 1989; Rottmann, Graves, Watson, Roy, & Yanong, 2003). In the present study was focused to understand the nutritional composition of wild mixed zooplankton (collected from freshwater lakes) compared with laboratory cultured *Artemia* nauplii.

Materials and Methods

Artemia Culture in Laboratory

Artemia cysts were ((Red Jungle Brand® - O.S.I® at U.S.A-Brine Shrimp Eggs) were hatched under the high light intensity in 15 L of the plastic tank (artificial sea water medium prepared) with vigorous aeration. Before hatching the 1 g of cysts was hydrated for 0.30 to 0.45 (minute) in 500 ml of freshwater and 20 ml of bleach was carried out in order to disinfect and decapsulate the cysts. The *Artemia* cyst counted is approximately for 270,000 to 300,000 CPG (cysts per gram). After 20 to 28 hrs, new nauplii were hatched (22 to 24 hours for all health nauplii were hatched out). In the quality of cyst hatching percentage (80-85%) was 245,000-260,000 NPG (nauplii per gram of cyst). Hatched out *Artemia* nauplii was cleaned with running freshwater for few minutes and they were utilized for the estimation of biochemical profiles, amino acids and fatty acids.

Collection and Identification of Wild Mixed Zooplankton

The wild mixed zooplankton (WMZ) samples were collected from Sulur Lake and Ukkadam Lake, Coimbatore, Tamil Nadu, India, using a plankton net (150 µm mesh size) by towing at a depth of 0.50 m to 1.00 m. The zooplankton sampling was made between 5.30 am to 6.30 am and samples were immediately transported to the laboratory with adequate aeration. The collected zooplankton samples were identified using standard manuals (Edmondson, 1959; Sharma & Michael, 1987; Battish, 1992; Reddy, 1994; Murugan, Murugavel, & Kodarkar, 1998; Altaff, 2004) and counted by Sedgewick-Rafter cell under a stereo microscope (Magnus, MS 24 Series). The zooplankton sample was rinsed with filtered freshwater and they were utilized for the estimation of biochemical constituents, profile of amino acids and fatty acids.

Estimation of Biochemical Constituents

The concentration of total protein was estimated by the method of Lowry, Rosenberg, Fare, and Randall (1951), using the ethanolic precipitated sample. The total carbohydrate was estimated according to Roe (1955) using TCA-extracted sample. The total lipid was extracted with chloroform–methanol mixture according to Folch, Lees, & Sloane-Stanley, (1957) and estimated by the method of Barnes & Blackstock (1973). The moisture and ash content was performed according to the standard procedures of AOAC (1995).

Profiles of Amino Acids and Fatty Acids

The profiles of amino acids in *Artemia* nauplii and WMZ sample were performed following the high-performance thin-layer chromatographic (HPTLC) method followed by Hess and Sherma, (2004). The fatty acids analyses were done using Gas Chromatography (GC) method (Nichols, D.S., Nichols, D. & McMeekin, 1993).

Statistical Analysis

The data were analyzed by one-way analysis of variance (ANOVA) using SPSS (ver.-20.0), followed by Duncan's multiple range test (DMRT) to compare the differences among treatments were significant differences ($P<0.05$) were observed. Data were expressed as mean ± S.D.

Results

Analysis of Zooplankton Composition

Totally 33 species of zooplankton was recorded in the Sulur Lake (Table 1). Off these 11 species were contributed by rotifera, 10 species by cladocera, 6 species by copepoda and 6 species by ostracoda. Total of 27 species of zooplankton were recorded from the Ukkadam Lake, which comprising 10 species of rotifera, 8 species of cladocera, 5 species of copepoda and 4 species of ostracoda (Table 1). In the present observation, among the zooplankton recorded, rotifera holds the top rank in percentage composition at Sulur and Ukkadam Lake. The rotifera were found to be predominant with 34% followed by cladocera with 31%, copepoda with 25% and ostracoda with 10% at Sulur Lake. At Ukkadam Lake, rotifera were found to be predominant with 35% followed by cladocera 30%, copepoda 27% and ostracoda 8 %.

Biochemical Composition of WMZ and *Artemia* Nauplii

In the present study, protein content was found to be significantly ($P<0.05$) higher in WMZ of Ukkadam Lake when compared to WMZ of Sulur Lake and *Artemia* nauplii whereas, carbohydrate and lipid levels were found to be significantly ($P<0.05$) higher in *Artemia* nauplii when compared to WMZ of Sulur Lake and Ukkadam Lake. While ash and moisture contents were not showed significant ($P>0.05$) difference in all live feeds tested (Table 2).

Amino Acid Composition of *Artemia* Nauplii and WMZ Samples

The *Artemia* nauplii showed the total amino acid level of 83.67%. Among these, the amino acids such as aspartic acid, glutamic acid, leucine and serine were recorded to be dominant. The WMZ of Sulur Lake and Ukkadam Lake were showed comparatively high amino acid content than that of *Artemia* nauplii. The total amino acid contents of WMZ of Sulur Lake were reported as 90.22%. Among the amino acids, valine, aspartic acid, lysine, glutamic acid and alanine were found to be higher. The total amino acid contents in WMZ of Ukkadam Lake were reported as

Table 1. List of zooplankton recorded in the Sulur Lake and in the Ukkadam Lake

Zooplankton	Species Name List	Sulur Lake	Ukkadam Lake
Rotifera	*Brachionus angularis* Gosse, 1851	+	+
	Brachionus calyciflorus Pallas, 1776	+	+
	Brachionus caudatus personatus Ahlstrom, 1940	+	+
	Brachionus diversicornis (Daday, 1883)	+	+
	Brachionus falcatus Zacharias, 1898	+	+
	Brachionus quadridentatus Hermann, 1783	+	+
	Brachionus rubens Ehrenberg, 1838	+	+
	Keratella tropica (Apstein, 1907)	+	+
	Asplanchna brightwelli Gosse, 1850	+	+
	Asplanchna intermedia Hudson, 1886	+	+
	Filinia longiseta (Ehrenberg, 1834)	+	-
Cladocera	*Diaphanosoma sarsi* Richard, 1894	+	+
	Diaphanosoma excisum Sars, 1885	+	-
	Daphnia carinata King, 1853	+	+
	Daphnia magna Straus, 1820	+	-
	Ceriodaphnia cornuta Sars, 1885	+	+
	Ceriodaphnia reticulata (Jurine, 1820)	+	+
	Moina brachiata (Jurine, 1820)	+	+
	Moina micrura Kurz, 1875	+	+
	Moinodaphnia macleayi King, 1853	+	+
	Macrothrix spinosa Richard, 1897	+	+
Copepoda	*Heliodiaptomus viduus* (Gurney, 1916)	+	+
	Sinodiaptomus indicus (Kiefer, 1934)	+	+
	Eucyclops speratus (Lilljeborg, 1901)	+	+
	Mesocyclops leuckarti (Claus, 1857)	+	+
	Thermocyclops hyalinus (Rehberg, 1880)	+	+
	Thermocyclops decipiens (Kiefer, 1929)	+	-
Ostracoda	*Cypris protubera* Victor & Fernando, 1978	+	+
	Eucypris bispinosa (Victor & Michael, 1975)	+	+
	Strandesia elongate Hartmann, 1964	+	-
	Heterocypris nuda Victor & Michael, 1975	+	+
	Heterocypris gergaria (Skogsberg, 1917)	+	+
	Cypretta fontinalis Hartmann, 1964	+	-

Notes: + Present; - Absent;

Table 2. Biochemical composition (%) of cultured *Artemia* nauplii and WMZ

Biochemical composition	Live feed organisms		
	Artemia nauplii	WMZ Sulur Lake	WMZ Ukkadam Lake
Protein	59.23 ± 2.16^{c}	61.58 ± 1.66^{ab}	63.60 ± 1.93^{a}
Carbohydrate	21.30 ± 1.07^{a}	20.20 ± 0.42^{ab}	19.24 ± 0.95^{c}
Lipid	19.04 ± 0.73^{a}	18.03 ± 0.40^{ab}	17.10 ± 0.67^{c}
Moisture*	87.67 ± 2.08^{a}	87.10 ± 0.53^{a}	86.87 ± 1.08^{a}
Ash	10.40 ± 0.69^{a}	10.57 ± 0.81^{a}	11.40 ± 1.51^{a}

*Wet matter basis; Mean±SD; Mean values within the same row sharing the same superscript are not significantly different ($P > 0.05$)

91.55%. Among the amino acids, the valine, lysine, aspartic acid, glutamic acid and alanine were found to be dominant (Table 3). In this study, total essential amino acids were found to be significantly higher (P <0.05) in WMZ of Ukkadam Lake and WMZ of Sulur Lake when compared to *Artemia* nauplii. The nonessential amino acids were found to be significantly higher (P<0.05) in *Artemia* nauplii when compared to WMZ of Ukkadam Lake and WMZ of Sulur lake.

Fatty Acid Composition of *Artemia* Nauplii and WMZ Samples

The total fatty acid content of *Artemia* nauplii was 72.46% comprising myristic acid (14:0), oleic acid (18:01) and myristoleic acid (14:01) were found to be higher. The unsaturated fatty acids such as eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA) levels of *Artemia* nauplii were 2.8 % and 0.91% respectively. The total fatty acids content in WMZ of Sulur was 95.44% (Table 4). Among the fatty acids, myristic acid, oleic acid, lauric acid (12:0), DHA (22:6 n-3) and Palmitoleic acid (16:01) were found to be dominant. The high levels of EPA (20:5 n-3) and DHA (22:6 n-3) were recorded as 3.2 % and 9.4% in WMZ of Sulur Lake. The total fatty acid content of WMZ of Ukkadam Lake was 96.69%. Among these, myristic acid, oleic acid, lauric acid, DHA and palmitoleic acid were found to be higher. The high level of EPA and DHA were recorded as 3.26% and 9.2% in WMZ of Ukkadam Lake (Figure 1). While the percentage of highly unsaturated fatty acids (HUFA) *viz*., EPA and DHA of WMZ of Ukkadam was 9.35% and 9.85% respectively. The recorded values of polyunsaturated fatty acids (PUFA) such as oleic acid, arachidonic acid and linolenic acid were 16.14%, 1.54% and 0.14% in WMZ of Ukkadam; 14.84%, 1.40% and 0.74% in WMZ of Sulur and 13.45%, 1.20% and 5.12% in *Artemia* nauplii respectively. A fatty acids profile of WMZ of Ukkadam shows rich in PUFAs, HUFAs and n-3 fatty acids. The total n-3 fatty acid content of WMZ of Ukkadam was 32.62%. The saturated fatty acids were significantly elevated (P<0.05) in *Artemia* nauplii. However, myristic acid, oleic acid, palmitoleic acid, and lauric acid were only deducted in WMZ of Ukkadam and WMZ of Sulur Lake. Among WMZ analysed, Ukkadam showed significant (P<0.05) elevation. In the case of unsaturated fatty acids, it showed significant (P<0.05) elevations in WMZ of Ukkadam Lake followed by WMZ of Sulur Lake and *Artemia* nauplii.

Discussion

Lake aquatic systems are rich in micro and macrofauna. Zooplankton is considered as the ecological indicators of water bodies (Gajbhiye & Desai, 1981). Factors such as light intensity, food availability, dissolved oxygen and predation affect the population dynamics of zooplankton. Low pH or higher salinity can reduce their diversity and density of plankton (Horne & Goldman, 1994; Manickam *et al*., 2014). In the present study zooplankton, percentage composition was found more with rotifera with 35% in Ukkadam and 34% in Sulur Lake, followed by cladocera with 31% in Sulur and 30% in Ukkadam, copepoda with 27% in Ukkadam and 25% in Sulur followed by ostracoda with 10% in Sulur Lake and 8% in Ukkadam Lake. The present result was similar to earlier observation by Ramakrishna (2014); Manickam *et al*. (2014); Dede and Deshmukh (2015); Bhavan, Selvi, Manickam, Srinivasan, Santhanam,

Table 3. Amino acid composition of cultured *Artemia* nauplii and WMZ

Amino acids	*Artemia* nauplii	WMZ Sulur Lake	WMZ Ukkadam Lake
Arginine	4.22±0.54^{b}	5.70±0.47^{a}	5.74±0.57^{a}
Histidine	4.32±0.34^{b}	5.14±0.28^{ab}	5.82±0.74^{a}
Isoleucine	3.26±0.11^{b}	3.90±0.24^{ab}	4.20±0.17^{a}
Leucine	7.51±0.97^{a}	6.98±.054^{ab}	6.24±0.50^{b}
Lysine	6.52±0.88^{b}	8.25±1.0^{a}	8.51±0.97^{a}
Methionine	1.71±0.12^{b}	3.25±0.48^{a}	3.61±0.44^{a}
Phenylalanine	3.98±0.15^{b}	4.61±0.22^{ab}	5.2±0.74^{a}
Threonine	3.43±0.19^{b}	4.81±0.58^{a}	4.87±0.75^{a}
Cystine	0.15±0.10^{c}	0.92±0.19^{b}	1.20±0.21^{a}
Valine	4.62±0.57^{b}	9.75±1.19^{a}	9.23±1.05^{a}
Total EAA	39.72	53.31	54.62
Alanine	6.89±0.84^{b}	7.26±1.52^{a}	7.24±1.00^{a}
Asparctic acid	8.63±1.48^{a}	8.26±1.21^{a}	8.18±1.04^{a}
Glutamic acid	8.46±1.54^{a}	7.48±1.13^{a}	7.81±1.28^{a}
Glycine	6.81±0.90^{a}	3.67±0.55^{b}	3.51±0.22^{b}
Serine	7.14±1.20^{a}	4.98±0.41^{b}	4.88±0.52^{b}
Tyrosine	6.02±0.87^{a}	5.26±0.29^{b}	5.31±0.43^{b}
Total NEAA	43.95	36.91	36.93
Total	83.67	90.22	91.55

Mean±SD; Mean values within the same row sharing the same superscript are not significantly different (P > 0.05)

Table 4. Fatty acid composition of cultured *Artemia* nauplii and wild mixed zooplankton

Fatty acids	*Artemia* nauplii	WMZ Sulur Lake	WMZ Ukkadam Lake
12:00	2.51±0.28[b]	13.42±1.89[a]	14.20±2.04[a]
14:00	22.15±0.46[ab]	26.61±2.45[a]	21.21±3.52[ab]
15:00	0.97±0.06[a]	0.98±0.04[a]	1.20±0.42[a]
16:00	5.97±0.62[a]	1.20±0.15[b]	1.40±0.46[b]
17:00	0.15±0.02[a]	0.14±0.07[a]	0.10±0.06[a]
18:00	2.87±0.36[b]	3.15±0.48[b]	4.12±0.57[a]
20:00	-	0.10±0.03[b]	0.24±0.07[a]
21:00	0.24±0.05[b]	0.25±0.01[b]	1.20±0.36[a]
22:00	0.38±0.08[b]	0.31±0.02[b]	0.80±0.03[a]
24:00	-	-	0.54±0.56[a]
14:01	8.95±1.20[a]	2.30±0.76[b]	2.20±0.26[b]
16:01		8.20±0.46[a]	7.80±0.24[a]
18:01	13.45±2.04[a]	14.84±2.38[a]	16.14±2.45[a]
18:1 n-9		2.98±0.73[a]	2.60±0.87[a]
18:3 n-3	0.85±0.09[b]	0.92±0.09[ab]	1.60±0.61[a]
18:3 n-6	5.12±0.73[a]	0.74±0.03[b]	0.14±0.03[b]
18:2 n-6	-	-	-
20:2 n-6	-	-	-
20:4 n-6	1.20±0.32[a]	1.40±0.26[a]	1.54±0.42[a]
20:5 n-3	2.80±0.45[a]	3.20±0.67[a]	3.26±0.83[a]
22:6 n-3	0.91±0.07[b]	9.40±1.56[a]	9.20±0.74[a]
20:4 n-5	0.74±0.03[b]	1.20±0.40[ab]	1.40±0.27[a]
22:01	3.20±0.62[c]	4.10±0.26[b]	5.80±0.32[a]
Total	72.46	95.44	96.69

Mean±SD; Mean values within the same row sharing the same superscript are not significantly different ($P > 0.05$)
Saturated fatty acids (SFA): 12:0, 14:0, 16:0, 18:0, 20:0, 22:0; Monounsaturated fatty acids (MUFA): 14:1, 16:1, 18:1, 20:1, 22:1; PUFA and HUFA: 18:2 n-6, 18:3 n-6, 18:3 n-3, 18:4 n-3, 20:2 n-6, 20: 3 n-6, 20:4 n-6, 20:3 n-3, 20:5 n-3, 22:5 n-3, 22:6 n-3; Total n-3: 18:3 n-3, 18:4 n-3, 20:3 n-3, 20:5 n-3, 22:5 n-3, 22:6 n-3; Total n-6: 18:2 n-6, 18:3 n-6, 20:2 n-6, 20:3 n-6, 20:4 n-6.

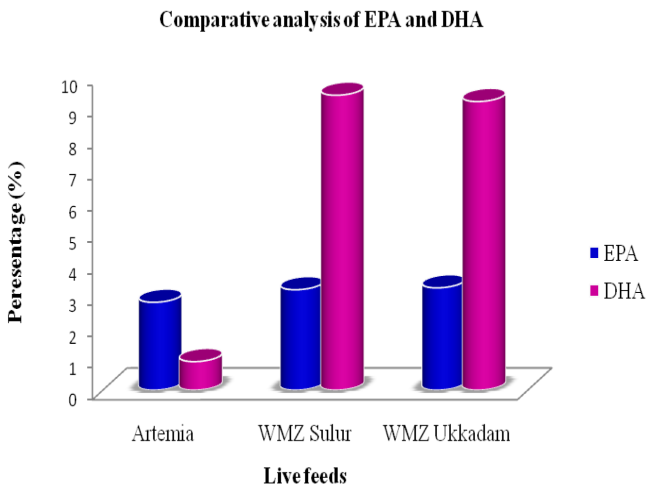

Figure 1. EPA and DHA contents of cultured *Artemia* nauplii and wild mixed zooplankton.

and Vijayan (2015); Manickam *et al*. (2015). Most of the microorganisms can be measured as live food for larval forms of commercially important freshwater fishes and prawns. The finfish and shellfish early larval rearing in captive condition would be greatly simplified when freshwater fish and prawn larvae would readily consume artificial diets, but the major challenge would be determining the nutritional requirements and correct size of particles for optimal growth of the species is a big question. These problems can be overcome by using lived which is naturally available in the lake ecosystems. Although these organisms are locally available, very few investigations have attempted to determine their nutritional quality and culture aspects due to the ready availability of *Artemia* cysts.

Live food seems to provide a good source of exogenous enzymes and helps in chemoreception and visual stimuli (Kolkovski, Arieli, & Tandler, 1995). However, the nutritional quality of zooplankton varies considerably and thus plays a major role in producing quality larvae and juveniles (van der Meeren *et al*., 2001). In the present study, the biochemical composition of protein was higher in WMZ of Ukkadam (63.60%) followed by WMZ of Sulur (61.58%) and cultured *Artemia* nauplii (59.23%). The protein formed the major fraction compared with lipid and carbohydrate, indicating the usefulness as energy reserve (Conover, 1964; Conover and Corner, 1968). The observed marked variations in protein content might be due to the fact that it is utilized as a metabolic substrate. The lipid level was higher in *Artemia* nauplii (19.04%) than that of WMZ of Ukkadam Lake (17.10%). For wild mixed zooplankton having low level of lipid content for reason in a protein important energy reserve as may be true (Maruthanayagam & Subramanian, 1999). Lipid content in zooplankton has been found to relatively diverse, and to vary with developmental stage, species, feed preference, latitude, season, and life cycle strategy (Stottrup, 2003).

Lipid content in mixed zooplankton from two lakes varied from 17.10 to 18.03% wet matter and dry matter was inversely related to water temperature, which is in agreement with the findings of Jana & Manna (1993). The lipid content in freshwater zooplankton is known to have considerable importance (Vijverberg & Frank 1976) and might be influenced by a seasonal succession of phytoplankton species or source of food fed by zooplankton (Proulex & de la Nove, 1985; Kibria, Nugegoda, Fairclough, Lam, & Bradbv, 1999). In the present study, lipid content was lower than that of protein and carbohydrate. The result was aggregated with wild organisms of zooplankton (copepoda) protein content of higher than that of cultured zooplankton (Aman & Altaff, 2004). The lipid content of tropical zooplankton is significantly low when compared to temperate zooplankton and it was proved by the findings of Sreepada, Rivonker, & Parulekar (1992). The variations in the lipid content can also be attributed to its storage and utilization during the period of starvation when it serves as an effective energy reserve (Nageswara Rao & Krupanidhi, 2001). The lipids are the major constituents of living organic matter, involved in a variety of cellular function including membrane structure (phospholipids and glycolipids) and energy storage (triacylglycerols and wax esters) (Vance & Vance, 1985; Wainman & Smith, 1997). The function of the protein as an important energy reserve may be true for zooplankton having low lipid content (Maruthanayagam & Subramanian, 1999). The variations in amino acid content among the three types of live feeds are specific. The total amino acid content in WMZ of Ukkadam (91.55%) was higher than WMZ of Sulur (90.22%) and *Artemia* nauplii (79.05%) and that can be related to their physiological differences (Safiullah, 2001). The present study showed that the amino acids contents in WMZ of Ukkadam were dominated by valine, lysine, aspartic acid, glutamic acid, alanine, leucine, in a similar order agreed with pioneer research works (Santhanam, 2002; Rajkumar, Santhanam, & Perumal, 2004; Ashok Prabu, Perumal, & Rajkumar, 2005; Perumal, Rajkumar, & Santhanam, 2009). The amino acids composition of mixed zooplankton from different lakes had a relatively similar essential and non-essential amino acids composition and the relative amount was higher than previously reported (Yurkowski & Tabachek, 1979; Watanabe *et al*., 1983; Kibria *et al*., 1999), which might be due to the mixed community of zooplankton. Amino acid profile of plankton is generally genetically programmed than diet related.

In the present study, analysis of totally 16 amino acids was observed in WMZ of Ukkadam, WMZ of Sulur Lake and *Artemia* species with valine, aspartic acid, lysine, glutamic acid, leucine, alanine and serine as the prominent ones. Only very limited information is available on the amino acid content of mixed zooplankton. Santhanam and Perumal (2001) have found 10 amino acids in the cultured copepod, *O. rigida* with the predominance of norvaline. This is proved by Rajkumar and Vasagam (2006) that the higher amount of amino acids present in the *A. clausi* than rotifera and *Artemia* nauplii with a predominance of lysine, alanine and glutamic acid. Ashok Prabu and Rajkumar (2007) found 10 amino acids from the cultured copepod, *A. spinicauda* with the major component of asparagine. Recently, Perumal *et al*. (2009) have reported 16 and 15 amino acids in wild copepods, *A. spinicauda* and *O. similis* respectively with threonine, glutamic acid, alanine, aspartic acid, serine, valine and methionine as the prominent ones. Similarly, some foreign authors are also reported that the rich amino acids were observed in wild collected with mixed copepods (Van der Meeren, Olsen, Hamre, & Fyhn, 2008; Drillet, Jorgensen, Sorensen, Ramlov, & Hansen, 2006) stated that the highest concentration was found in glutamic acid, which accounted for 10% of total amino acids.

Fatty acids play a vital role in maintaining the structural and functional integrity of fish/prawn cell membranes. Zooplankton contains high levels of arachidonic acid, which help in the growth, and survival of larvae as documented by Bell, Carfell, Tocher, Macponald, and Sargent (1995) and Sargent, Bill, Bell, Handerson, and Tocher (1995). The observed essential fatty acid content was higher (96.69%) in WMZ of Ukkadam compared to 2 other zooplankton as 95.44% in WMZ of Sulur and 72.46% in *Artemia* nauplii tested in the present study. Aman & Altaf (2004) reported that the *Mesocyclops aspericornis* has higher total saturated (61.24 mg g^{-1}) and unsaturated fatty acid (41.15 mg g^{-1}) contents than does *S*. (*R*.) *indicus*. Fatty acids like heptadecanoic acid, caprylic acid and capric acid were not recorded in *M. aspericornis,* while *S*. (*R*.) *indicus* lacked arachidonic and behenic acids. The saturated and monounsaturated fatty acids, with the essential polyunsaturated fatty acids (PUFA), including DHA and EPA, present in generally lower proportions (up to 10%). The WMZ of Sulur and WMZ of Ukkadam Lake showed highest levels of DHA (9.4% and 9.2%) and EPA (3.2% and 3.26%), it is similar to the findings of Evjemo *et al*. (2001); Vengadeshperumal *et al*. (2010). The lowest level of DHA and EPA in *Artemia* (0.91% and 2.8%) was noticed in the present study. This could be an adaptation to long chain essential fatty acids. Both the absolute amounts of individual fatty acids and their relative proportion are important in the nutrition of fish larvae (Sargent, Mc Evoy, & Bell, 1997). In the present study, the content of total n-3 fatty acids in WMZ of Ukkadam (14.06%) was higher than the WMZ of Sulur (13.52%) and *Artemia* (4.56%). Although, most finfish and shellfish for both freshwater as well as marine larval nutrition research has focused on the role of n-3 HUFA's play an important role in larval prawn nutrition, particularly ARA, which is important as a precursor of some prostaglandins and other biologically active compounds that regulate growth and reproductive functions (Barclay & Zeller, 1996; Sargent *et al*., 1997). The present results indicated tropical wild mixed zooplankton of Ukkadam Lake might have more desirable characteristics as larval diets than traditional live feed *Artemia* nauplii.

In conclusion, the present study on the nutritional composition of wild mixed zooplankton is important to assess the energy available to plankton feeders. The biochemical composition of WMZ and cultured *Artemia* nauplii were analyzed; protein was higher in WMZ of Ukkadam than WMZ of Sulur Lake and cultured *Artemia* nauplii. The carbohydrate and lipid contents were higher in cultured *Artemia* nauplii followed by WMZ of Sulur and WMZ of Ukkadam Lake. The total amino acid content in WMZ of Ukkadam was higher than WMZ of Sulur Lake and *Artemia nauplii*. The essential amino acid and fatty acids were higher in WMZ of Ukkadam Lake and lower in cultured *Artemia* nauplii. However, nonessential amino acid was higher in *Artemia* and lower in WMZ of Sulur as well as WMZ of Ukkadam. The fatty acids of DHA and EPA were high in WMZ of Sulur Lake and low in cultured *Artemia* nauplii. Nutritional analyses indicated that wild mixed zooplankton are suitable live feeds for freshwater fish and prawn larval rearing and also their nutritional contribution is evaluated with the aim to consider the nutritive potentiality of this wild mixed zooplankton for nursery rearing of commercial important finfish and crustaceans.

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