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Effects of Different Diets on Population Growth of Cultured Cyclopoid Copepod, *Mesocyclops leuckarti* (Claus, 1857)

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Abstract: In recent times aquaculture has become an increasingly important part of the world economy. Copepods play major roles in pond ecosystems serving as food for small fish, micro-predators on fish and other organisms, fish parasites, intermediate hosts of fish parasites and hosts and vectors of human diseases like cholera. Growth, reproduction and biochemical composition were analyzed for the copepod *Mesocyclops leuckarti* fed on four diets and their ratio like Bakers yeast (B), Baker's yeast+ Wheat flour (BW, 1:2), Bakers yeast + Chicken manure (BC, 1:2) and Bakers yeast + Chicken manure + Wheat flour (BCW, 1:2:2). The mean peak density of the copepod population was 569 individual/lit, for all four diets used. The highest was 587 individual/lit, on diet having combination of Bakers yeast, Chicken manure and Wheat flour (BCW). A small copepod *Mesocyclops leuckarti* tends to have a short life span and it was found to be important food items for fish larvae.

Keywords: Copepod, Population growth, Natural food, Cyclopoid copepod

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Introduction

Copepods are of great ecological significance and serve as a major food for numerous organism including fish and crustaceans (Kinne, 1977; Goswami, 1977; James and Thirunawookarase, 1986). Copepods have a wide range of size. Considering the various

developmental stages in their life cycle, young naupli stages which are small about 50 μ m in size are of particular interest for early feed for fish larvae. They have a characteristics movement which induces feeding behaviour in young fish larvae. Copepoda are known for

nutritive value, digestibility and cleaning effect in the rearing tank (Kahan, 1992). Mass cultivation of *Acanthocyclops tonsa* (Stottrup *et al.*, 1986), *Acanthocyclops insunsi* (Ohno *et al.*, 1990), Calanoids (Dharani, 1998) and Harpacticoids, *Tisbe holothuria* in a continuous culture system consists of closed copepod bioreactor connection to a continuous micro-algal cultivation system (Stottrup and Norskar, 1997). Copepods are widely distributed and best known group of voracious feeders. They feed on a variety of food items such as algae, pollen, detritus, bacteria, rotifers, crustaceans, chironomids mosquito larvae and even larval fish (Fryer' 1957; Manakovl 1976; Marten, 1990) therefore they occupy three of the four major trophic positions in the food chain detritivorous, herbivores and carnivores. The calanoids and cyclopoid species are mostly omnivorous while harpacticoids are mostly detritus feeder.

Copepods make use of their chemo- and mechanoreceptors to locate and ingest its prey. Calanoids appear to use both chemoreceptors, while cyclopoids depend more on mechanoreceptors than chemoreceptors in detaching the prey (Williamson, 1991). Due to the importance of the copepods as primary and secondary consumers in the aquatic food and feeding habitats, this group is intensively investigated for both animals from wild and under laboratory conditions. Important contributions on the aspect are by Fryer (1957), Gliuriz (1969), Smyly (1961), Selander *et al.* (2019), Soler-Jiménez *et al.* (2019) and Altaff (2020).

Materials and Methods

Zooplankton samples were collected from freshwater lake at Mombatta Lake at

Daulatabad valley around Aurangabad, India. Live zooplankton samples were transported to the laboratory in polythene bag within an hour. Different groups of copepods were separated under binocular stereozoom dissection microscope using a fine brush and needle. *Mesocyclops leuckarti* were identified on the basis of Edmondson (1959), Van de Veldle (1984), Lim and Fernando (1985), Maas (1994), Reddy (1994), Dussart and Defaye (1995) and Altaf (2004). They were maintained in pretreated water (tap water double filtered with 42 um bolten silk and allowed to settle in large aquarium at room temperature for 48 h and aerated for 12-24 h prior to use). They were fed with Baker's yeast, wheat flour and chicken manure on alternate days. Multiple generation of *Mesocyclops leuckarti* were reared in the laboratory which have been used for various experimental studies.

The Copepoda were maintained as stock cultures in the laboratory. Each new culture was started by adding 10 adults *Mesocyclops leuckarti*. The copepods were fed a daily ration of four different diets (i) Baker's yeast (B) alone, (ii) Baker's yeast + wheat flour (BW, 1:2), (iii) Baker's yeast + chicken manure (BC, 1:2) and (iv) A diet containing all three components Baker's yeast + chicken manure + wheat flour (BCW, 1:2:2).

Population growth:

Ten ovigerous females (40 eggs/female) and five adult males were selected to begin each growth experiment. Experimental copepods were kept in 4 glass bottles (beaker) under room temperature and light (300 lux), with gentle aeration. During the daily transfer to clean bottles containing fresh food, copepods were placed on cavity slides and measured for

total body length (from the anterior end of the head to the tip of the caudal ramus). The number of offspring per female mean fecundity (number of nauplii/female), longevity (days) and post embryonic development period (hours) were recorded and all copepods were followed until natural death for each experiment. There were four replicates.

Results

Population Growth:

The three phases of population development identified for *Mesocyclops leuckarti* raised on four different diets (i) Bakers yeast [B] alone, (ii) Bakers yeast + wheat flour [BW, 1:2], (iii) Bakers yeast + chicken manure [BC, 1:2] and (iv) A diet containing all three components – Baker's yeast + chicken manure + wheat flour [BCW, 1:2:2] are shown in Figure 1. The first phase of population growth/initial growth (IG) was the shortest about 3 days. The fastest growth rate in this phase was attained on diet Baker's yeast. The second phase Growth (G) was the longest, from day 4 to 16. In this phase also, diet B yields the highest growth rates. The last or stabilization (s) phase was the period after which the *Mesocyclops leuckarti* population tend to diminish. During this period the highest growth rates were achieved on diets Bakers yeast and Bakers yeast + chicken manure. Maximum population density peaks for *Mesocyclops leuckarti* were similar for all diets. Varying from 533 ind./liter (Baker's yeast) to 587 ind./liter (Bakers yeast + chicken manure + wheat flour). The peak population density reached on days 14 and 16 for diets (B) and (BW), respectively and on day 20 for BCW diets (Table 1). Length of the copepods varied from 1800 to 1900 μm

for females, 1580 to 1670 μm for males, from 470 to 172 μm for nauplii. For female copepodids and nauplii the best diet was Baker's yeast (B), whereas for males it was Baker's yeast + wheat flour (BW). The mean duration of embryonic and post-embryonic development, together with other life cycle characteristics are shown in Table 2. There were no significant differences in period of embryonic development, which varied from 23.89 to 24.44 h among diets. There were some differences in post-embryonic development of *Mesocyclops leuckarti* which had the longest development time 8.57 days, when fed diet BC; whereas the BW diet resulted in slightly shorter development time of approximately 7.87 days.

Table 1: Maximum population density peaks and optimum culture times for the copepod *Mesocyclops leuckarti* maintained on different diets: Baker's yeast (B), Baker's yeast + wheat flour (BW, 1:2), Baker's yeast+ chicken manure (BC, 1:2) and Baker's yeast + chicken manure+ wheat flour (BCW, 1:2:2)

Diets	Maximum Peak (ind./lit.)	Optimum culture (Day)
B	543	14.7
BW (1:2)	563	16.1
BC (1:2)	585	21.5
BCW (1:2:2)	587	20.4
Total population	569.5	

In general, the mean number of nauplii per female was 51.54 for diet BW. Total fecundity (total number of nauplii produced over a female's life span) was similar for diets BC and BCW, with 48.85 ± 3.47 and 48.46 ± 3.94 nauplii, respectively. Copepods eating only algae (diet B) showed slightly lower total fecundity with 44.81 ± 3.66 nauplii.

Fig.1: Population growth phase (Initial growth, Growth, Stabilization).of four different diets of (B), (BW), (BC) and (BCW)

Table 2: Life history parameters of the copepod *Mesocyclops leuckarti* maintained on diets of Baker's yeast (B), Baker's yeast + wheat flour (BW, 1:2), Baker's yeast+ chicken manure (BC, 1:2) and Baker's yeast + chicken manure+ wheat flour (BCW, 1:2:2)

S. No.	Parameters	Diets			
		B	BW	BC	BCW
1.	Mean Embryonic Development Time (h)	24.16±2.55	24.44±2.76	24.44±2.76	23.89±2.78
2.	Mean post Embryonic Development Time (Days)	8.17±0.27	7.87±0.26	8.57±0.27	8.51±0.27
3.	Mean Fecundity (Nauplii/Female)	44.81±3.66	51.54±4.05	48.85±3.47	48.46±3.94
4.	Mean Number of Offspring/Female	4.00±0.77	4.00±0.77	3.46±0.77	3.62±0.70
5.	Longevity (Days)	53	50	46	44
6.	Temperature (C)	25	26	25	26

There were no significant differences among diets in the number of offspring per female. Diets B and BW resulted in slightly higher numbers of offspring per female (Table 2). There were differences in longevity among copepods on the four diets (Table 2). Animals

on the BC and BCW diets died much sooner than animals on the other diets and animals on BCW had significantly shorter life spans than animals on BC. There was an inverse relationship between temperature and longevity; mean longevity was 44 days at 26 C

and 46 days at 25 C. At 25 C, copepods on diet B lived longer than those on diets BC and BCW.

Discussion

Present study of copepods life cycle culture methods and their use as natural food for fish larvae might help develop more accurate techniques for large scale culture of copepods, thus making feasible their use as a high quality and easily digestible food. All the diets used in the present study were efficient. Copepods fed the (BCW, 1:2:2) diet reached the highest density. The mean peak density of the culture was almost 569 ind. /liter (the highest was 587 ind./liter on the diet having combination of Bakers yeast + chicken manure + wheat flour (BCW, 1:2:2).

The culture procedure used in the present investigation differed from others described in the literature in that cultures were started using adults rather than eggs or nauplii. According to Schipp *et al.* (1999), eggs should not be used because the rinsing process damages their setae, preventing normal molting and resulting in their death within 24 h.

Schipp *et al.* (1999) observed that species of *Acartia* have a generation time of 5-7 days, depending on water temperature. Their preliminary trials indicated that an 8-day culture cycle was required to maximize copepod productivity. Hardy and Duncan (1994) reported that temperature was the main factor controlling the embryonic development time of the Cladocera *Daphnia gessneri* reared on higher food levels (0.03 mg c/lit.), with mean values of 24-31 h at 32 C and post-embryonic development time of 7 days.

The mean embryonic and post-embryonic development times observed for the cultures of *Mesocyclops leuckarti* were slightly higher than those observed by Hardy and Duncan (1984). However, the copepods lived longer than the Cladocerans, with 3 developmental stages (nauplii, copepodid and adult) and had greater mortality during molting. Noticeable differences in longevity were also found. Smaller copepods tend to have shorter life spans overall. Larger individuals of *Mesocyclops leuckarti* lived longest on diet B, whereas smaller individuals had shorter life spans on the other diets. According to Lynch (1980), the smaller species tend to have shorter life spans. Rahmati *et al.* (2020) studied the potential of using specifically dry microalgae to improve the nutritional composition in copepods as a suitable supplementary live food for freshwater fish larvae.

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