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***Research Article** (Open Access)*

EFFECT OF OXYGEN TENSION ON THE OXYGEN CONSUMPTION AND METABOLIC RATE IN *PENAEUS MONODON* (FABRICIUS, 1798)

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ABSTRACT
The *Penaeus monodon* shrimps were maintained in a salinity of 32 ppt at room temperature (28°C) and fed with artificial feed. The selected seven shrimp have lengths of 7.8 cm, 8.5 cm, 9.0 cm, 9.8 cm, 10.2 cm, 11.6 cm, and 12.3 cm. The weights of the shrimp are 4.65 gr, 5.3 gr, 5.85 gr, 6.1 gr, 7.72 gr, 12.5 gr, and 16.0 gr. The experimental results of oxygen consumption and metabolic rates were correlated at various body weights. The Pearson correlation coefficients between two variables are r = 0.981 -0.999 it shows a perfect positive correlation. The observed ANOVA results effect size f is large (1.01), which indicates that the magnitude of the difference between the averages is large. When the η2 equals 0.51, it signifies that the group accounts for 50.6% of the variation from the mean. The smaller the p-value, the stronger it supports H_1. The test statistic F equals 17.51, which is not in the 95% region of acceptance. The observed effect size f is large (1.61), which indicates that the magnitude of the difference between the averages is large.

***Keywords:** Oxygen tensions, Oxygen consumption, Metabolic Rates, Correlation Coefficient, ANOVA*

INTRODUCTION
Increasing ocean temperatures diminish gas solubility and accelerate respiration, resulting in oxygen loss, whereas rising water column stratification limits atmospheric reoxygenation (IPCC, 2019; Breitburg *et al*., 2018). Changes in rates and the total amount of oxygen used by a population can alter ambient oxygen conditions (Altieri and Gedan, 2014). Other research suggests that oxygen delivery adapts to meet maximal demand over a species' natural temperature range, with biogeography having a greater impact on physiology (Seibel and Deutsch, 2020). One of the most prevalent issues in the culture of tiger prawns, *Penaeus monodon*, is low oxygen levels in ponds. This is especially true at night, when phytoplankton density is high and the concentration of dissolved oxygen in water falls below the essential level. In rare cases, oxygen is reduced during moulting, resulting in widespread death. Temperature is one of the elements that influence animal oxygen consumption. It is well known that at high temperatures, respiration and oxygen use increase. As much as temperature varies during culture, knowledge of its effect on the oxygen consumption of the animal is important. Knowledge of temperature effects may also suggest optimal temperatures for transporting fry from the hatchery to ponds where they will be stocked. Once the oxygen consumption is determined, the oxygen needs can be anticipated, and dissolved oxygen levels must be kept above these values to guarantee the animal's survival. Although other factors (such as animal utilisation) may contribute to dissolved oxygen levels in water, fundamental knowledge of how much oxygen an animal consumes for a particular amount of time and under specific conditions is required in culture. The information acquired may be used in future investigations on the animal's metabolism (Clark, 1955; Dehnel, 1960; Kinne, 1963).

MATERIALS AND METHODS

For laboratory experiments, shrimp were collected by cast netting, transferred into large buckets containing oxygenated sea water, and immediately transported to the laboratory, where they were maintained in large circular aquaria. The shrimp were maintained in a salinity of 32 ppt at room temperature (28°C) and fed with artificial feed. The selected seven shrimp have lengths of 7.8 cm, 8.5 cm, 9.0 cm, 9.8 cm, 10.2 cm, 11.6 cm, and 12.3 cm. The weights of the shrimp are 4.65 gr, 5.3 gr, 5.85 gr, 6.1 gr, 7.72 gr, 12.5 gr, and 16.0 gr. The shrimps were acclimatized for about 4-5 days before starting the experiments. The shrimp from the aquaria were transferred to respiratory chambers according to the experimental oxygenated water made with aerators. Care was taken in choosing intermoult shrimp of the same length and weight for oxygen consumption. Moult staging was followed by Drach (1939) for these experiments. Care was taken to prevent any air bubbles in between the lid and water column of the respiratory chamber. The shrimp were allowed in the respiratory chamber for one hour, and the oxygen consumed by the shrimp was measured. The method was a modification of Winkler's method for determining dissolved oxygen in seawater by Caritt and Carpenter, 1966; Montgomery *et al*., 1964 using standard Winkler's reagents. The DO values, which are tabulated with the data on the Pearson correlation coefficient of individual body weight and total biomass of the R value, One-Way ANOVA Calculator for summary of data to the value of f and p.

RESULTS AND DISCUSSION

In the present investigation the selected seven shrimps at various body sizes and lengths were maintained in various constant oxygen levels at room temperature. The results were indicated the oxygen tensions and metabolic rate was not so much variations (Table 1). The experimental results were correlated with consumption of oxygen at various body weights. The rate of oxygen intake declined when dissolved oxygen levels were below 3 ml/liter. With a further drop in dissolved oxygen, consumption is also reduced per unit time. At concentrations greater than 4 ml/litre, normal oxygen consumption was found. Increasing the concentration of dissolved oxygen over 6 ml/litre by continuous aeration did not significantly increase oxygen consumption. The intermoult shrimps could survive dissolved oxygen levels as low as 0.7 ml/litre in the lab. Shrimps normally swim on the surface of the water and leap when there is a low quantity of dissolved oxygen. Oxygen levels below 0.6 ml/litre resulted in morality; however, this was mostly dependent on shrimp size and moult stage (Table 1, Fig. 1&2). Rama Rao, (1996) reported on feeding behavior, oxygen requirements and growth of larval and adult *Penaeus monodon* and concluded the shrimps weighing more than 25 g were unable to tolerate dissolved oxygen levels of less than 1 ml/liter. Similarly, prawns in the premoult stage perished when the dissolved oxygen levels dropped below 1 ml/liter. These shrimps frequently died as a result of the ecdysis phenomenon.

The Pearson correlation coefficient between two variables, are $r = 0.981$ -0.999 it shows a perfect positive correlation (Table 2). The similar results were reported by Rama Rao and Babu, (2021) the dissolved oxygen levels were not maintained constant and differences were more between the day time and night time. The dissolved oxygen levels were 4.73±0.295 ml/lit during the day time and values fell 2.08±0.183 ml/lit during early hours of the day before sunrise in the culture ponds. The Pearson Correlation Coefficient of individual body weight and total biomass of R value is +1. This is a strong positive correlation, which means that high X variable scores go with high Y variable scores. The P-Value is $< .00001$hence the result is significant at $p < .05$

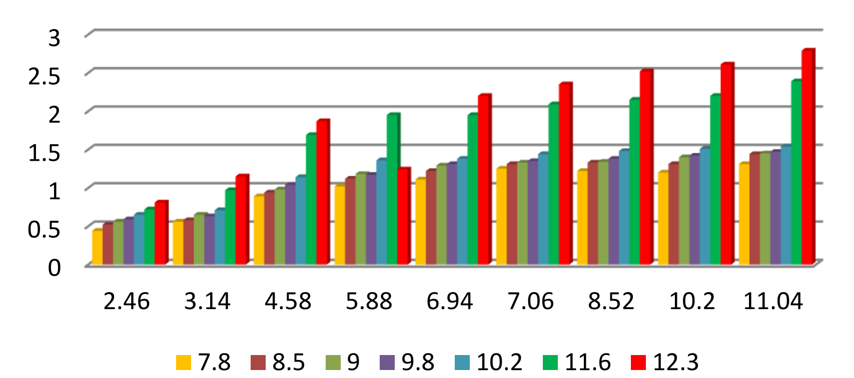
The ANOVA calculated values are exhibit differences between the consumed oxygen averages of some groups are big enough to be statistically significant. The p-value equals 0.0000031 [$p(x \leq F) = 0.999$]. The smaller the p-value, the stronger it supports H_1. The test statistic F equals 6.926, which is not in the 95% region of acceptance. The observed effect size f is large (1.01), which indicates that the magnitude of the difference between the averages is large. When the $\eta 2$ equals 0.51, it means that the group is responsible for 50.6% of the deviation from the mean. (Similar to R2 in the linear regression) Fig 3. The difference between the metabolic rate of *P. monodon* averages of some groups are big enough to be

Table 1: Oxygen consumption and metabolic rate at various concentrations of dissolved oxygen in *P. monodon*

			Concentration of oxygen ml/lit in the medium																	
S. No	Length cm	Weight gr	2.46		3.14		4.58		5.88		6.94		7.06		8.52		10.2		11.04	
			O_2 cons.	MR	O_2 cons.	MR	O_2 cons.	MR	O_2 cons.	MR	O_2 cons.	MR	O_2 cons.	MR	O_2 cons.	MR	O_2 cons.	MR	O_2 cons.	MR
1	7.8	4.65	0.44	0.1	0.56	0.12	0.89	0.19	1.02	0.22	1.11	0.24	1.25	0.26	1.22	0.26	1.2	0.26	1.31	0.28
2	8.5	5.3	0.52	0.1	0.58	0.11	0.94	0.18	1.12	0.21	1.22	0.23	1.31	0.25	1.33	0.25	1.31	0.25	1.44	0.27
3	9	5.85	0.56	0.1	0.65	0.11	0.98	0.17	1.18	0.2	1.29	0.22	1.33	0.23	1.34	0.23	1.4	0.24	1.45	0.25
4	9.8	6.1	0.59	0.1	0.63	0.1	1.04	0.17	1.17	0.19	1.31	0.21	1.35	0.22	1.38	0.23	1.42	0.23	1.47	0.24
5	10.2	7.72	0.65	0.08	0.71	0.09	1.14	0.15	1.36	0.18	1.38	0.18	1.44	0.19	1.48	0.19	1.51	0.2	1.54	0.2
6	11.6	12.5	0.72	0.06	0.97	0.08	1.69	0.14	1.95	0.16	1.95	0.16	2.09	0.17	2.15	0.17	2.2	0.18	2.39	0.19
7	12.3	16	0.81	0.05	1.15	0.07	1.87	0.12	1.24	0.14	2.2	0.14	2.35	0.15	2.52	0.16	2.61	0.16	2.79	0.17

Cons. = Concentration *MR= Metabolic Rate*

Figure 1: P. monodon oxygen consumption



statistically significant (@0.05). The smaller the p-value, the stronger it supports H_1. The test statistic F equals 17.51, which is not in the 95% region of acceptance. The observed effect size f is large (1.61), which indicates that the magnitude of the difference between the averages is large. The η2 equals 0.72, it means that the group explains 72.2% of the variance from the average (similar to R2 in the linear regression) Fig 4. The similar results were found by Rama Rao and Babu, (2022) the shrimps oxygen consumption at various temperatures ranging from 25-30°C. At 25°C the metabolic rate is further increased, but the increase in metabolic rate between 15°C and 20°C is much higher when compared to the increase in metabolic rate between 20°C and 25°C. The oxygen consumption is twice doubled with increase in temperature of 10°C from 15°C to 25°C or from 20°C to 30°C. But the increase in oxygen consumption is not doubled from 25°C to 35°C in *P. monodon* (Rama Rao, 196; 1923). According to Catedral and Sayson, (1977) the relationships appear linear in the temperature range studied (20-35°C). In this investigation, post larvae weighing 0.8-80 mg were employed. The same regression lines were identified in this investigation for those weighing up to 200 mg. It will be necessary to investigate if juveniles and adults will follow the same regression lines (Madeniian, 2008; Mohanty, 2001).

Figure 2: *P. monodon* metabolic rate

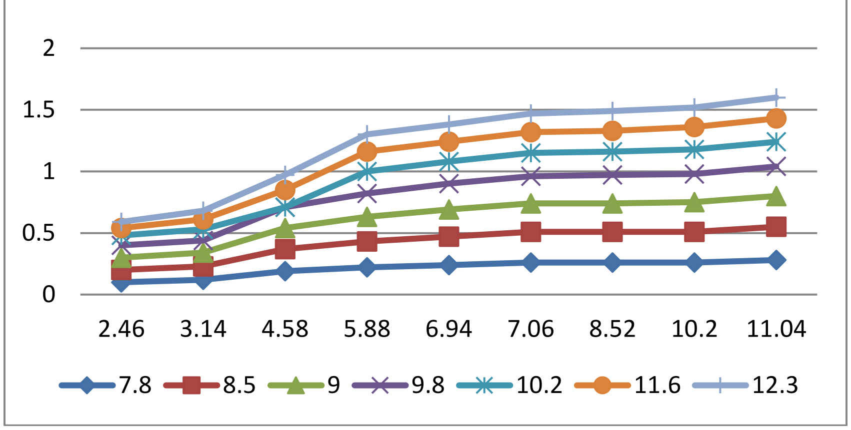


Table 2: Pearson correlation coefficient of oxygen consumption in *P. monodon*

Weight (gr)	4.65	5.3	5.85	6.1	7.72	12.5	16.0
4.65	1						
5.3	0.999	1					
5.85	0.997	0.998	1				
6.1	0.995	0.997	0.996	1			
7.72	0.989	0.988	0.991	0.987	1		
12.5	0.987	0.983	0.985	0.981	0.995	1	
16.0	0.991	0.988	0.987	0.986	0.992	0.996	1

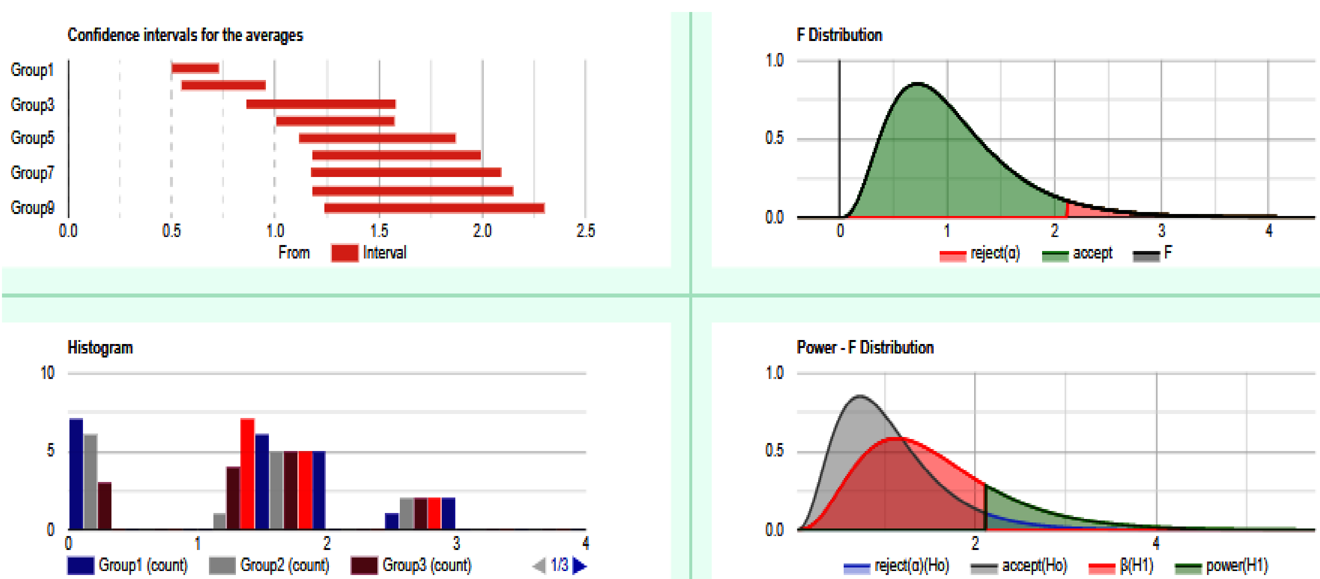


Figure 3: Results of ANOVA for oxygen consumption *P. monodon*

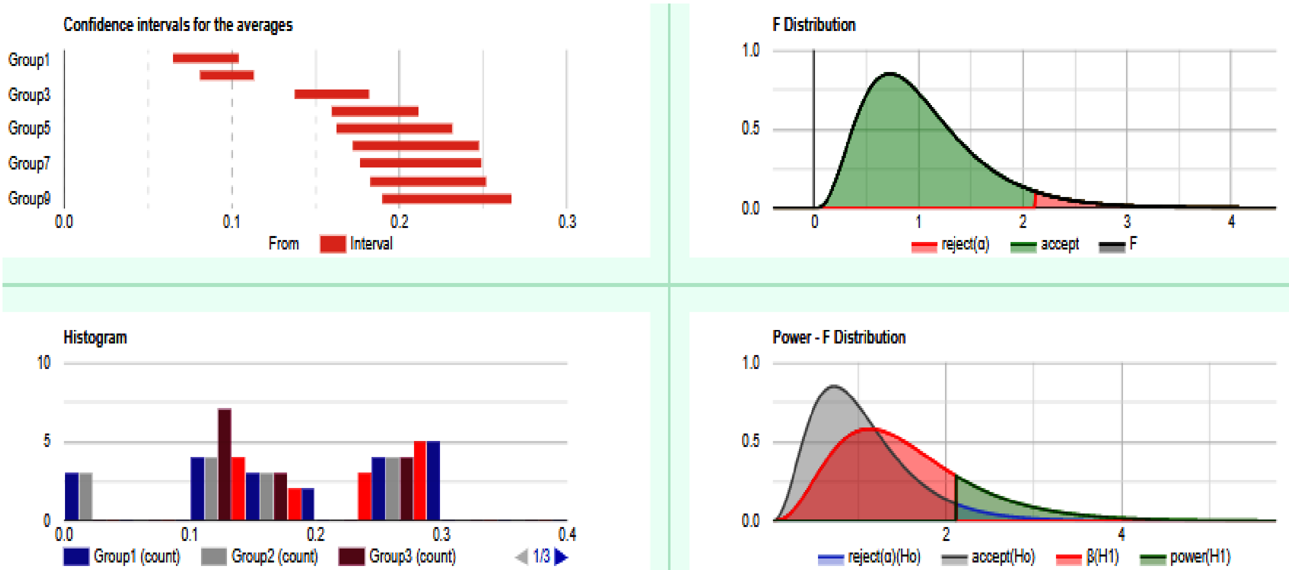


Figure 4: Results of ANOVA for metabolic rate *P. monodon*

CONCLUSION

Studies were carried out to determine the effect of oxygen consumption and metabolic rate in *Penaeus monodon* at various oxygen concentrations. When the quantity of dissolved oxygen in the aquatic medium exceeded 4 ml/litre, a normal metabolic rate was identified. Increasing the volume of oxygen in the medium has resulted in an increase in the metabolic rate due to the shrimp's active locomotory behaviour. This is particularly relevant for minimal in immature shrimps.

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DECLARATION

The methodology was collaboration by author, he contributed to the completion of this work and also carried out the final manuscript was read and approved.

ETHICAL APPROVAL

This study was conducted according to international ethical standards set by the Institutional Animal Care and Use Committee.

CONSENT TO PARTICIPATE

The local fishermen were involved in the sample collection and sampling study.

DATA AVAILABILITY STATEMENT

The author confirm that the data used to support the findings of this study are available within the manuscript.

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