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Statistical Analysis: Marine Capture Production of West Bengal, Andhra Pradesh and Kerala

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Abstract

In this study, basic statistical tools viz., measure of central tendency, dispersion, skewness, correlation and ANOVA tests were applied to analyze the marine capture production data of different groups like Pelagic, Demersal, Crustaceans and Molluscs collected from Marine Products Exports Development Authority, Cochin for the period from 1985 to 2011 pertaining to three costal states of India such as West Bengal, Andhra Pradesh and Kerala. Each group of fish was considered as a treatment for the chosen time series period. Descriptive statistics revealed the elevation of production levels of different groups for states studied. Molluscs production from Andhra Pradesh did not vary much between the years having low standard deviation (918.46) while pelagic fish production varied highly in Kerala having standard deviation (86818.71). In the case of crustaceans, West Bengal had high coefficient of variance (100) and Kerala had low coefficient of variance (19.50) for demersal group. Various kinds of skewed distribution could be observed between groups in all three states. Marine fish productions of different groups from the states of West Bengal and Andhra Pradesh had good correlation except with Kerala where even negative production was observed especially in crustacean production. ANOVA also endorsed that significant production level among various fish groups could be observed in all the states. Similarly, the fish production of every group obtained from the states of West Bengal and Andhra Pradesh differed significantly with Kerala despite no difference in various fish production between the states of West Bengal and Andhra Pradesh could be found.

Keywords: ANOVA, correlation, descriptive statistics, marine capture production

1. Introduction

The marine fisheries sector in India has witnessed a phenomenal growth during the last five decades both quantitatively and qualitatively. India has a long coastline of 8118 km and an Exclusive Economic Zone of 2.02 million km^2. Marine fishery potential of the Indian Exclusive Economic Zone (EEZ) is estimated to 3.934×10^6 t in 2007. Further, it is reported that about 58% of the resources is available at a depth of 0–50 m, 35% at 50–200 m and 7% from beyond 200 m depth. The present catch of 2.8×10^6 t has been largely derived from the intensively fished coastal zone up to 120 m which contributed 72% of the estimated fishery potential and the fisheries sector contributed ₹ 1, 75,573 crore to the Indian

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GDP (at current prices) during FY 2017–18 (Srinath, 2003; Boopendranath, 2007). West Bengal was in the first position in the State-wise Fish Production in India during 2010–2011; the total fish production including Marine and Inland of West Bengal is 1,615,313 mt (Ministry of Agriculture, Government of India 2012). The continental shelf up to 200 m depth covers an area of 20,000 km^2 which is 3.6% of the total area of the Indian continental shelf and shallow having a muddy bottom and its configuration is affected by the large river systems and tidal currents (Sachinandan et al., 2015). Andhra Pradesh is with a coastline of about 974 km spread over nine coastal districts and it ranks fifth position in marine fish landings of the country. The average annual marine fish landing of Andhra Pradesh during 2000–2010 was 1.99 lakh tons. Fishing effort declined by 33% and 9% in terms of fishing units and fishing hours respectively. Pelagic finfishes contributed 55.6% to the total marine catch, followed by demersal finfishes (27%), crustaceans (14.4%) and molluscs (1.1%) (Maheswarudu et al., 2013). Kerala, one of the prominent maritime States in India with coast line of 590 km, is blessed with the most productive portion of Arabian Sea and have a continental shelf area of 39,139 Sq km. The percentage increase of total fish production of Kerala in the year 2010–11 to 2011–12 is 1.70%. In total fish production, Andhra Pradesh was the highest contributor and Kerala stands 4th position. During 2012-13, 5.31 lakh tonnes of marine fish were landed in Kerala showing a decline of 0.22 lakh tones. (Lakshmi et al., 2016; Jomon et al., 2019). To have an in-depth understanding of the behavior of any set of data, exploratory analysis is always needed. It includes calculation and interpretation of different descriptive statistics such as measure of central tendency, measure of dispersion, measure of skewness, measure of kurtosis, correlation and Analysis of Variance (ANOVA). These tests are being used by various researchers for analysis of descriptive statistics in different discipline for estimating the Measures of central tendency, dispersion (Marshal et al., 2010; Andrew et al., 2014; Zulfiqar et al., 2016; Sanchiliana et al., 2016; Parampreet et al., 2018). The distributional shape of real data is analyzed by examining the values of the third and fourth central moments as a measurement of Skewness and kurtosis in small samples. while some others suggest much larger values of skewness and kurtosis for normality by using univariate and multivariate Skewness and kurtosis as measures of nonnormality (Sarah et al., 2012; Blanca et al., 2013; Meghan et al., 2017, Fatih, 2020). In the case of correlation is a simple statistical method used to assess a possible linear association between two quantitative variables and categorical variables to calculate and interpret (Malawi, 2012; Suniti, 2018). The powerful statistical technique ANOVA that can be used in many areas like sciences, engineering and manufacturing applications and presents its application (Ostertagova et al., 2013; Mouhamadou, 2014, Radhakrishnan et al., 2016; Flavius, 2017; Mariusz, 2020). Using all these fundamental and important methods, statistics on the marine production data for the 27 years from 1985 to 2011 obtained from three important states of West Bengal, Andhra Pradesh and Kerala were computed and interpreted taking the various produces as treatments in this study.

2. Materials and Methods

In this study, the marine production data for various groups viz., Pelagic, Demersal, Crustaceans and Molluscs pertaining to three states such as West Bengal, Andhra Pradesh and Kerala were collected for 27 years from 1985 to 2011. The data chosen for the study was a secondary data obtained from the website of Marine Products Export and Development Authority (MPEDA), Cochin. These data were analyzed and compared between the various groups of produces among the states and between states using certain statistical tools and techniques like descriptive statistics, correlation and ANOVA. In this study, the data chosen for analysis were chosen upto 2011 since later year onwards the Indian fish production data were merged with production obtained from the culture fisheries.

2.1. Descriptive statistics

Descriptive statistics help in understanding the nature of target population to a great extent. These statistics give a meaning to the entire data set. The advantage of descriptive statistics is to provide an insight in the humongous data set. Descriptive statistics could be used to describe a single variable or more than one variable. In the case of more than one variable, descriptive statistics could aid in summarizing the relationships between variables using tools such as scatter plots. It describes observed data by collection procedure like mean, mode, median, tabulation and graphical presentation, measures of central tendency, dispersion, Skewness, kurtosis, correlation etc.

Measure of central tendency or averages are statistical constants which enable us to comprehend in a single effort the significance of the whole. In simple words, it treated as a single value which represents the entire data. In this study, the measures of central tendency arithmetic Mean and Median. The median divided the group into two equal parts, one part comprising all values greater and the other values less than the median.

Dispersion is a measure of the extent to which individual items or the data vary. Measure of dispersion could be used to understand the consistency of averages of production data and to compare between two or more-time series production data. The measures of dispersion analyzed in this study were Standard deviation or root mean square deviation which is square root of the arithmetic mean of the squares of the deviation of the values taken from mean and another measure was Coefficient of variance (C.V.) which is the ratio of the standard deviation to the mean which was calculated for comparing the variability of two Series of data obtained from different attributes.

Measures of dispersion explain about the variability in a series whereas measure of skewness describes about the direction of variation. In general, skewness measures the lack of symmetry and degree of skewness based on value of less than−1 (less skewed) or greater than +1(highly skewed). If skewness is between−1 and −½ or between +½ and +1, the Distribution is moderately skewed. If skewness is between −½ and +½, the distribution is approximately symmetric. Kurtosis is a measure of the data whether they are heavy-tailed or light-tailed relative to a normal distribution. If the data sets with high kurtosis, it would tend to have heavy tails or outliers and vice versa. The higher kurtosis means more of the variance is the result of infrequent extreme deviations, as opposed to frequent modestly sized deviations.

2.2. Correlation

Pearson's correlation coefficient is a statistical method of quantifying the association, or "coherence", between two variables. It is therefore a very popular tool for analyzing data that arise in many scientific disciplines, for instance biology (Soares et al., 2011; Julia et al., 2010). In this study, the relationship between major marine capture production (Pelagic, Demersal, Crustaceans and Molluscs) and three costal states (West Bengal, Andhra Pradesh and Kerala) of India were analyzed over the period 1985–2011 using correlation analysis with the null hypothesis (H_o) that there was no statistical significant correlation between the marine capture production groups which were computed among coastal states of India.

Pearson correlation coefficient was calculated by examining degree association between different pairs of explanatory variables and between explanatory variables and dependent variables through zero order correlation matrixes using the following sample correlation coefficient

$$r=\frac{\sum xy-\frac{(\sum x)(\sum y)}{n}}{\sqrt{\sum x^2-\frac{(\sum x)^2}{n}}\sqrt{\sum y^2-\frac{(\sum y)^2}{n}}}$$

2.3. Analysis of variance (ANOVA)

Analysis of variance (ANOVA) is a statistical technique that is used to check if the means of two or more groups are significantly different from each other. ANOVA checks the impact of one or more factors by comparing the means of different samples. Another measure to compare the samples is called a t-test. It is understood that t-test and ANOVA give the same results if there are only two samples are tested. However, using a t-test alone would not be reliable in cases where there are more than two samples. ANOVA is a statistical tool used to detect differences between group means. (Sawyer, 2009). In this study, to test the significant difference between various marine capture productions like Pelagic, Demersal, Crustaceans and Molluscs and Coastal states of India were analyzed over the period 1985–2011 by using univariate analysis with the null hypothesis (H_o) that there was no statistically significant difference in marine capture production between Coastal states of India.

3. Results and Discussion

In the present study, the measure of central tendency, dispersion, skewness and kurtosis for annual time series data from 1985–2011 for Pelagic, Demersal, Crustaceans and Molluscs in Marine capture production were analyzed and also Correlations were computed among costal states west Bengal, Andhra Pradesh and Kerala for the time series data. Similarly differences in Marine Capture Production (Pelagic, Demersal, Crustaceans and Molluscs) between Coastal states of India (West Bengal, Andhra Pradesh and Kerala) were also tested.

3.1. Descriptive statistics

Generally, low standard deviation indicates that the data points tend to be very close to the mean while high standard deviation indicates that the data points are spread out over a large range of values. In this study, it could be observed that Molluscs in Andhra Pradesh had low standard deviation (SD=918.46) which indicated that the production data points were close to the mean. Whereas pelagic in Kerala had high standard deviation (SD=86818.71) which indicated that the production data points were spread out over a large range of values. Any group with a greater C.V. is said to be more volatile whereas series with a lower C.V. is said to be more consistent. As per the results obtained from the above analysis, it was found that crustaceans in West Bengal were highly volatile having C.V. value of 100 whereas Demersal in Kerala were highly consistent with C.V. value of 19.50 (Table 1).

In the case skewness analysis (Table 2), it could be observed in fish production of West Bengal that highly skewed distribution in three groups viz., Demersal, Crustaceans and Molluscs and moderately skewed Distribution in pelagic. But, in Andhra Pradesh moderately skewed Distribution could be observed in two groups viz., Demersal and Molluscs while symmetric distribution was observed in rest of other two groups viz., Pelagic and Crustaceans. Similarly in fish production obtained from Kerala, only one group Demersal was with moderately skewed distribution and remaining other three groups were Pelagic, Crustaceans and Molluscs followed approximately symmetric distribution.

Further, Molluscs production from the state of West Bengal was observed with leptokurtic distributions (β_2>3) having more sharply peaked than the normal curve while remaining fish production data showed platykurtic distributions (β_2<3) being flat-topped compared with the normal curve.

3.2. Correlation

The correlation coefficient obtained for Pelagic group while

Table 1: Descriptive statistics for various groups of MFP from different states

Groups	States	Mean	Median	Std. Deviation	Std. Error	CV
Pelagic	West Bengal	76018.7	49148	59742.47	11497.44	78.59
	Andhra Pradesh	104253.7	100176	26362.68	5073.50	25.29
	Kerala	362903.6	359459	86818.71	16708.27	23.92
Demersal	West Bengal	36074.56	23764	33113.84	6372.76	91.79
	Andhra Pradesh	48027.81	43227	11689.81	2249.70	24.34
	Kerala	103802	101248	20241.94	3895.56	19.50
Crustaceans	West Bengal	17971.7	8415	18029.18	3469.72	100.00
	Andhra Pradesh	23723.22	22668	7763.029	1493.99	32.72
	Kerala	63444.26	64044	14768.22	2842.14	23.28
Molluscs	West Bengal	823.6296	448	1133.42	218.13	72.67
	Andhra Pradesh	1561.259	1380	918.46	176.76	58.83
	Kerala	28922.26	30554	9855.05	1896.61	34.07

Table 2: Kurtosis and Skewness for various groups of MFP

Treatments	States	Kurtosis	Skewness
Pelagic	West Bengal	-0.33	0.89
	Andhra Pradesh	-0.56	0.36
	Kerala	0.42	-0.46
Demersal	West Bengal	1.08	1.42
	Andhra Pradesh	0.24	0.98
	Kerala	-0.30	0.56
Crustaceans	West Bengal	0.86	1.18
	Andhra Pradesh	-0.91	-0.09
	Kerala	-0.01	0.39
Molluscs	West Bengal	5.72	2.30
	Andhra Pradesh	0.55	0.97
	Kerala	0.14	-0.47

Table 3: Correlations matrix for various groups of MFP

Pearson Correlation		Pelagic	Demersal	Crustaceans	Molluscs
West Bengal	Pelagic	1	0.943**	0.908**	0.827**
	Demersal		1	0.955**	0.927**
	Crustaceans			1	0.923**
	Molluscs				1
Andhra Pradesh	Pelagic	1	0.791**	0.882**	0.745**
	Demersal		1	0.762**	0.836**
	Crustaceans			1	0.809**
	Molluscs				1
Kerala	Pelagic	1	0.102	-0.178	0.575
	Demersal		1	0.422	0.263
	Crustaceans			1	0.115
	Molluscs				1

comparing with other groups viz., Demersal, Crustaceans and Molluscs, it had linear significant relationship (p<0.01) (Table 3 and Figure 1). It indicated that fish production of various groups had strong positive relationship between pelagic groups while compared with the production of Demersal, Crustaceans and Crustaceans in West Bengal and Andhra Pradesh except Kerala.

Similarly, while comparing Demersal group fish production of all three states with other groups viz., Pelagic, Crustaceans and Molluscs, it had significant linear relationship (p<0.01). It revealed that demersal fish production had significant positive relationship while compared with other fish production groups in West Bengal and Andhra Pradesh except Kerala.

The correlation co-efficient obtained for the data of Crustaceans compared with Pelagic, Demersal and Molluscs, it had significant linear relationship at 1% level of significant (i.e. p<0.01). In this case also, positive relationship could be observed between crustaceans production with other groups viz., pelagic, Demersal and Molluscs in West Bengal and Andhra Pradesh except Kerala. However, there was a weekly negative relation between Crustaceans and pelagic and also weekly positive relationship between Crustaceans, Demersal and Molluscs were observed in the state of Kerala.

While comparing the production data on Molluscs obtained from all three states, significant linear relationship (p<0.01) could be obtained while comparing with Pelagic, Demersal and Crustaceans production data. It revealed that the production in all four groups was positively correlated in the states of West Bengal and Andhra Pradesh except Kerala (Figure 2).

3.3. Analysis of variance

After conducting the analysis of variance among the different groups of fish production viz., pelagic, demersal, crustaceans

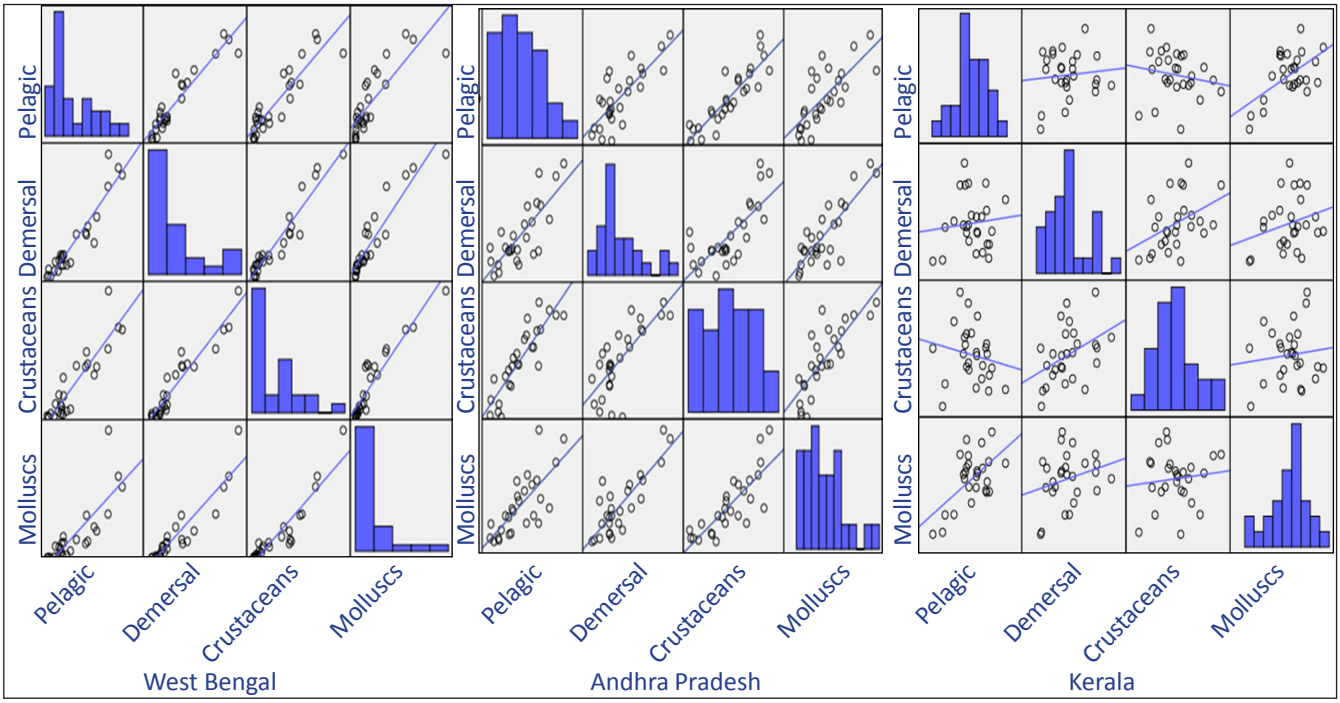

Figure 1: Marine fish production from various coastal states of India

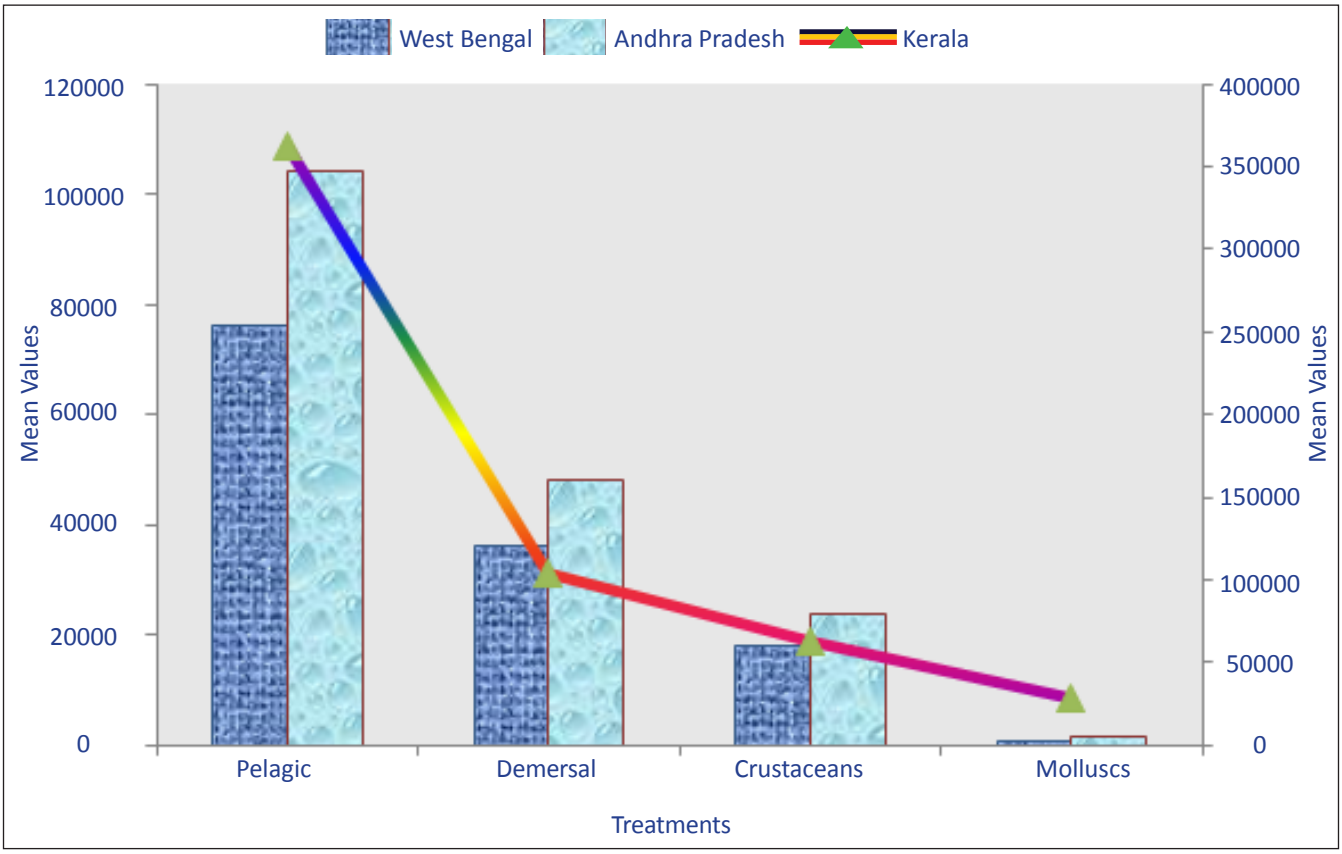

Figure 2: Mean MFP of various groups from different states of India

and molluscs between different states such as West Bengal, Andhra Pradesh and Kerala, it could be observed that production level were significantly differed (p<0.05) between the fish production groups revealed (Table 4 and Figure 3). However, there was no significant difference could be observed between states of West Bengal and Andhra Pradesh

Table 4: ANOVA for various for various groups of MFP from different states of India

Dependent variable	States	N	Mean*	Std. Error	F-statistics
Pelagic	West Bengal	27	76018.70[a]	11497.44	F=171.586
	Andhra Pradesh	27	104253.74[a]	5073.50	(*p*=0.000)
	Kerala	27	362903.59[b]	16708.27	
Demersal	West Bengal	27	36074.56[a]	6372.76	F=64.427
	Andhra Pradesh	27	48027.81[a]	2249.70	(*p*=0.000)
	Kerala	27	103801.96[b]	3895.56	
Crustaceans	West Bengal	27	17971.70[a]	3469.72	F=82.300
	Andhra Pradesh	27	23723.22[a]	1494.00	(*p*=0.000)
	Kerala	27	63444.26[b]	2842.14	
Molluscs	West Bengal	27	823.63[a]	218.63	F=209.294
	Andhra Pradesh	27	1561.26[a]	176.76	(*p*=0.000)
	Kerala	27	28922.26[b]	1896.60	

*: Means giving the same superscript do not differ significantly ($p>0.05$) by Duncan's test

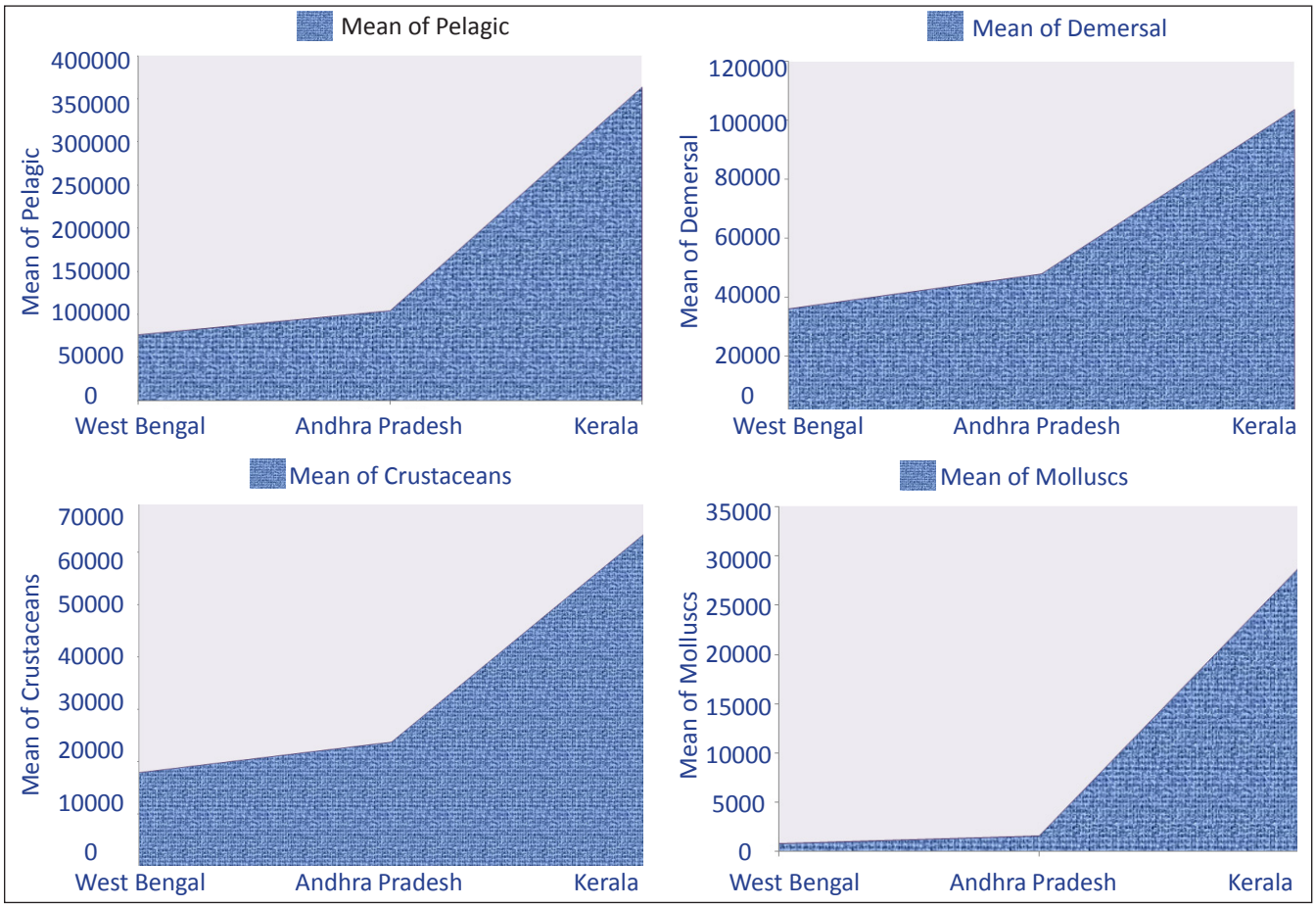

Figure 3: Mean MFP groups obtained from different states of India

in all fish production groups despite, there was significant difference was observed between Kerala with other states. It could be concluded that there was significant difference in the various fish productions viz., pelagic, demersal, crustaceans and molluscs, obtained from Kerala compared with West Bengal and Andhra Pradesh.

4. Conclusion

MFP of different groups obtained from the coastal states of India were correlated with each other and found significant differences in production level among the MFP groups in the state of West Bengal and Andhra Pradesh except Kerala. In Kerala, crustaceans production was negatively correlated with other fish productions and other groups also poorly correlated compared with productions from other states. Further, ANOVA also showed significant variation among fish production groups between Kerala with other two states.

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