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Trend and Seasonality Analysis on International Shrimp Market Prices Exported from Andhra Pradesh, India

M. Rajani*, and A. Balasubramanian
College of Fishery Science, Andhra Pradesh Fisheries University, Muthukur, Nellore Dt., Andhra Pradesh (524 344), India

Abstract

Shrimp remains one of the most traded food items worldwide, and its farming is an important activity in various maritime states of India. Shrimp prices experience uncertain fluctuations caused by changes in market demands, domestic and export demands. These undulations in market price impact the national economy. Owing to this, the study was designed with the objective to analyse the trends and seasonal changes in shrimp market prices, by collecting monthly shrimp price data from various published sources like MPEDA statistics and field offices of MPEDA from January 2020 to December 2023. The shrimp were categorized into count price grades, ranging from 30 to 70 Count (C) per kg. The analysis revealed that, over the long term, shrimp prices for the 40 C to 70 C grades in the Andhra Pradesh export market showed an insignificant upward trend. Monthly price variability in Andhra Pradesh showed that size grade 30C had the lowest variability in June, while the size grade 50C had the highest variability in April. The study also revealed that the seasonal indices in shrimp prices were highest in the month of January for all shrimp count size grades (30 to 70C per Rs./kg) and lowest in April (40 to 70 C per Rs./kg) and in July (30C per Rs./kg) in the Andhra Pradesh export market.

Keywords: Trend, seasonal indices, shrimp prices, size grade, variability

Introduction

Shrimp remains one of the most traded foods worldwide, especially in the developed countries, due to its taste, nutritional benefits, and significant demand. The changing demographic pattern of the global population has also made shrimp a preferred species in developing countries also. With the marine resources continuously depleting, aquaculture emerges as a key industry (Patel & Patel, 2018). India is a major shrimp producer, consistently hovering around 20% of share in global shrimp exports. The state of Andhra Pradesh contributes the largest share- about 70%- of the country's shrimp production. The aquaculture industry supports livelihoods, but also enhances foreign exchange earnings. Favourable conditions and advanced aquaculture farming practices contributes to its growth (Sandhya, 2024).

The current shrimp-farming area in India is about 1,76,000 hectares (ha). Of this, about 1,60,000 ha (91%) is currently used for the cultivation of Pacific white shrimp (*Litopenaeus vannamei*), 14,080 ha (8%) is used for black tiger shrimp (*Penaeus monodon*) culture, and around 1,760 ha (1%) for the production of freshwater giant prawn (*Macrobrachium rosenbergii*) (George, Chinnadurai, & Vidya, 2020). Among the penaeids, only two species -tiger shrimp and Pacific white shrimp- together contributes for more than 90% of the farmed shrimp production. Almost major portion of this shrimp is exported. In FY 2023–24, India exported 716,004 metric tonnes of frozen shrimp to the United States, which emerged as the largest importer, accounting for 297,571 MT or 41.6% of the total export volume. China was the second-largest importer with 148,483 MT (20.8%), followed by the European Union with 89,697 MT (12.5%), Southeast Asia with 52,254 MT (7.3%), Japan with 35,906 MT (5%), and the Middle East with 28,571 MT (4%). The shrimp farming practice is also an important activity in coastal waters of Andhra Pradesh in India (George et al., 2020; DT Next, 2024). The major driving traits that lead India's positive growth in seafood exports are the rapid rise in the production of *P. Vannamei*, the diversification

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*Email: rajani231190@gmail.com

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of aquaculture species besides *P. monodon*, and sustained measures to ensure quality and improve infrastructure for producing value-added products (MPEDA, 2023).

In the year 2022-23, a total area of 108,526.27 ha was under L. *vannamei* culture in nine maritime states, producing 815,745 MT, with Andhra Pradesh leading in total area under culture and production. Gujarat and Tamil Nadu were in the next positions. *L.vannamei* shrimp farming has contributed to the development of infrastructure in the coastal regions, employment opportunities, and the socio-economic development of the coastal population of Andhra Pradesh (MPEDA, 2023). Shrimp and prawns have historically been among the most heavily traded aquatic commodities. Frozen shrimp is the largest exported item, both in terms of quantity and value, during the last decade. India's export growth story was primarily driven by the success of brackish water aquaculture of shrimp (PMMSY, 2020). India's export of frozen shrimp increased from 0.652 million MT (50.58%) worth USD 4,889.12 (74.31%) in the year 2019–2020 to 0.711 million MT worth USD 5,481.63 in the year 2022–2023 (Department of Fisheries, 2022; MPEDA, 2023).

Price is a key factor that influences the decisions of both producers and consumers. For producers, the output price is crucial for planning, assessing business opportunities, and adapting to market changes. It also acts as a primary mechanism that links market levels and actors across the supply chain (Truong, Le, & Pham, 2023). Certain countries like China and Vietnam import Indian shrimp, undertake value addition and sell them for a higher price in international markets. In addition, strict regulations for maintaining quality standards also act as a game changer in the export market. Shrimp prices are largely driven by market demand and consumer preference for a specific size, which leads to higher prices. However, shrimp prices experience uncertain fluctuations due to varying market demands in both domestic and export markets (Fortuna, 2023). The fluctuations in supply of shrimp play a key role in determining the prices of *Vannamei* shrimp in the global market. *Vannamei* shrimp has become one of the most sought-after seafood commodities in the international market and has emerged as a major contributor to the country's exports (Zulfikar, 2022; Fortuna, 2023).

The present study has been undertaken with the following specific objectives: to analyse the trend in the shrimp count prices and to examine the seasonal variability in market prices of shrimp exported from Andhra Pradesh.

Materials and Methods

The present study was undertaken using secondary data collected from published statistical sources for the state of Andhra Pradesh. Information on market channels for shrimp exports of selected size grades, 30C to 70C, for the state of Andhra Pradesh was collected from the field offices of Marine Products Export Development Authority (MPEDA) over a period of 48 months, from January 2020 to December 2023.

The collected time series data of monthly prices were de-seasonalized to adjust for seasonal variation, in order to estimate the trend of monthly shrimp prices across different size grades in Andhra Pradesh, by applying method as outlined by Acharya and Agarwal (2009).

De-seasonalized price for the month 't' =

$$\frac{\text{Market Price for 't' month}}{\text{Seasonal price index}} \times 100$$

After de-seasonalization, the linear trend was estimated by applying the Ordinary Least Squares method, as given by the following equation:

$$Y_t = a + bt + \epsilon_t$$

Where, Y_t = trend value at time t; t = time period; a = intercept parameter; b = slope parameter and $å_t$= error term.

Monthly trends of shrimp market prices for Andhra Pradesh were computed and compared. The goodness of fit of the trend line to the data was tested by computing the coefficient of multiple determination, denoted as R^2.

Seasonal indices are one of the widely accepted sophisticated tools for the analysis of time series data, specifically for seasonal variations in prices. Seasonality is observed in both the arrivals and prices of farm products. It arises from the nature of production, supply and demand in markets, and price formations for crops, as well as seasonal variations resulting from climatic factors and the biological growth processes of products. Following the seasonality in production and arrivals, prices also exhibit seasonal fluctuations. Normally, the prices of storable produce are lower at harvest time

and then rise as the season progresses, reaching their peak just prior to the next harvest. The study of seasonal fluctuations is considered important as a guide for the producers to market their produce and for consumers to purchase their needs at the right time. It also serves as a guide for the government to implement its policy measures (procurement and buffer release) at the appropriate time, in the case of shrimp as well. Knowledge of seasonality in prices helps in planning aquaculture. As seasonal fluctuations is a regularly recurring pattern, the first step is to estimate the seasonal index for every 12 months through centred moving averages (Nahatkar, Kiradiya, & Sharma, 1998).

The seasonal variance was calculated using the twelve-month centred moving average (TMMA) decomposition method, as it provides the periodic changes excluding seasonality. The actual values were divided by calculated TMMA values to determine the seasonal variations.

$$MA(12) = \frac{1}{12} \times \sum PI$$

Here, all the data related to prices were converted into index form, i.e. multiplied by 100.

$$SI = \frac{\sum PI}{MA} \times 100$$

Where, MA (12) = twelve month moving average; PI = market price indices; SI = seasonal indices for market prices.

An additional 2-month moving average is computed to centre the 12-month moving average. As a result, irregular and seasonal impacts are represented by the ratio to the moving average. The most random influences will generally be minimized if the ratios for each period are then averaged over several years (Acharya & Agarwal, 2009).

Adjusted seasonal indices (ASI) = seasonal Indices ×correction factor.

Here, correction factor = 1200 ÷ Sum of seasonal indices.

Further, seasonal monthly prices index was estimated by applying the formula given as follows:

$$SI = \frac{(I_h - I_l)}{I_l} \times 100$$

Where, I_h = highest value of seasonal index and I_l = Lowest value of seasonal index.

Descriptive statistics and the coefficient of variation (CV) were used to compare month-wise variability in the market prices of shrimp in the selected size grades. By taking mean monthly data across the years, the impacts of irregular components in the monthly time series data were removed, and the results were deflated by a correction factor to generate seasonal monthly indices of market prices. The level of intra-year price volatility was estimated using the following two techniques, which were then combined with the coefficient of variation.

Intra-year price rise (IYPR) =

$$\frac{HIPI - LSPI}{LSPI} \times 100$$

Where, the highest and lowest seasonal price indices are denoted by HSPI and LSPI, respectively.

Coefficient of average seasonal price variation (ASPV)

$$\frac{\frac{HSPI - LSPI}{HSPI + LSPI}}{2} \times 100$$

$$\text{Coefficient of variation} = \frac{\sigma}{\bar{X}} \times 100$$

Where, σ is standard deviation and $\bar{X}$ is mean.

Results and Discussion

Andhra Pradesh ranks first in shrimp production in India, and during 2022-23, it exported 2,83,225 MT of seafood worth Rs. 18,073 crore ($2,284.46 million). The state contributed 16.32% of seafood exports in the financial year 2022-23, with exports made through Visakhapatnam seaport, Krishnapatnam seaport, and Visakhapatnam air cargo, as per the MPEDA report (Babu, 2024). In 2021-22, Andhra Pradesh exported 2,67,166 MT of seafood worth Rs. 16,864 crore ($2,291.64 million) (Srinivas, 2022; The Times of India, 2023). In 2023, the state had the highest *Vannamei* shrimp production in India, reaching over 9,12,000 MT. Although Andhra Pradesh was the largest shrimp producer state in India, accounting for 70% of the country's shrimp output (Sandhya, 2024), market prices in the state

have been undulating for the last four years (Fig.1) due to the impact of Covid-19 pandemic and the rejection of shrimp products by importing countries for various reasons. These include detection of antibiotic residues, non-compliance with quality or food safety standards, presence of banned substances or contaminants, inadequate cold chain or packaging during shipment, mismatches in labelling or documentation, and phytosanitary or sanitary inspection failures (Ragumaran, Raj, George, Sangeetha, & Mitha, 2021; Krishnan & Cheran, 2022, Suresh, Sabu, Kishore, & Kumar, 2025).

The absolute price movements for shrimp in Andhra Pradesh over the last four years (from 2020 to 2023) are shown in Fig. 1. The price differential for the 30C size grade over the last four years was INR 22/kg between 2020 and 2021, INR 2/kg between 2021 and 2022, and INR 34/kg between 2022 and 2023. In the case of 40C shrimp, the price differential over the past four years was INR 31/kg between 2020 and 2021, INR 7/kg between 2021 and 2022, and INR 35/kg between 2022 and 2023. Similarly, for the 50C grade, the price differentials were INR 17/kg between 2020 and 2021, INR 16/kg between 2021 and 2022, and INR 19/kg between 2022 and 2023. For 60C, the price differential over the past four years was INR 14/kg between 2020 and 2021, INR 21/kg between 2021 and 2022, and INR 18/kg between 2022 and 2023. Similarly, for 70C, the price differential was INR 11/kg between 2020 and 2021, INR 31/kg between 2021 and 2022, and INR 18/kg between 2022 and 2023.

Table 1. Linear trend in prices of shrimp in the selected size grades of Andhra Pradesh

Size Grades	Linear Model	R^2 value	Sig.p-value
30 count price	Y_t = 463.15- 0.37 t	0.0091	0.52
40 count price	Y_t = 372.45 + 0.02 t	0.0027	0.97
50 count price	Y_t = 314.69 + 0.46 t	0.0272	0.26
60 count price	Y_t = 285.74 + 0.59 t	0.0469	0.14
70 count price	Y_t = 257.30 + 0.74 t	0.0738	0.06

* Significant at 5% level and t is time period of 48 months

Table 2. Month-wise variability in prices of shrimp count in selected size grades in AP

Months	Andhra Pradesh (Size Grades (Rs/kg))									
	30 count price		40 count price		50 count price		60 count price		70 count price	
	Mean	CV(%)	Mean	CV(%)	Mean	CV(%)	Mean	CV(%)	Mean	CV(%)
January	512.50	10.73	433.75	11.35	362.50	36.17	328.75	37.50	307.50	35.71
February	493.75	6.79	416.25	9.06	360.00	29.44	326.35	34.73	302.50	33.04
March	473.75	8.24	373.75	10.44	318.75	32.76	298.75	28.98	276.25	34.97
April	427.50	15.56	327.50	17.70	285.00	57.45	262.50	52.52	245.00	51.96
May	432.50	8.93	345.00	6.90	310.00	16.33	292.50	17.08	272.50	23.63
June	422.50	2.27	335.00	7.11	300.00	23.09	275.00	28.87	252.50	37.75
July	400.00	5.77	335.00	5.17	290.00	31.62	265.00	40.41	242.50	47.17
August	450.00	10.42	380.00	12.34	327.50	33.04	302.50	34.03	282.50	39.48
September	455.00	13.75	373.75	12.23	331.25	25.94	301.25	26.58	282.50	18.93
October	453.75	15.67	377.50	15.65	335.00	31.09	307.50	35.00	277.50	28.72
November	456.25	16.87	380.00	17.22	341.25	50.39	315.00	47.96	278.75	44.79
December	471.25	11.17	397.50	10.89	351.25	26.58	325.00	25.17	283.75	35.44

A positive price increment was observed in all the selected size grade of shrimp from 2020 to 2022. However, a negative price difference was noted in 2023 compared to the previous year. The emerging negative price trend during the year 2023 might be due to large scale dumping of shrimp from various countries into the international market and the rejection of many containers exported from India due to the detection of antibiotic residues (SSA, 2023; Lily, 2024; SSA, 2024; Suresh et al., 2025). This kind of trend highlights the need to raised awareness on best management practices, as well as the urgent necessity of developing local markets to ensure sustainability while remaining profitable in shrimp culture (Rajani & Balasubramanian, 2023; SSA, 2023).

The linear trends were computed to ascertain the long-run movement of market prices for shrimp in the selected size grades over 48 months, from January 2020 to December 2023 (Table 1). The price for the 40C, 50C, 60C and 70C size grades showed an increasing trend (though statistically insignificant). Furthermore, the market prices for 30C decreased, but without any significant difference. The coefficients of the linear models indicated the direction and magnitude of price changes over time. Among the size grades, only the 70C price exhibited a relatively stronger increasing trend (slope = +0.74), although its R^2 value (0.0738) reflected a weak explanatory power for the linear model. All R^2 values were quite low, indicating that the linear trend explained only a small portion of the variation

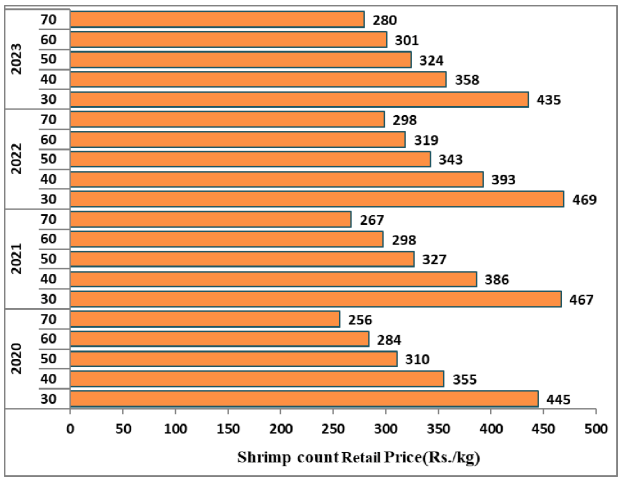

Fig. 1. Average retail prices of *Vannamei* shrimp in Andhra Pradesh

in shrimp prices for each grade. These trends may be attributed to factors such as market fluctuations, seasonal variations, and changes in demand and supply dynamics (Asche, Bellemare, Roheim, Smith, & Tveteras, 2015; Kumar, Sharma, & Reddy, 2020).

The variability in market prices of shrimp in the different selected size grades in Andhra Pradesh is depicted in Table 2. The high and low monthly variability in shrimp prices for 30C was 16.87% in November and 2.27% in June, respectively, while the respective variability for the 40C was 17.70% in April and 5.17% in July. For 50C, the high and low variability were 57.45% in April and 16.33% in May respectively. The estimated high and low monthly

Table 3. Month -wise seasonal indices in shrimp count price in Andhra Pradesh from January 2020 to December 2023

Months	30 count Price	40 count Price	50 count Price	60 count Price	70 count Price
January	112.87	116.31	111.18	109.51	111.69
February	108.74	111.62	110.42	109.20	109.88
March	104.34	100.22	97.76	99.51	100.34
April	94.15	87.82	87.41	87.44	88.99
May	95.25	92.51	95.08	97.43	98.98
June	93.05	89.83	92.01	91.60	91.71
July	88.09	89.83	88.95	88.27	88.08
August	100.01	101.90	100.45	100.76	102.61
September	100.21	100.22	101.60	100.35	102.52
October	100.03	101.23	102.75	102.43	100.79
November	100.48	101.90	104.66	104.93	101.25
December	103.79	106.59	107.73	108.26	103.06

variability of shrimp prices for 60C were 52.52% in April and 17.08% in May, respectively. For the 70C size grade, the respective high and low variability estimated was 51.96% in April and 18.93% in September.

Increased demand for seafood, especially in export markets, generally leads to price volatility due to mismatches in supply and demand. In some years, factors like weather patterns, disease outbreaks, or limited supply due to farming conditions could restrict the availability of shrimp, causing significant price fluctuations. Shrimp farming is seasonal, which can lead to supply fluctuations and, in turn, price variability (Lanka, 2022; Chandrasekar, Jayaraman, & Suresh, 2023; Chandrasekar & Madhusudhan, 2023; John & Anand, 2024). It can be observed from the estimated month-wise variability in the prices of shrimp counts that almost all the counts, except 30C, showed high variability in April and low variability in May. The high price variability for the 40C to 70C in April might be due to good supply of shrimp in the international market and competition in the market (FAO, 2021). Similarly, low-price variability was observed in the months of May, July and September for the same count, i.e. 40C to 70 C. It may be noted that summer season crop is the major shrimp farming season in India, and the supply of shrimps to the market is substantial during the months of May–June. Demand and supply metrics could possibly be the reason for the price variation across these month (Gibson & Feijoo, 2020; Bhargavi et al., 2024). Furthermore, the shrimp market is growing due to rising domestic and international demand, driven by awareness of its nutritional benefits, expanding middle-class consumption, and increasing exports to major markets (Credence Research, 2024). Both maximum and minimum price variability in 30C was lower compared to other counts.

Seasonal indices for the period from 2020 to 2023 were constructed to determine the long-run seasonal variation in the market prices of shrimp for selected size grades, by calculating the 12-month centered moving average and are presented in Table 3.

In Andhra Pradesh, the highest seasonal index of shrimp price was recorded in January for all the size grades (Table 3), while the lowest was found in July (88.09% in 30C and 88.08% in 70C), and April for the remaining size grades (87.82 % in 40C; 87.41 % in 50C; and 87.44 % in 60C). For the consecutive eight months, starting from August to March, the price index value was found to be more than 100, while the remaining four months registered index values of less than 100 in almost all counts, except 50C and 60C. The highest seasonal index in export-oriented shrimp prices is observed in international market, where high demand for seafood, including shrimp, occurs during major festivals seasons such as Christmas, New Year, and other holidays (Geethalakshmi, Gopal, Unnithan, & Jeyanthi, 2009; Jennings, 2013). This demand often leads to a surge in prices in the market, and the seasonal increase in consumption can cause price volatility due to changes in supply and demand. The US shrimp market, which was once dominated by domestic catches, is now mostly supplied by imports. For domestic producers, this results in lower revenues, while US consumers eat more shrimp at lower prices (Asche, Oglend, & Smith, 2022). However, the lowest seasonal index in shrimp prices occurs due to balanced supply and demand, post-harvest stability, absence of major festivals or trade disruptions, and consistent climatic and environmental conditions. The lowest seasonal index in July and April may be attributed to factors such as reduced demand during off-peak seasons, lower consumer spending, and decreased export activity. Additionally, environmental factors like the monsoon season can affect shrimp supply and quality, leading to price fluctuations (FAO, 2018).

Table 4. IYPR, ASPV and CV in selected size grades of shrimp market in AP.

Selected size grades	IYPR	ASPV	CV
30 counts	28.13	24.66	5.93
40 counts	32.44	27.91	8.87
50 counts	27.19	23.94	7.97
60 counts	25.24	22.41	7.67
70 counts	25.51	22.62	7.34

Further, the average seasonal price variation (ASPV), co-efficient of variation (CV) and the extent of intra-year price variation measured in terms of intra-year price rise (IYPR) are presented in Table 4. In the Andhra Pradesh market, the highest intra-year price was observed for the shrimp size grade 40C (32.44%), followed by 30C (28.13%) and 50C (27.19%), although the difference between the maximum and minimum values was small for all shrimp size grades. A higher intra-year price rise

reflects significant price fluctuations within the year, often due to supply-demand imbalances, seasonality, or external market conditions. In this case, shrimp prices increased by 32.44% within the year, indicating substantial price volatility. However, the highest and lowest ASPV values were observed in the shrimp size grades 40C and 60C at 27.91% and 22.41%, respectively. The highest average seasonal price variation of 27.91% indicates that price fluctuate within the year due to seasonal demand and supply effects. The coefficient of variation was observed to be low across all shrimp size grades, with 5.93% for 30C, 8.87% for 40C, 7.97% for 50C, 7.67% for 60C, and 7.34% for 70C in Andhra Pradesh. This indicates a consistent pricing pattern, reflecting stability in the prices of different shrimp size grades. As a result, there is minimal fluctuation, suggesting a stable market for these size grades.

Shrimp prices for 40C, 50C, 60C, and 70C increased, while 30C prices decreased, though no significant difference was observed among the counts. Among all size grades, the 70C count demonstrated a relatively stronger positive trend, despite showing a weak fit in linear trend. In shrimp exports, the lowest seasonal index price was observed in April for 50C, and highest was recorded in January for 40C. The intra-year variation was also small across all shrimp size grades in the Andhra Pradesh market. It can be inferred from the study that seasonal fluctuations in shrimp import prices could be observed in the importing countries as a result of consumer preference for the nature of the commodity, supply fluctuation from other countries, etc. These fluctuations shall be limited through maintaining product quality, adopting advanced processing methods to increase shelf life, and providing value addition to shrimp products.

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