

Research On Competitive Dynamics in The Vegetable Market Based on Sales Data Analysis

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Abstract. This study analyzes the market sales of various vegetable categories. Statistical analysis reveals that leafy greens have the highest sales, followed by chili peppers and edible fungi, while cauliflower and aquatic root and stem vegetables have lower sales, with tomatoes having the least sales. Time series analysis uncovers seasonal fluctuations in vegetable sales, and Pearson's correlation coefficient is used to explore relationships between categories. The results show a strong positive correlation between leafy greens and cauliflower, while correlations with tomatoes are weaker. In the competitive dynamics section, the study focuses on seasonal vegetables such as peeled lotus root and radish leaves, analyzing their quarterly sales trends and the impact of seasonality on restocking and pricing decisions. Additionally, competition between portioned and bulk vegetables is revealed, with portioned vegetables being priced lower, incurring less transportation loss, and offering better product quality.

Keywords: Seasonal variations, Sales patterns, Competitive relationships, Packaging formats.

1. Introduction

With the increasing global demand for fresh vegetables, the competition in the vegetable market has become more intense^[1, 2]. In this context, understanding the sales dynamics of vegetable products and their competitive relationships is crucial for retailers, producers, and supply chain managers^[3, 4]. Vegetable sales are influenced not only by seasonal changes but also by consumer preferences, market price fluctuations, and supply chain factors^[5, 6]. Therefore, studying the competitive relationships within the vegetable market and their impact on sales patterns provides data-driven decision support for retailers and supply chain management.

This study is based on sales data from multiple vegetable categories and employs statistical and correlation analysis methods to explore the seasonal variations, sales patterns, and interrelationships between different vegetable categories. By analyzing the competitive and complementary relationships between vegetable products, the study reveals the complex competitive landscape within the vegetable market and provides new insights for vegetable sales strategies, pricing decisions, and supply chain management. In particular, the analysis of sales data for portioned and bulk-packaged vegetables demonstrates the significant impact of packaging formats on market competitiveness.

2. Exploring Seasonal Trends and Correlations in Vegetable Sales

The data used in this study is sourced from <http://www.mcm.edu.cn>. Upon obtaining the raw data, an initial visual analysis was conducted, as illustrated in Figure 1

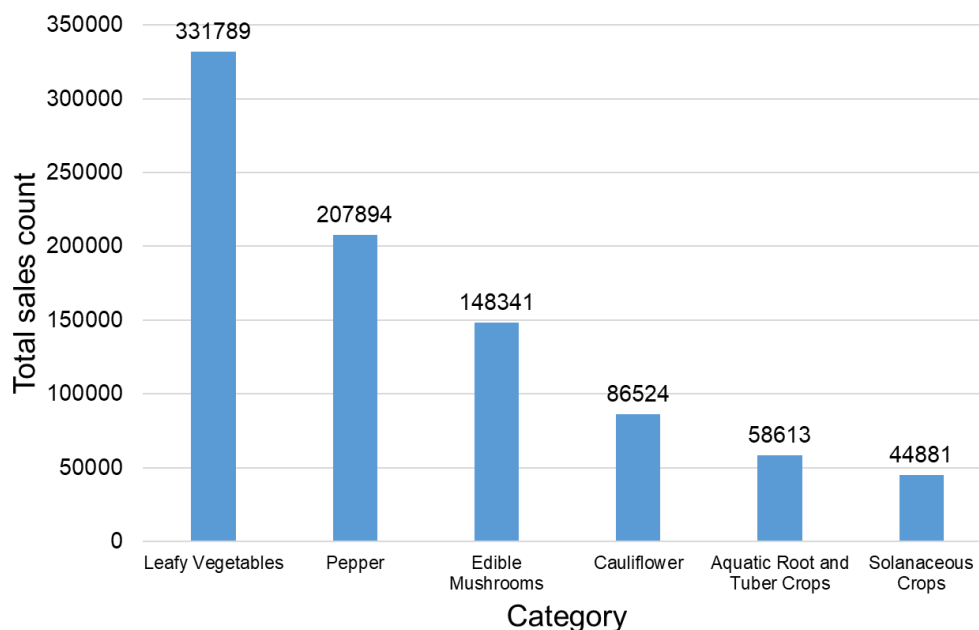


Figure 1: Statistical description of sales quantities for various vegetable categories

Based on the initial statistical analysis, it is evident that leafy greens dominate the market in terms of sales volume, followed closely by chili peppers and edible fungi. In contrast, cauliflower and aquatic root and stem crops exhibit relatively lower sales figures, with tomatoes registering the smallest sales volume. This trend likely reflects the dietary preferences of the local population. By visualizing the descriptive statistics of individual purchases across different vegetable categories, an initial understanding of the data distribution has been achieved. This exploration provides valuable insights into the consumer preferences and purchasing patterns for various vegetable types.

Furthermore, to investigate the seasonal variations and annual sales patterns of different vegetable categories, this study visualizes the sales data for selected vegetables, as shown in Figure 2.

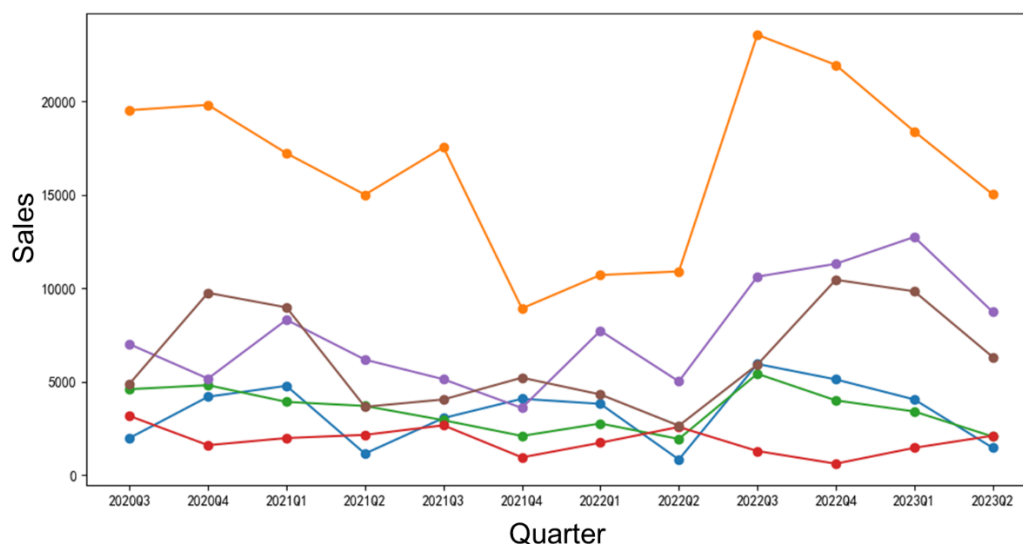


Figure 2: Times series of vegetable categories

By observing and analyzing the time series plots, it is evident that although the sales volume of each vegetable category exhibits distinct distribution patterns across quarters and years, the limited number of data points and the relatively large scope of analysis may result in the loss of some underlying patterns. On the other hand, the daily sales data for each vegetable category contains too many data points, making it difficult to effectively describe these patterns. To quantify this relationship, this study intends to perform a correlation analysis to explore the patterns across different categories.

This study aims to use the Pearson correlation coefficient to measure this relationship. The Pearson correlation coefficient quantifies the strength of the linear relationship between two variables, ranging from -1 to 1. A ρ close to 1 indicates a strong positive correlation, near -1 suggests a strong negative correlation, and close to 0 implies little to no linear relationship^[7]. And the results are shown in Figure 3.

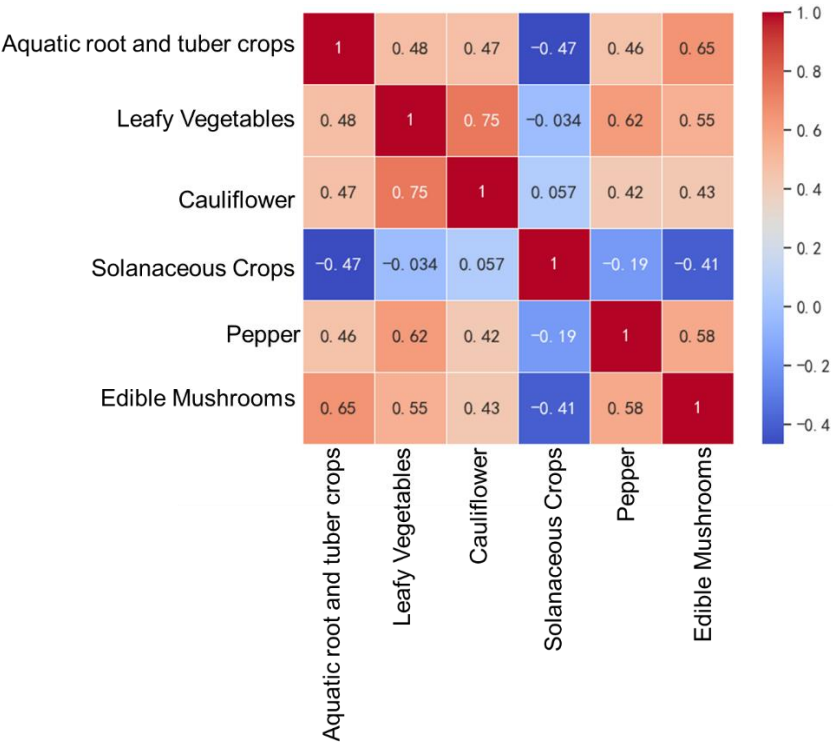


Figure 3: correlation analysis of vegetable categories

The graph reveals that the strongest correlation exists between leafy flowers and cauliflower, with a correlation coefficient of 0.747. A comparison of the time series plots for these two categories shows significant seasonal fluctuations in sales, with highly consistent trends, suggesting that both vegetables likely share similar environmental requirements, such as temperature or precipitation, for growth. In contrast, the correlation coefficient between cauliflower and tomatoes is 0.057, indicating almost no linear relationship between their sales, suggesting that their sales trends are largely independent. Additionally, the correlation between water-stem vegetables and tomatoes is -0.467, indicating a negative relationship, which may be attributed to fluctuations in the supply chain and production levels influenced by seasonal changes. A significance test of the correlation coefficient matrix showed that most coefficients are statistically significant at the 99% confidence level, highlighting the presence of meaningful linear relationships, although some correlations involving tomatoes and other vegetable categories were not statistically significant.

3. Competitive Dynamics in Vegetable Sales

Building on the previous section, in order to conduct a more detailed analysis of the seasonality and timeliness of individual items within each category, this study further focuses on several key products that are more critical to the restocking and pricing decisions of local supermarkets. This study first selects representative seasonal vegetable products, namely Peeled Lotus Root and Radish Leaves, and performs quarterly visualization for these two items, as shown in Figure 4.

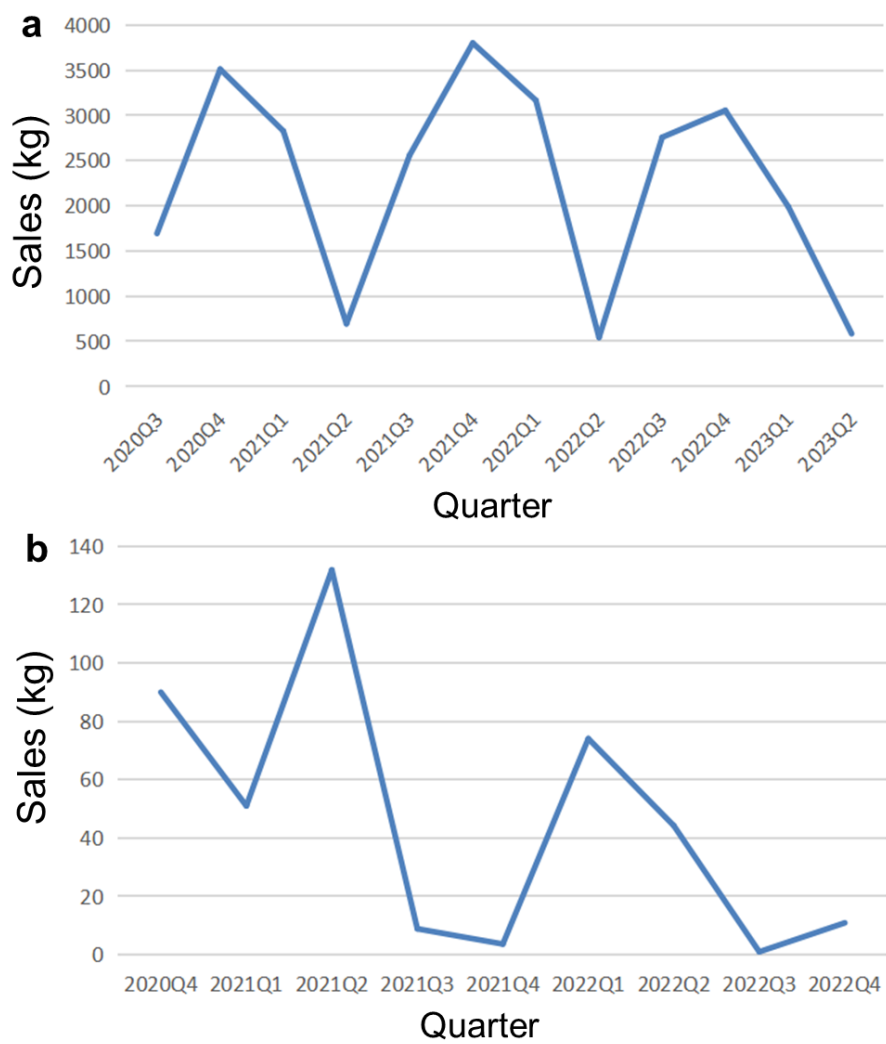


Figure 4: Quarterly sales of vegetable items. (a) peeled lotus root; (b) radish leaves.

The graphs reveal that the sales of Peeled Lotus Root show notable seasonal fluctuations, with peaks at the end and beginning of the year, and a significant dip during the summer months. Similarly, Radish Leaves follow a distinct seasonal pattern, with sales reaching their highest points in spring and autumn, while being lower in both winter and summer.

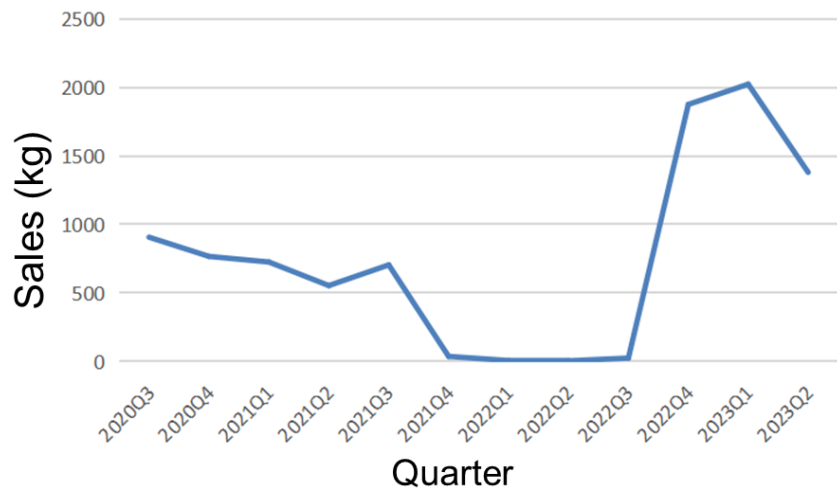


Figure 5 Quarterly sales of baby bok choy

As shown in Figure 5. The sales data shows that baby bok choy experienced stable sales in the initial quarters, but a significant drop occurred starting in the fourth quarter of 2021, lasting for a full year. During the following four quarters, sales were nearly zero. However, in the fourth quarter of 2022, sales suddenly rebounded sharply. This suggests that there may have been supply chain disruptions during that period, and when the supply chain normalized in the fourth quarter of 2022, market demand surged dramatically. This highlights the strong seasonality of certain vegetable products^[8] and serves as a reminder for supermarkets to closely monitor products with high seasonality when making restocking decisions, in order to avoid losses and capitalize on potential profit opportunities^[9].

The analysis of sales correlation among vegetable products reveals both competitive and complementary relationships^[10]. When the sales of one vegetable product are negatively correlated with another, meaning that an increase in the sales of one leads to a decrease in the sales of the other, it indicates a competitive relationship. This competition is often driven by similarities in market characteristics, such as usage, seasonality, or pricing. As shown in Figure 6.

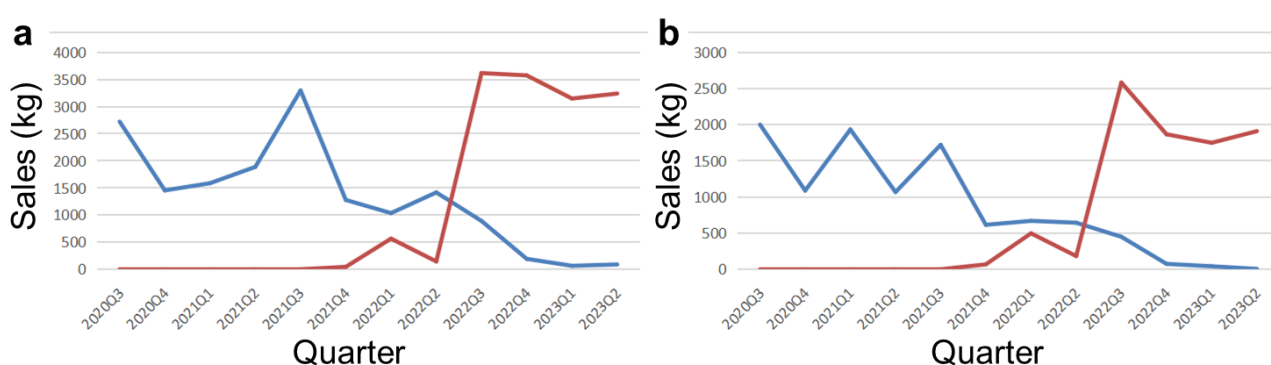


Figure 6: Competition among Yunnan Lettuce and Yunnan Baby Bok Choy

The sales data for Yunnan baby bok choy, Yunnan baby bok choy (by portion), Yunnan lettuce, and Yunnan lettuce (by portion) shows that the sales of bulk-packaged vegetables remained relatively stable prior to the introduction of portion-packaged vegetables. However, after portion-packaged vegetables entered the market, the sales of bulk-packaged vegetables experienced a sharp decline. This is most likely due to the fact that portion-packaged products are more affordable, incur less loss during transportation, and generally offer better product quality.

To validate the above hypothesis, the relevant data from the original dataset has been organized into Table 1. The analysis reveals a clear correlation between the sales volume of portioned vegetables and bulk vegetables, the average selling price, and the loss rate (%). This supports the hypothesis that portioned vegetables are priced lower, incur lower transportation losses, and offer better product quality.

Table 1: Pricing and Loss Rates of Yunnan Vegetable Products

Product Name	Average Selling Price (CNY/kg)	Loss Rate (%)
Yunnan Lettuce	8.155427	15.25
Yunnan Lettuce (Portion)	4.467492	9.43
Yunnan Baby Bok Choy	6.857281	12.81
Yunnan Baby Bok Choy (Portion)	4.034011	9.43

4. Conclusion

This study analyzes seasonal trends and competitive dynamics in the vegetable market. Key findings show that leafy greens dominate sales, with significant seasonal fluctuations across categories. Correlation analysis reveals strong relationships between vegetables with similar growing conditions, while others, like tomatoes, show independent sales patterns.

The introduction of portion-packaged vegetables has impacted bulk-packaged sales, driven by affordability and quality. Additionally, products with high seasonality, such as Peeled Lotus Root and Baby Bok Choy, highlight the importance of adaptive restocking strategies.

Overall, the study offers valuable insights for optimizing inventory and pricing decisions. Future research could explore the impact of external factors like climate change on market trends.

References

- [1] RICHARDS T J, RICKARD B. COVID-19 impact on fruit and vegetable markets[J]. *Canadian Journal of Agricultural Economics/Revue canadienne d'agroeconomie*, 2020,68(2): 189-194.
- [2] CHRISTIAENSEN L, RUTLEDGE Z, TAYLOR J E. The future of work in agri-food[J]. *Food Policy*, 2021,99: 101963.
- [3] SEDGHY B M, NEMATOLLAHI M, TAJBAKHSI A. Market dynamics between retail channels and short food supply chains: A case of organic fruits[J]. *Journal of Retailing and Consumer Services*, 2024,79: 103775.
- [4] PÉREZ-MESA J C, PIEDRA-MUÑOZ L, GALDEANO-GÓMEZ E, et al. Management strategies and collaborative relationships for sustainability in the agrifood supply chain[J]. *Sustainability*, 2021,13(2): 749.
- [5] YAN B, CHEN X, CAI C, et al. Supply chain coordination of fresh agricultural products based on consumer behavior[J]. *Computers & Operations Research*, 2020,123: 105038.
- [6] FERNQVIST F, GÖRANSSON C. Future and recent developments in the retail vegetable category—a value chain and food systems approach[J]. *International Food and Agribusiness Management Review*, 2021,24(1): 27-49.
- [7] MEI K, TAN M, YANG Z, et al. Modeling of feature selection based on random forest algorithm and Pearson correlation coefficient[C]// *Journal of Physics: Conference Series: IOP Publishing*, 2022: 12046.
- [8] WALLNOEFER L M, RIEFLER P, MEIXNER O. What drives the choice of local seasonal food? Analysis of the importance of different key motives[J]. *Foods*, 2021,10(11): 2715.
- [9] PING H, LI Z, SHEN X, et al. Optimization of vegetable restocking and pricing strategies for innovating supermarket operations utilizing a combination of ARIMA, LSTM, and FP-Growth algorithms[J]. *Mathematics*, 2024,12(7): 1054.
- [10] WANG B, ZHANG Y, WANG T, et al. Analysis of Competitiveness and Complementarity of Chinese Fruits and Vegetables in Pakistani Market in the Context of Industrial Internet of Things[J]. *Mobile Information Systems*, 2022,2022(1): 3189858.