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IMPACT OF COVID-19 ON THE SUPPLY AND PRICES OF LETTUCE, POTATO AND TOMATO IN MINAS GERAIS

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Abstract

The COVID-19 pandemic has affected the dynamics of the production, commercialization and consumption of vegetables. Lettuce, potato and tomato, an herbaceous vegetable, a tuberous vegetable and a fruit vegetable, respectively, are among the group of vegetables purchased most frequently. The objective of this study was to evaluate how the pandemic affected the price and supply of lettuce, potato and tomato in 2020 compared to previous years based on data from CEASA-MG from 2016 to 2021. The supply of lettuce was constant in 2020 but lower than the previous year until the month of August, and in December, the price was equal to that of the previous year. The supply of potato was lower throughout 2020 than in previous years. The price of potato was lower in 2020 than the price charged in 2019, until October 2020. The supply of tomato was low throughout 2020. Additionally, with respect to price, there was a decrease from March to July 2020 and a subsequent increase, surpassing the prices of previous years starting in October. In conclusion, both the supply and price of these vegetables were affected by the COVID-19 pandemic.

Keywords: vegetables; coronavirus; market; Brazil; wholesales.

IMPACTO DA PANDEMIA DE COVID-19 NA OFERTA E PREÇOS DE ALFACE, BATATA E TOMATE EM MINAS GERAIS

Resumo

A pandemia causada por Covid-19 afetou a dinâmica de produção, comercialização e consumo das hortaliças. Foi realizado um estudo abrangendo uma hortaliça herbácea, uma hortaliça tuberosa e uma hortaliça fruto, sendo elas, alface, batata e tomate, as quais pertencem ao grupo de hortaliças com maior porcentagem de compra. A partir de dados do atacado do CEASA-MG de 2016 a 2021 objetivou-se avaliar como a pandemia do novo coronavírus afetou o preço e oferta de alface, batata e tomate em 2020 comparado aos anos anteriores. A alface teve oferta constante em 2020 e mais

baixa que o ano anterior até o mês de agosto, sendo o preço igualado ao do ano anterior em dezembro. A oferta da batata foi inferior ao longo de 2020 quando comparado aos anos anteriores. O preço da batata foi inferior ao preço praticado em 2019 até outubro de 2020. O tomate teve a oferta mais baixa ao longo de 2020. E, com relação ao preço, houve queda de março a julho de 2020 e posteriormente aumento, superando os preços dos anos anteriores a partir de outubro. Conclui-se que tanto a oferta como o preço dessas hortaliças foram afetadas pela pandemia causada por Covid-19.

Palavras-chave: hortaliças; coronavírus; mercado; Brasil; atacado.

Introduction

Vegetables are a market niche that encompasses all people because one of these products is consumed in at least one meal per day. Even so, according to data from the Ministry of Health and the World Health Organization (WHO), daily vegetable consumption in Brazil is below recommended levels; this low level can be explained by factors such as purchasing power, access and customs (IBGE, 2011; WHO, 2003). Even vegetable consumption is less than ideal, there is significant production and a diversified and segmented market throughout Brazil. Thus, any change in daily life impacts this chain, both positive and negative (NASCIMENTO, 2020), such as the pandemic caused by the new coronavirus.

In one study, vegetables were divided into four groups based on consumption, i.e., percent purchased (BERNO; SILVA, 2020). The first group, which accounted for the highest percentage of purchases, included tomato, lettuce, potato, carrot and onion. Group 2, which accounted for the second highest percentage of purchases, consisted of broccoli, garlic and zucchini. Group 3 consisted of sweet potato, eggplant, cabbage, cucumber, arugula, beet, cassava, squash, cabbage, chayote, sweet pepper, cauliflower, green beans, parsnips and okra. Group 4 consisted of watercress, chard, and coffin, among others.

The availability of vegetables varies greatly with climatic conditions, a phenomenon also observed with price. Higher prices occur after the summer, and the transport of these products can also result in price variations (NASCIMENTO, 2020) because sometimes some vegetables are in season in the south but there is a poor yield in the southeast during the same period. In addition to production being impacted by the COVID-19 pandemic, prices have become another aggravating factor in this market. According to CONAB (CONAB, 2021a), lettuce, potato and tomato are among the five main vegetables. In addition, these vegetables are among the group of vegetables most purchased by Brazilians (BERNO; SILVA, 2020; CARDOSO *et al.*, 2022). For those two reasons, they were chosen as the objects of this study. The objective of this study was to evaluate

how the COVID-19 pandemic affected the price and supply of lettuce, potato and tomato in 2020 compared to price and supply in the four years prior to the onset of the pandemic.

Lettuce (*Lactuca sativa* L.) is prominent among vegetables. It is one of the most present leafy foods in meals throughout Brazil, often served with tomato. According to statistics reported by Cenário Hortifruti Brasil (Brazilian Fruit and Vegetable Scenario) (KIST *et al.*, 2019), the lettuce harvest area accounted for 86,856 ha, there were 670,585 lettuce producers, and lettuce production increased from 576,602 tons in 2006 to 908,186 tons in 2017. This annual leafy vegetable originated in temperate regions of Europe and Asia and is a member of the Asteraceae family. The nutrients in lettuce vary among varietal types, the main ones being vitamins A, B1 and B2, and lettuce is a source of iron, calcium and manganese. The most common types of lettuce in Brazil are smooth head, head or iceberg, smooth loose, crisp loose, purple loose, mimosa and romaine (MALDONADE *et al.*, 2014). Regarding cultivation, this vegetable can be grown in fields in traditional systems, in fields under organic cultivation, and in cultivation by hydroponics or in soil (HENZ; SUINAGA, 2009).

Potato (*Solanum tuberosum* L.) is a species native to South America; it is herbaceous and annual. Among the most important food crops in the world, potato is the third most important, and with regard to commodities, it ranks first among nongrain crops. It is a dicotyledon belonging to the Solanaceae family and the genus *Solanum*, which contains more than 2000 species. Of all the species, approximately 160 produce tubers, but only approximately 20 are cultured (SILVA; LOPES, 2015). Potato culture requires long photoperiods and mild temperatures during growth, conditions that favor good tuber yield and quality. In Brazil, three harvests are performed, namely, the wet, winter and dry seasons, with the peak harvest occurring from August to October. Due to sanitary conditions, management and disease control, no more than two consecutive potato crops should be grown in the same area, and crop rotation with rice, corn, sorghum, sugarcane or pasture is recommended (SILVA; LOPES, 2015). Because of this, leased land accounts for the largest area for potato production and characterizes potato as a good crop for production and income diversification for producers (CONAB, 2021b).

Tomato (*Solanum lycopersicum* L.) belongs to the Solanaceae family and is a very important crop because it is included in human food in various ways, for example, salads, sauces and extracts (CONAB, 2021ab). It originated in the Andean region, which extends from Ecuador and passes through Colombia. However, the domestication of the tomato occurred in Mexico, a secondary center of origin. In Brazil, tomato is of great importance because it is produced in all regions; however, production is highest in the southeastern, southern and central-western regions *(NICK et al.*, 2018). Tomato is produced for two purposes: industry and table. For industry, there is greater phytosanitary control because the cultivars and the management adopted are more susceptible to

pests and diseases. Conversely, table cultivars, which are consumed *in natura*, require more cultural treatments, such as staking; these cultivars are divided into four groups: cherry, Santa Cruz, Roma and salad (CLEMENTE *et al.*, 2013; NICK *et al.*, 2018). In 2016, the FAO reported that tomato was being produced in 175 different countries and occupied an area of 4.8 million hectares (CONAB, 2021a,b). According to the FAO, the three main tomato-producing countries are China, India and the United States, while Brazil occupies ninth position, with a production of 4.17 million tons or 65.14 tons per hectare (FAOSTAT, 2018).

Despite their importance, the potato and tomato production chain faces serious commercialization problems. Studies suggest that between 2019 and 2020, 51% of producers faced a shortage of consultants for commercialization, 30% had difficulty accessing commercialization sites (wholesale and retail markets), and 14% had serious problems with transportation that became obstacles to commercialization. Supply centers (CEASAS, acronym in Portuguese) are the main market destination for potatoes and tomatoes (63%), followed by "wholesale" (13%) and direct sales, such as fairs (8%) (CONAB, 2021a).

The COVID-19 pandemic had a large initial impact on this market. Because people spent more time at home (closing of schools and restaurants), consumption patterns changed, greater food production in homes. Due to safety issues and the economy, the migration of consumer channels to, for example, online sales and organic products has become an option. In contrast, the abandonment of natural foods and the consumption of processed foods also increased, as these products have greater durability, allowing for less frequent trips to the market, thus resulting in less exposure to infection by the coronavirus (CEPEA, 2020a).

Throughout the pandemic, the market set new goals to better serve consumers, and there are studies that contradict that the increase in the consumption of healthy products or, conversely, the increase in the consumption of processed foods is related to the pandemic (FIOCRUZ, 2020; STEELE *et al.*, 2020). This result seems to depend on the sampling, i.e., the sociodemographic composition of the populations analyzed. There is a difference based on the level of development of the region, purchasing power, education level, gender, and age, among other factors *(STEELE et al.*, 2020).

The producers who served cafeterias and restaurants and those who held open markets were highly impacted, and some establishments closed; others managed to circumvent this impasse by changing their modes of producing, selling and thinking. According to Hortifruti/Cepea, 37% of farmers increased their production and management efficiency, 20% reduced their planting area, 6% invested in new technologies, 7% reduced phytosanitary management and reduced costs, and 10% performed other actions. However, throughout 2020, 20% still did not implement any measures to

cope with the crisis (CEPEA, 2020b), showing that impact and resistance to change are decisive factors in this market.

Material and Methods

The research conducted herein utilized supply and wholesale price data from the CEASA-MG. The crops chosen were lettuce, tomato and potato. The supply (kg) and price (R$) data were searched on the CEASA website (http://www.ceasaminas.com.br/informacoesmercadogeral.asp), selecting “produtos” (“products”), “oferta de produtos” (“product supply”) and “preço médio de produtos” (“average product price”). Next, Grande BH - CEAMG was selected as the market. Lettuce, tomato and potato were selected as the products, and the study period was from January 2016 to March 2021.

With these data, simple moving average (SMA) and weighted moving average (WMA) analyses was performed considering data at 3, 4 and 5 months. For the SMA, the simple arithmetic mean was calculated. The WMA was calculated based on different weights, for which the highest weight was attributed to the most recent month. As three months were considered for the calculation, the weights assigned were 0.2, 0.3 and 0.5. Using the SMA and WMA for the entire evaluation period, the absolute error was calculated by subtracting the real value from the estimated value. Using the absolute error for each SMA and WMA, the *mean absolute deviation* (MAD), i.e., the mean of the absolute errors of each mean, was calculated. The lowest MAD value was chosen as the ideal model for data representation (SILVA *et al.*, 2018). The ideal model was the WMA calculated for 3 months, both for the production data and for the price data for lettuce, potato and tomato.

The raw data obtained as described above were processed using INDEVES software of the Department of Economics and Rural Sociology of ESALQ USP, with the aim of determining the seasonal variation indices for the supply and prices of the three crops selected for this study. It is a mathematical procedure based on the centralized mobile geometric mean method, which is indicated to calculate the seasonality of supply and prices based on annual or biannual data (HOFFMANN, 1991). The first step of this methodology is to calculate the centralized mobile geometric mean (MGM) for each month of the data series of the desired period of months/years. For example, for the month of March 2020, taking the Napierian logarithm of the supply means for the period, the MGM is calculated as follows:

$$MGM_{mar2020} = \frac{(\ln P_{jul2019} \times 0.5) + \ln P_{aug2019} + \cdots + \ln P_{jun2020} + (\ln P_{jul2020} \times 0.5)}{12}$$

MGM is the mobile geometric mean and lnP is the Napierian logarithm of the supply data for the month in question. For the calculation, the supply data for a month (for March in the example) and the data from the previous six months and the subsequent six months were considered, with the first and last months (July 2019 and July 2020 in the example) multiplied by 0.5 to obtain the result for a period of 12 months. After calculating the MGMs, the differences between the supply data of each month and its moving average were calculated. The means of these differences were also calculated for each month of the year, resulting in mean values from March to December, from which the arithmetic means were computed.

The results of the calculations that did not equal zero were corrected by removing the respective arithmetic mean from each mean of the monthly difference. The seasonal indices were obtained by raising the results to the base of the Napierian logarithm and multiplying by 100. For the calculation of the irregularity indices (maximum and minimum indices), the standard deviations for the results of the seasonal indices of each month were initially calculated and then raised to each result based on the Naperian logarithm. These numbers, when multiplied by the seasonal index obtained, resulted in higher indices, and when divided, they resulted in lower indices. Following the same methodology, the minimum, average and maximum price indices charged in CEASAMINAS - Grande BH during the same period were also obtained, which were taken as representative of the prices charged in the state. The results are then presented in graphs.

Results and Discussion

Figure 1A shows the WMA of lettuce supply in CEASAMINAS - Grande BH from March 2016 to February 2021. Figure 1B shows the WMA of lettuce prices charged by CEASAMINAS - Grande BH in the same period. The lettuce supply was influenced more by production than by seasonality, which was somewhat constant. In 2017, there was a marked supply in the months of March to July. The lowest offerings in all years were concentrated in the months of August to October, but this was not the rule, reinforcing once again the constant supply of lettuce in CEASAMINAS - Grande BH. When comparing the year 2019 with the year affected by the pandemic (2020), a smaller supply fluctuation was observed because in 2020, it remained stable throughout the analyzed period and in 2019, the supply started high and fell during the year.

For price, as illustrated in Figure 1B, the prices during the pandemic year (2020) were lower in almost all months than those in nearly all months in the other years, except for the months of October to December 2017, for which the prices were similar to those for January 2021.

Figure 1. Weighted moving average of the supply in kg (A) and price in R$ (B) of lettuce at CEASAMINAS - Grande BH from March 2016 to February 2021.

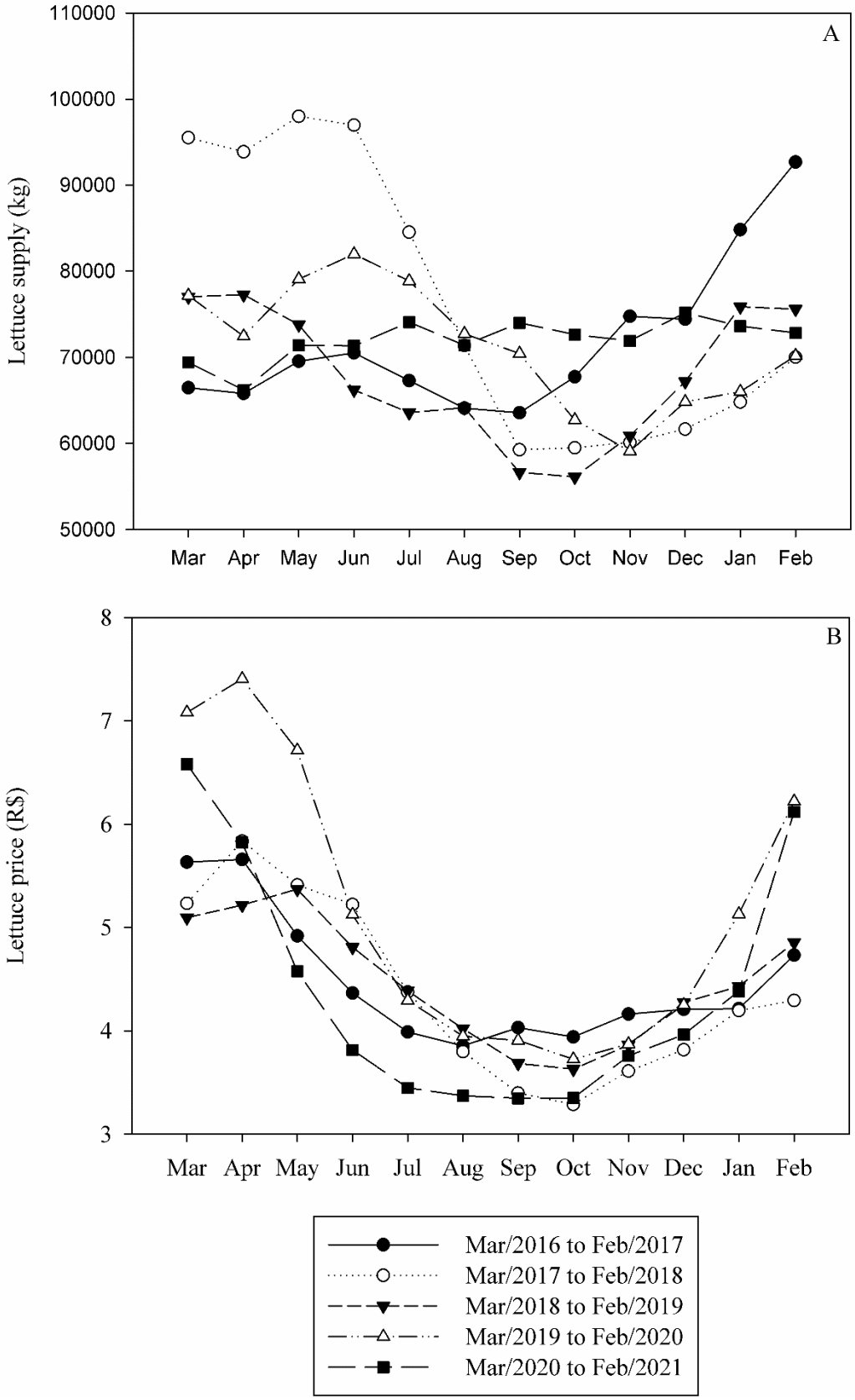


Figure 2A shows the WMA of the potato supply in CEASAMINAS - Grande BH for the period from March 2016 to February 2021, and Figure 2B shows the WMA of the potato prices charged by CEASAMINAS - Grande BH in the same period. The potato supply was influenced by seasonality, with a decrease in supply starting in March and with the lowest supply occurring in June in all years analyzed. When comparing the year in which the pandemic began (2020) with the previous year, the supply was lower than that in the previous year during all months. There was continuous growth in the potato supply in 2019, resulting in a high product supply until March 2020, coinciding with the decrease in supply with the beginning of the COVID-19 pandemic, a decrease that resulted in the lowest potato supply among the years evaluated in the period between October 2020 and February 2021.

Regarding the price charged by CEASAMINAS - Grande BH, the price was dependent on supply and seasonality. For potato, the lowest prices and least price fluctuation occurred From March 2017 to February 2019. However, these variables were highly influenced by the high supply of the product in the market because the highest supply of this product and the smallest decrease across those two years occurred in June, as seen in Figure 2A. In 2019, concomitantly with the increase in supply throughout the year, there was a reduction in the price of potato; however, with the pandemic and reduction in supply in 2020, the price of potato increased in 2020, especially in June, which was the month with the lowest supply. The price of potato in 2020 followed the same trend as that in 2016, from March to October, revealing a setback in the production, supply and commercialization of this crop during the pandemic.

Figure 3A shows the WMA of tomato supply in CEASAMINAS - Grande BH in the period from March 2016 to February 2021, and Figure 3B shows the WMA of tomato prices charged by CEASAMINAS - Grande BH for the same period. With regard to supply, there were no large variations in 2020; however, it was lower than in the other years. In the months of March to May and August to November, the supply was lower supply compared to that in other years; thus, there was a lower supply of tomato (Figure 3A). The price did not follow the supply; from April to July, the price decreased significantly, and in August, the price began to increase, peaking in November and remaining high until January 2021 (Figure 3B).

Figure 2. Weighted moving average of the supply in kg (A) and price in R$ (B) of the potato at CEASAMINAS - Grande BH from March 2016 to February 2021.

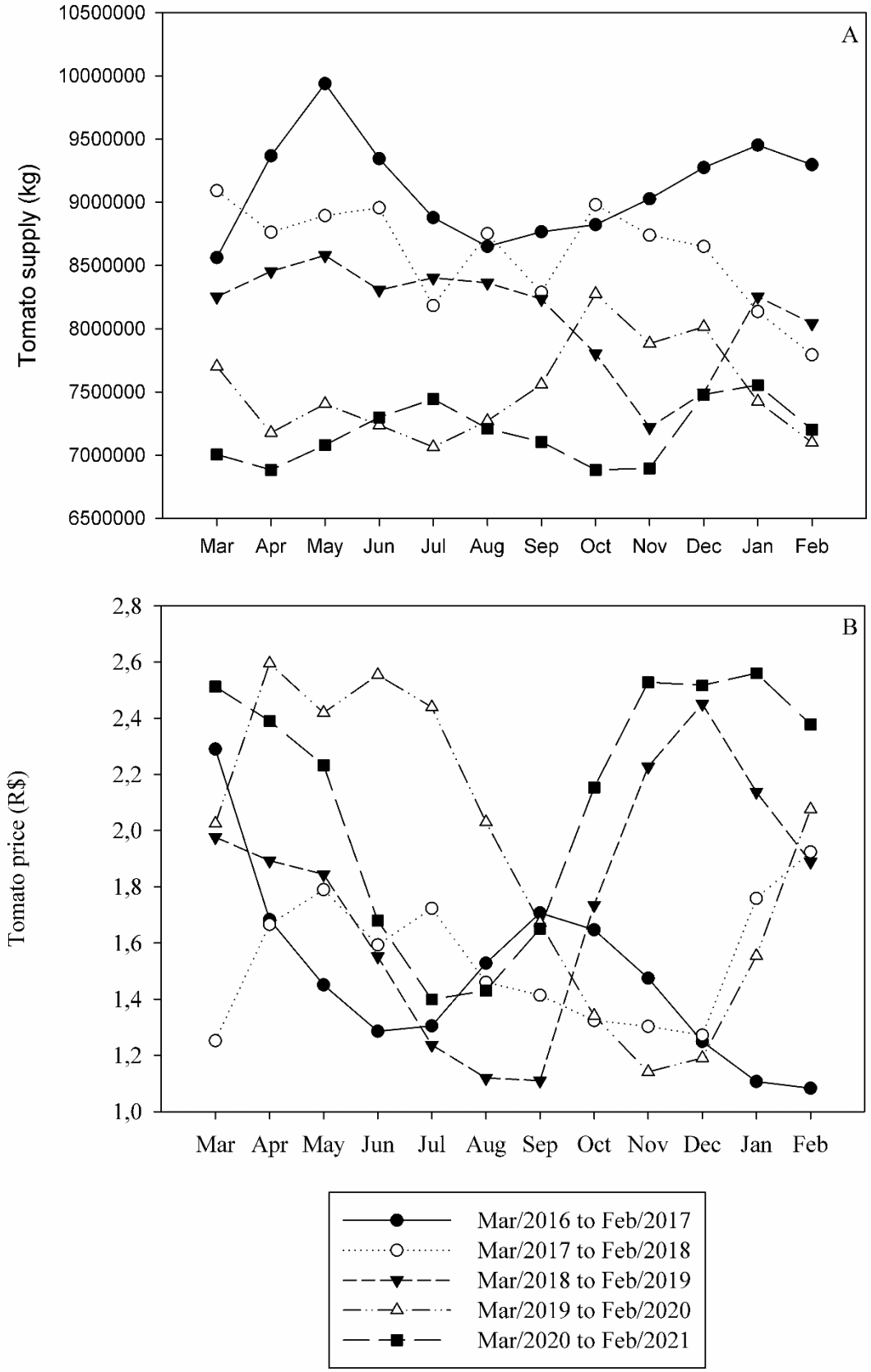
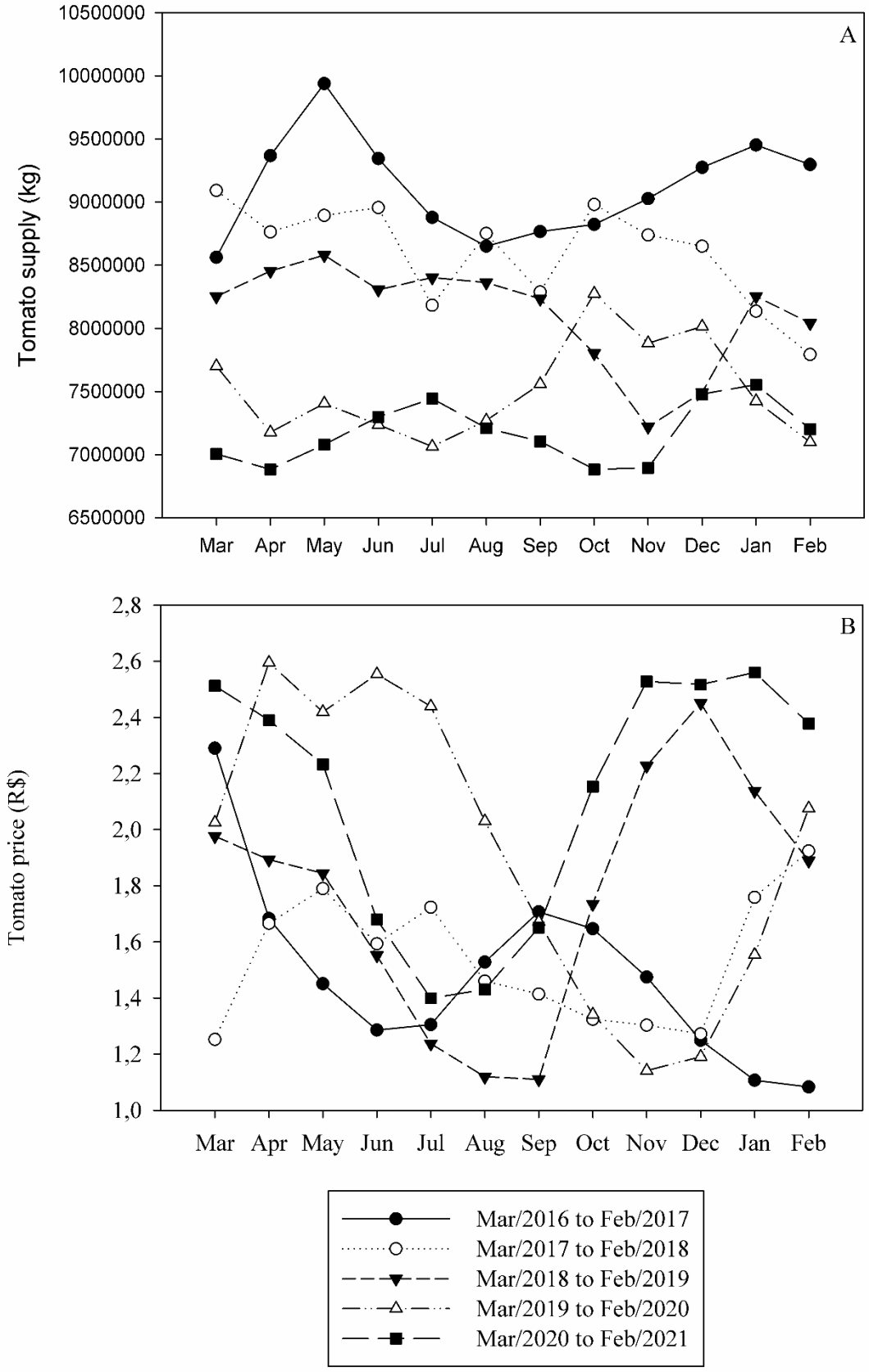


Figure 3. Weighted moving average of the supply in kg (A) and price in R$ (B) of tomato at CEASAMINAS - Grande BH from March 2016 to February 2021.



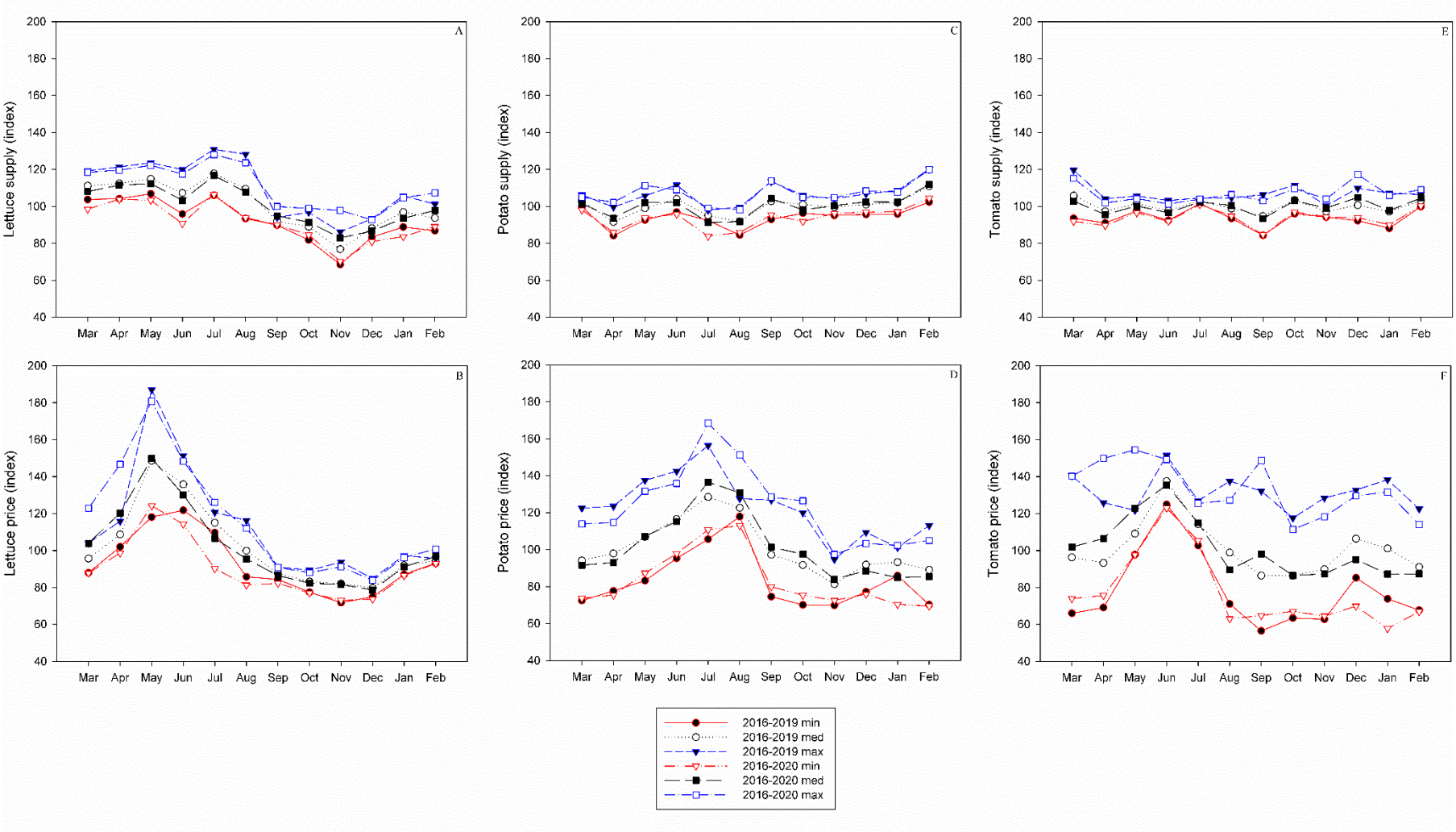
To assess the impact of the pandemic on the seasonal variation in the supply and price of lettuce, potato and tomato in the CEASAMINAS - Grande BH, maximum, average and minimum indices were used to jointly evaluate the data from 2016 to 2019 (no pandemic), and maximum, mean and minimum indices were used to jointly evaluate data from 2016 to 2020 (pandemic) (Figures 4A, 4B, 4C, 4D, 4E and 4F). The greater the distance between the maximum, average and minimum indices, the greater was the variation in the supply and price for a given month across the years evaluated.

Among the years analyzed, there was greater variation in the lettuce supply in May and September, and there was greater distance between the maximum, average and minimum indices both when including 2020, marked by the pandemic, when excluding 2020 (Figure 4A). Conversely, prices varied substantially in March among the years analyzed; March was also the month with the highest prices charged by CEASAMINAS - Grande BH. There was no influence of the year 2020, marked by the pandemic, when analyzing and comparing the data from previous years (Figure 4B).

Regarding potato, there was greater distance between the maximum, average and minimum indices for 2016-2019 and 2016-2020 in May and July. Thus, supply decreased in May and increased in July, albeit with large variations in these supply values across the years (Figure 4C). The price of potato varied substantially in July and August, with less variation in June and from September to November; there was also little influence of the year 2020 (pandemic) when data from that year was included in the average of the other four years analyzed (Figure 4D). When greater seasonal variation was observed for the potato supply in July, because it is a crop for which the price is dependent on the supply, greater seasonal variation was also observed for price in the same period (Figure 4C and 4D).

Regarding the tomato crop, there were no large variations in the supply when comparing the 2016-2019 and 2016-2020 indices (Figure 4E). However, when comparing the prices for these same time periods, in the months of January to March, there was a significant increase in the maximum index for the 2016-2020 period (Figure 4F). With regard to price, there was substantial variation in prices across the years, characterized by greater distance between the maximum, average and minimum indices, except in April and May for both 2016-2019 and 2016-2020 (Figure 4F).

Figure 4. Indices of seasonal variation in the supply and price of lettuce (A and B), potato (C and D) and tomato (E and F) at CEASAMINAS - Grande BH between 2016 and 2019 and between 2016 and 2020.



For the supply and price of the three crops analyzed in CEASAMINAS - Grande BH, when the data for 2020 (pandemic) were added to the data for previous years, there was little impact of COVID-19 on the seasonal variation in the supply, price and, consequently, the entire production chain because these data were eventually diluted and the observed trend was a general trend, not the current trend. The pandemic affected both the supply and price of the crops studied herein; however, the price trends throughout the seasons were less impacted, resulting in similar maximum, average and minimum indices for 2016-2019 and 2016-2020 (Figures 4A, 4B, 4C, 4D, 4E and 4F).

Many factors contribute to the final price of the product. Among these factors, the pandemic can be highlighted, which affected the unemployment rate and consequently the purchasing power of Brazilians. Thus, crops with a high supply will generally have reduced prices so that the product does not accumulate in the market, without sales, and is wasted. However, when there is high demand for a product with low supply, the price trends upward, and thus, the product is limited to Brazilians with greater purchasing power (BARBOSA *et al.*, 2020).

According to the IBGE in a survey conducted by the National Survey by Continuous Household Sample (Pesquisa Nacional por Amostra de Domicílios - PNAD Continuous), the unemployment rate in Brazil increased both in relation to the previous quarter (12.2% to 13.3%) and in relation to the same period from the past year (12% to 13.3%). The same occurred in Minas Gerais; however, the variation was greater. Last year, the unemployment rate was 9.6%, while this year, in the same quarter evaluated (April, May and June), the rate was 12.9%, which was also higher than that in the previous quarter (January, February and March), i.e., 11.5% (IBGE, 2020).

The pandemic also affected the way people work, i.e., for some workers, planting, product application, harvesting and transportation were limited to smaller scales. A study with small farmers and technical managers was conducted in the states of SP, AM and PA. The pandemic had a multidimensional impact, i.e., it affected health, production, marketing, income and forms of communication. The challenges imposed were overcome, and despite decreases in production and marketing, no producer experienced a total loss of production or a total decrease in sales. Based on the interviewees' statements, the decrease in marketing was greater than that in production (FUTEMMA *et al.*, 2021).

Some studies were conducted that focused on the marketing and consumption of vegetables during the pandemic and how the pandemic has affected the vegetable production chain, exports and imports as well as the safety involved in the production, processing and consumption of vegetables.

Although vegetables are important sources of vitamins and minerals, the pandemic has affected both distribution and commercialization. The lower circulation of people on the streets negatively influenced the sale and, consequently, the consumption of vegetables during this period.

In addition, because schools, daycare centers and restaurants closed, there was an immediate effect on the purchase of small-scale agricultural products (LIMA *et al.*, 2020; NASCIMENTO, 2020; PEDROSO, 2020). The results obtained in this study agreement with those from previous studies and indicate that, in fact, the COVID-19 pandemic affected the vegetable production chain, mainly causing a decrease in production, prices and commercialization, and that across the months, there was a gradual restructuring of this market.

Conclusion

The COVID-19 pandemic negatively affected the supply and prices of lettuce, potato and tomato crops produced in Minas Gerais state in 2020.

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Authors Contribution

All authors contributed to the idealization of the study, participating directly in the experimental planning, assembly and conduct of the experiment, data analysis and writing of the manuscript. The authors approved the final version of the manuscript.

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