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Original article

# Popularity and characteristics of e-retail fresh fruit sales in China

Yijun Chen[1], Fei Dang[2], Yunze Li[1], Yuanxing Rao[2], Ruilong Hao[1], Adele Lu Jia[2] and Huiqin Ma[1]

[1] Horticulture Policy and Economy Research Center, College of Horticulture, China Agricultural University, Beijing, P.R. China

[2] College of Information and Electrical Engineering, China Agricultural University, Beijing, P.R. China

## Summary

**In 2019, China was the largest fruit producer and the second-largest fruit importer in the world. E-retail of fresh fruit has undergone rapid development, but specific and important information of relevance to e-retailers is largely lacking. Sales information of 14 fruit, including pomes, stone fruit, citrus, tropical fruit and berries, was collected using Python 3.7.3 on Alibaba's C2C platform Taobao and B2C platform Tmall from December 2018 to November 2019, and key horticultural-related parameters were analyzed. Collective sales of the 14 fruit amounted to 10.09 million and 59.79 million pieces (units) on Taobao and Tmall, respectively. Citrus, apple, mango and kiwi led in sale quantities, reflecting their high adaptability to third-party logistics-supported e-retail. Fruit quality was expressed by a matrix of parameters, including fruit size, single-fruit weight, cultivar, origin of production, descriptive words in the commodity name, and satisfaction rating of credence by consumers. Lychee, cherry and strawberry were priced highest, followed by avocado, grape and blueberry. Standard package sizes were used, 2.5 kg and 5 kg being the most popular. 'Fresh', 'free delivery' and 'in season' were the top terms used to promote fruit. 'Imported' also ranked high in the commodity names, and avocado, cherry, mango and kiwi were dominated by Mexico, Chile, Vietnam and New Zealand, respectively, with delivery mainly from the first harbor of import. Our results revealed, for the first time, that e-retail fruit in China has evolved a set of features in fruit type tendencies, packaging and marketing, which differ from those of the conventional fruit retail business.**

**Keywords**
Alibaba, commodity feature, e-retail fruit, imported, logistics, promotion

## Significance of this study

*What is already known on this subject?*

- In 2019, China was the largest fruit producer and second-largest importer in the world, and fruit e-retail was booming and welcomed by consumers. Fruit e-retail has been studied from economic, logistic and computer science standpoints, but its horticultural aspects have seldom been addressed.

*What are the new findings?*

- Citrus, apple, mango and kiwi were favored in e-retail and led in sale quantities. Lychee, cherry and strawberry were priced highest. E-retail fruit quality was indicated by size, single-fruit weight, cultivar, origin of production and other characteristics. The most popular package sizes were 2.5 kg and 5 kg. 'Fresh', 'free delivery' and 'in season' were the top terms in e-retail fruit promotion. Avocado, cherry, mango and kiwi were the most popular imports, and mostly delivered from the hub cities Shanghai, Guangzhou and Nanning.

*What is the expected impact on horticulture?*

- The results could be used to optimize the specific parameters of fruit e-retail in China, and serve as a reference for other e-retail fruit studies.

## Introduction

In 2019, China was the largest fresh fruit producer in the world with 169,494 million tons (including melons) (China Agriculture Year Book, 2020). It was ranked the second-largest fruit importer in the world, with 6,829 thousand tons valued at USD 9.5 billion (CFNA, 2020). Banana, cherry, dragon fruit, grape and durian were the top five imported fruit, in terms of volume, in 2015 (Lei et al., 2018), whereas the sequence changed to banana, durian, dragon fruit, grape and pineapple in 2019 (Chinese Customs, 2020).

Internet facilities are well established in China. At the end of 2019, 8.5 million base stations, 5.5 million of them 4G, provided whole-nation coverage (Ministry of Industry and Information Technology, 2020). The number of smartphone users reached 932 million in 2020 (China Mobile Internet Development Report, 2020), and lifestyle and business models have become increasingly internet-based. In the first half of 2020, online consumers of fresh and agricultural products totaled 257 million and 248 million, respectively (CNNIC, 2020). Online business has become an important additional or alternative channel for fruit producers, importers and distributors.

E-retail is defined as retailing via the internet (Jayakrishnan, 2015). Consumers search for and order commodities online, while the sellers carry out packing, shipping and payment collection using a series of online tools. E-retail fruit are mainly sold by two types of channels in China: comprehensive platforms which resemble an online hypermarket, and vertical e-business players who focus on fresh products only (Zhang et al., 2016). The major comprehensive platforms in China are Tmall, Taobao, JD.com, Weidian, Youzan, and some others. These platforms are characterized by high traffic, and services to e-retail shops. Mainly third-party logistics are used by sellers in the comprehensive platform, where a large

proportion of the highway transportation is not supported by cold-chain facilities (Zhang et al., 2019). The second type of channel is represented by Missfresh, Fruitday and others, which are regarded as professional dealers who focus on fresh products. Such dealers usually create their own cold-chain logistics to deliver better fruit to the customer and guarantee swift arrival, but they are regionally limited.

Online shopping can be done 24 hours a day, 7 days a week. The shopping environment, and ease of finding options and comparing prices, is highly convenient for many customers. Online shops usually provide additional benefits, such as discounts and coupons for potential customers and efficient delivery services (Shanthi and Kannaiah, 2015). With the Covid-19 pandemic, lockdowns and the need for social distancing have generated new motivations for online shopping. Almost all countries investigated, for example, China (Gao et al., 2020), the United States (Chenarides et al., 2020) and Greece (Lampropoulos et al., 2020), have reported that more and more consumers are purchasing food online and using delivery services.

At the time of this study, the Alibaba Group is one of the largest e-business companies in China and worldwide. Taobao, launched in May 2003, was their customer-to-customer (C to C) e-business platform, with an annual volume of trade reaching over RMB 1,000 billion in 2019 (Alexa, https://www.alexa.com/siteinfo/taobao.com). A fruit shop could be registered at Taobao with an earnest money deposit of RMB 1,000 (about USD 140) and a business license, making this platform friendly for small business and individuals. Tmall, Alibaba's business-to-customer (B to C) platform, was launched in April 2008, and in 2019, was ranked the second-largest e-business platform in the world, with an annual volume of trade of more than RMB 2,000 billion (Alexa, https://www.alexa.com/siteinfo/tmall.com). Entry criteria for a Tmall shop consisted of a minimum of RMB 180,000 (about USD 25,200) registered capital, food-safety documents when relevant, and an annual service fee to the platform, among others.

E-retail of fresh products, including fruit, has been studied in the fields of economics (Sturiale et al., 2017), logistics (Zhang and Li, 2018) and computer sciences (Zhao et al., 2020). However, results and analyses from a horticultural commodity point of view are lacking. In the present study, we hypothesized that fruit e-retail is not an identical homologue of its offline counterpart. The objectives were to identify the popular fruit in e-retail, their season and SKU features, to provide a valuable reference of e-retail fruit in China for producers, distributors, importers and related researchers.

## Materials and methods

Fourteen fruit were selected for this study, including highly produced pomes (apple and pear), stone fruit (peach, including nectarine, and plum), citrus, tropical fruit (mango, banana, durian) and berries (grape and blueberry). Kiwi, cherry and avocado were selected as both highly produced in China and with high import quantities. Lychee was included as a representative of high-end seasonal fruit. Fruit production data were collected from the China Agriculture Year Book (2020). Fruit import data were collected from the Chinese Customs website (Chinese Customs, 2020) and total import was the sum of all records for 2019.

Data pertaining to e-retail fruit sold on the Taobao and Tmall platforms were collected. The following keywords were selected for stock-keeping unit (SKU) searches and collection: "apple", "pear", "peach" (in Chinese, peach includes nectarine, and in the following, "peach" refers to peach + nectarine), "cherry", "banana", "pineapple", "litchi", "mango", "grape", "strawberry", "blueberry", "mandarin", "lemon", "orange", "pomelo", "kiwifruit", "avocado" + "fruit". Searches were carried out on the 15$^{th}$ of each month from December 2018 to November 2019.

The data were collected from the 100-page sequence of sale amounts, 50 SKU per page, using Python 3.7.3. The program was automatically ended if the SKU listing was fewer than 100 pages. The collected data were in the form of csv documents and were regarded as the total sale amount for a particular fruit for a month. A dictionary of different meanings was manually compiled the first time data were collected and added to in the following months. Non-fresh fruit commodities with fruit name keywords such as "apple iPhone", "dried pear", "banana chips" were screened for and automatically discarded using string matching (Navarro, 2001).

The data for each fruit were further cleaned manually, labeled and assigned to Excel sheets. The major information included: name of the SKU, place of product origin, name of the producer, package size, fruit grade, cultivar and other information, including country of origin for imported fruit, price, number of sales in the last 30 days, internet link for the SKU, information on the shop, and consumers' satisfaction ratings. Data analysis was carried out using Microsoft Excel 2016 and SPSS 21.0. To simplify the data for citrus, those for mandarin, lemon, orange and pomelo were combined in this paper and the results indicated as citrus.

## Results

### The commercial scale and popularity of fruit in e-retail

The monthly volume of sales by Tmall was far more than that for the Taobao platform (Figure 1A). Total sales by Taobao and Tmall amounted to 10.76 million and 62.44 million pieces from December 2018 to November 2019, respectively. Annual fruit sales for the two platforms demonstrated a similar trend, with the highest sales recorded in March, related to China's most important holiday – the Chinese New Year, when consumers usually buy large amounts of product, including fruit for the holiday. Relatively low sales were found during the summer, when locally produced fruit were more available and the offline supply became competitive.

Compared to all fruit sold online, the specific sale of imported fruit on Taobao and Tmall was similar in some respects and different in others. Taobao sold 0.73 million pieces in a year, while Tmall sold 3.88 million pieces – 5.28 times more. The monthly variations in sales of imported fruit differed from the trend for all fruit, with more sales just before July for both platforms (Figure 1B). This trend could be explained by the high amount of domestic fruit in the summer, which suppressed the purchasing of imported fruit.

Leading e-retail sales on Alibaba were for citrus, apple, mango and kiwi in 2019 (Figure 2). Citrus made up most of the sales, by far, among the 14 fruit, with its proportion in Taobao slightly higher than that in Tmall. Apple held a stable second position, and kiwi, which took 11% in both Taobao and Tmall, ranked third and fourth on the two platforms, respectively. Mango showed very good performance compared to the traditional high production of pear and peach, taking the fourth and third positions on Taobao and Tmall, respectively. Cherry ranked seventh on both Taobao and Tmall. Differences were seen after cherry: the proportions of pineapple and avocado were higher for Tmall than for Taobao,

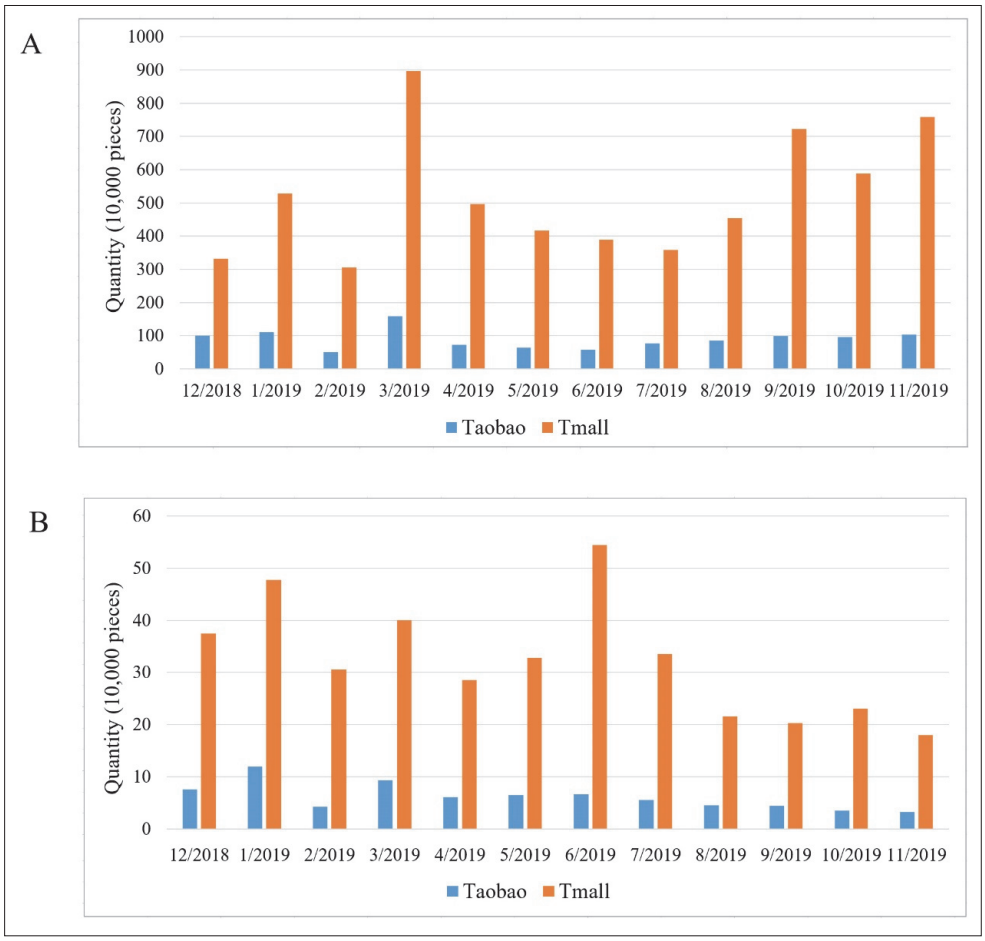



**Figure 1.** Monthly e-retail fruit sales (A) and imported fruit sales (B) on Alibaba platform.

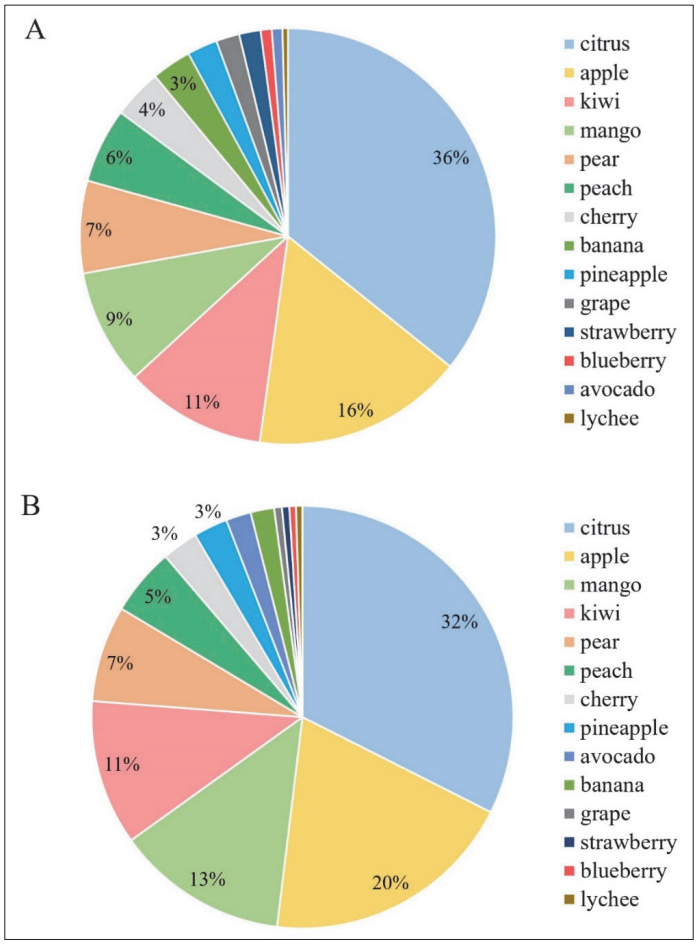



**Figure 2.** E-retail sales volume of the 14 fruit on Alibaba platforms Taobao (A) and Tmall (B) from December 2018 to November 2019.

while banana, grape, strawberry, blueberry and lychee occupied a relatively small proportion of the 14 fruit (Figure 2).

**Seasonal sale characteristics for the different fruit**

The 14 fruit sold on Alibaba could be assigned to three major clusters according to their change in monthly sales patterns (Figure 3A). Cluster I fruit were sold in high quantity almost year-round, and included citrus, apple, mango, and kiwi, although the latter two showed bigger monthly changes than citrus or apple. Cluster II fruit sold in high quantity through long seasons, and consisted of peach, pear, cherry, pineapple, banana and avocado. Banana is usually regarded as a year-round fruit, but its e-retail on the Alibaba platform showed a seasonal characteristic, possibly due to strong competition with offline sales during the low season for online sales. Cluster III fruit sold in low quantities or during short seasons, and included grape, strawberry, blueberry and lychee (Figure 3A).

Sale of the 14 types of imported fruit on Alibaba was different from the general trend of total fruit quantity, and the fruit could be assigned to one of four clusters depending on sale quantities and seasonal supply (Figure 3B). Avocado

**Table 1.** Quality attributes listed for the different fruit in e-retail.

| Fruit | Number of SKUs | With diameter info | With single-fruit weight | With cultivar/type |
|---|---|---|---|---|
| Apple | 38,045 | 33,599 | 1 | 36,591 |
| Citrus | 87,314 | 6 | 28,314 | 68,198 |
| Kiwi | 29,439 | 1 | 18,882 | 20,898 |
| Mango | 33,107 | 0/ | 16,301 | 32,408 |
| Pear | 26,598 | 2 | 12,147 | 24,721 |
| Peach | 17,587 | 0 | 0 | 11,647 |
| Cherry | 14,731 | 2,581 | 0 | 14,706 |
| Banana | 13,509 | 0 | 0 | 0 |
| Pineapple | 10,997 | 0 | 0 | 0 |
| Grape | 8,794 | 0 | 0 | 4,466 |
| Strawberry | 5,669 | 0 | 0 | 4,456 |
| Blueberry | 5,026 | 1,088 | 0 | 6 |
| Avocado | 5,900 | 0 | 1,840 | 0 |
| Lychee | 2,399 | 0 | 0 | 1,130 |

The peach item included nectarines.

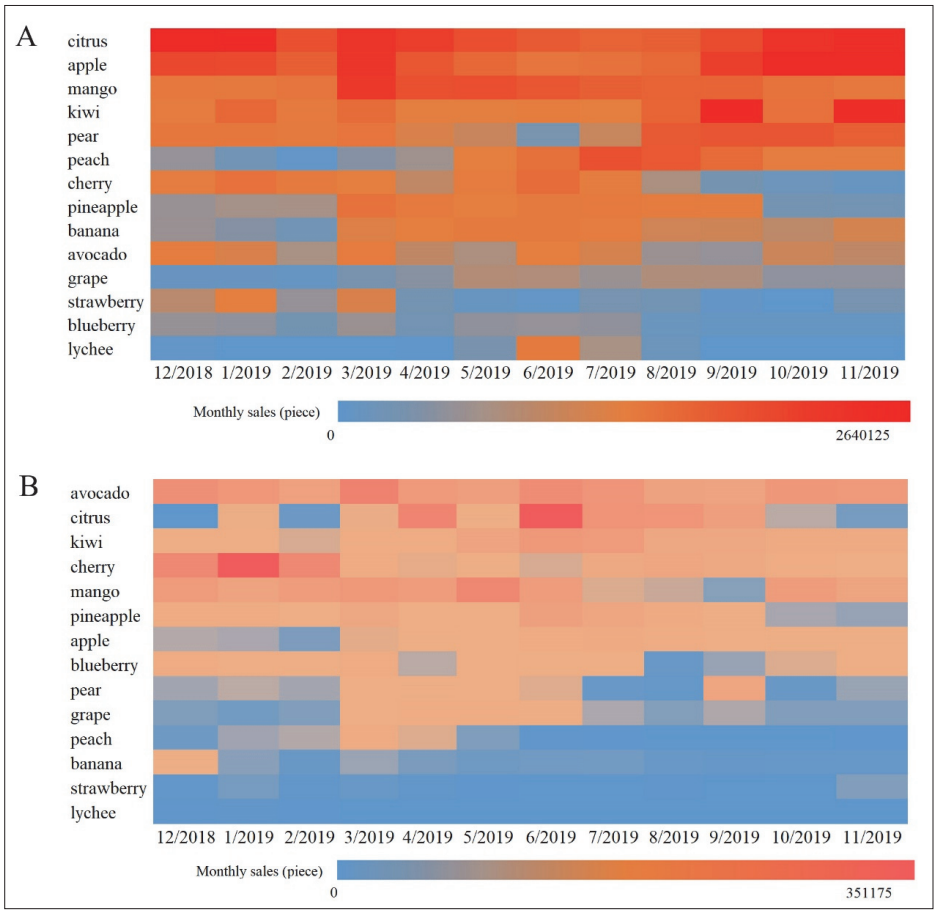



**Figure 3.** Seasonal trend of e-retail fruit sales on Alibaba platforms for (A) all 14 fruit, and (B) imported fruit.

and citrus made up cluster I, with high sales year-round. Kiwi, cherry, mango, pineapple, apple and blueberry were in Cluster II, showing long seasonal supply. Cluster III had fruit with low sale quantities or a short online season, including grape, peach and banana. Cluster IV, consisting of strawberry and lychee, had very low sales, with very limited quantities of these fruit being imported and sold online (Figure 3B).

Avocado showed the highest total sales among the 14 imported fruit, and high sales year-round. Avocado is regarded as a high-end fruit in China. Its strong texture before undergoing climacteric change makes it tolerant to the process of express company delivery. Cherry was the second-largest imported fruit sold on the Alibaba platform. It is considered to be a high-end fruit that is gifted in the winter, and especially for the Chinese New Year. In the last 10 years, cherry has replaced winter grape as a result of trade up. Though cherry showed sales year-round, April, May and June were the low season for imported cherries, which could be because those three months were the high season for local cherries (Figure 3A). Imported mango ranked third in sales, with a low season from July to September (Figure 3B).

**E-retail fruit quality**

Quality, defined by a series of intrinsic and extrinsic parameters, is one of the most important parameters in consumers' purchasing decision. At the time of our study, a list of information needed to be filled out before a SKU could be put on the e-retail shelf. The listed quality-related attributes included diameter, taste, weight of a single fruit, sweetness, degree of ripeness, fruit variety and whether the product is organic. All of these attributes were elective information and among them, taste, sweetness and degree of ripeness were never provided by sellers on Taobao and Tmall during our sampling period.

Application of fruit-quality standards differed among the different fruit. Fruit diameter was usually given for apple, cherry and blueberry, while single-fruit weight was more often applied for citrus, pear, mango, kiwi and avocado. For banana, pineapple, strawberry, grape and peach, in general, neither fruit diameter nor single-fruit weight was provided (Table 1). A specific cultivar was closely related to characteristic extrinsic parameters, such as fruit shape, size and color, and intrinsic parameters, such as texture, sour or sweet, flavor/aroma. Cultivar was more commonly used in the elective information on the 14 fruit, except for banana, avocado, pineapple and blueberry. Cherry had the highest proportion of indicated cultivar names in the SKU. Fruit type (other than name of specific cultivar), such as flesh color, normal or flat peach, and peach or nectarine, was used more often for peach and kiwi (Table 1).

**Package size**

Package sizes of e-retail fruit differed from those used in offline sales, because they were optimized for the high-efficiency transportation requirement. Two total package weights could be found on both platforms: 2.5 kg and the less popular 5 kg.

On the Taobao platform, the 14 fruit could be divided into three groups according to their most popular package size (Figure 4A). The low-weight package group was represented by blueberry and cherry, with around 40% of their sales packaged in the range of 0.5 to 2.5 kg, where blueberry had

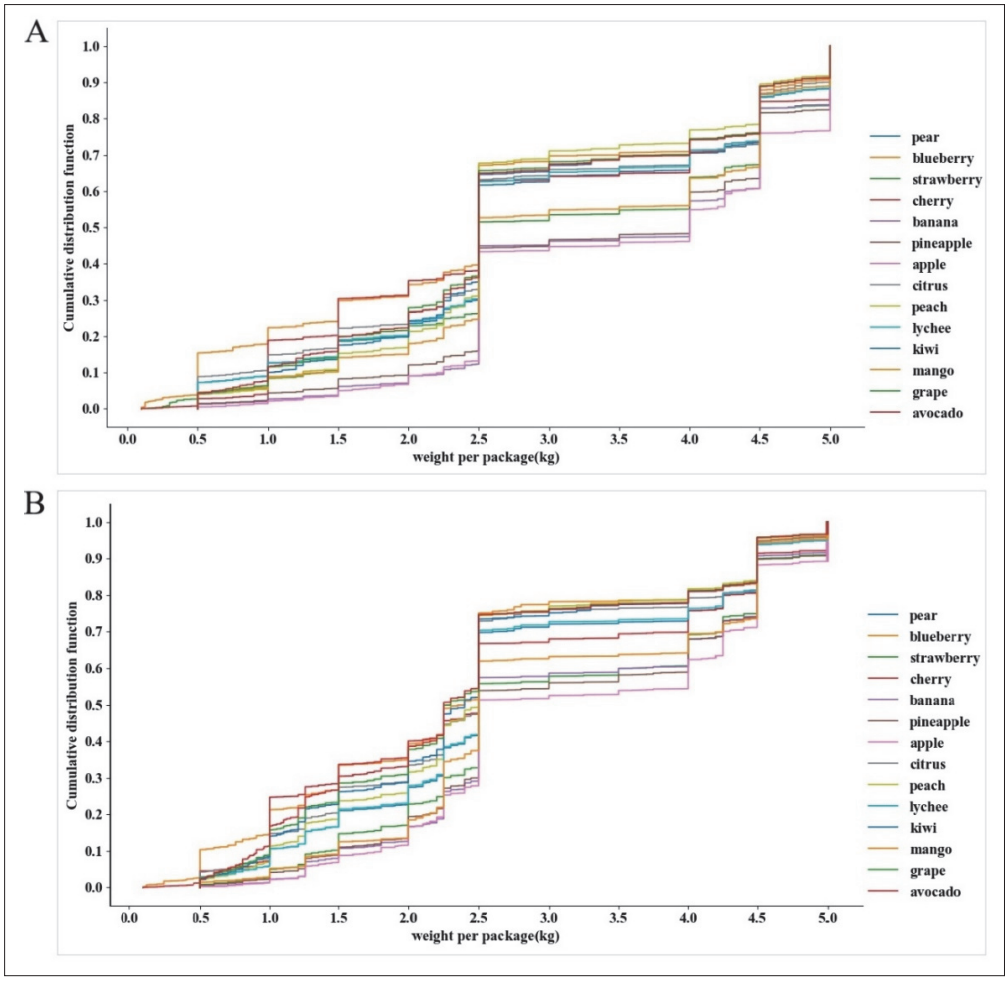



**Figure 4.** Package size distribution of e-retail fruit on Alibaba platforms Taobao (A) and Tmall (B).

higher coverage than cherry for the low-weight 0.5 to 1.5 kg package. The second group was fruit packaged at medium weight, included peach, avocado, grape, kiwi, citrus and pear: a high proportion of their package units was in the range of 2.5 to 4.5 kg. The third group were fruit with relatively big packages, including banana, pineapple, mango and, surprisingly, strawberry.

Similar fruit package groups and trends were seen on the Tmall platform (Figure 4B). However, compared to Taobao, Tmall packages were smaller. Packages of cherry, avocado and blueberry were more concentrated in the low-weight range, citrus, pear and peach were in the middle package weight group, and apple, pineapple, strawberry and banana were in the high package weight group (Figure 4B). It is worth noting that all of the e-retail fruit packages chose to use the Chinese system of weight over the metric system, where 1 kg is equal to 2 jin. This could be regarded as a marketing ploy to improve psychological feeling, as with the use of, for example, '0.99' versus an integral number in sale prices.

**Price**

Among the 14 fruit on the Taobao platform, cherry, lychee, grape, blueberry and strawberry made up the highest-priced group, with big price differences in different months (Supplemental Figure 1), and average annual prices of RMB 150.9, 130.8, 82.3, 78.8 and 74.3 per kilogram, respectively. Avocado, peach, apple, kiwi and mango fell into the medium-price group with average annual prices of RMB 48.7, 48.3, 45.6, 44.4 and 42.3 per kilogram, respectively. Pear, citrus, pineapple and banana were in the relatively low-price group with RMB 37.8, 35.5, 35.4 and 26.8 per kilogram, respectively. The price distribution pattern on the Tmall platform was similar to that on Taobao (Supplemental Figure 1). Cherry led with an annual average price of RMB 131 per kilogram, followed by lychee at RMB 85.3 per kilogram.

Discounting was frequently used in e-retail. The prices that we collected were the indicated prices of the SKUs, and discounting was used to achieve sales volume. Thus, frequent practices included getting 5 kg for the price of 4 kg, half price for the second piece, first-time purchase discount, limited time discount, and others. The price elasticity was different for the different fruit, fruit supply, and time of year, which was related to holidays and cost of storage or delivery.

**Cities of delivery**

Cities of delivery were characterized by a concentrated head part and long tail in sales volume, i.e., a small group of leading cities held a high percentage of the total delivery, while a very long list of cities shared the remaining percentage. Among the accounted for 8.4 million pieces delivered through the Taobao platform from 334 cities during the study year, the top 24 cities, which each delivered more than 100,000 pieces a year, took 69.3% of the total volume, and the top 10 cities took 45.1% of the total pieces. Among the summed 53.8 million pieces sold through Tmall from 257 cities, the top 15 cities, which each delivered more than 1 million pieces a year, took 77.2% of the total delivery, and the top 10 cities took 66.3% of the total pieces, demonstrating a remarkable trend of lead city dominance. Comparing the top 10 cities for Taobao and Tmall, 7 of them, namely Chengdu, Nanning, Xi'an, Yuncheng, Zhangzhou, Ziyang and Yantai, overlapped. The top 15 delivery cities for Taobao and Tmall are shown in Supplemental Figure 2A.

The major cities for imported fruit delivery were concentrated in the coastal provinces. Through the Taobao platform, 641,383 pieces of imported fruit were delivered in the study year, in 9 cities, each of which delivered more than 10,000 pieces, summing to 87.4% of the total delivery. Through Tmall, 3,481,061 pieces of imported fruit were delivered, with 6 cities each delivering more than 100,000 pieces a year, summing to 86.2% of the total delivery. Shanghai was the leading city in the delivery of imported fruit, with 0.26 million and 1.46 million pieces via Taobao and Tmall in the study year, respectively. Among the top 10 cities for Taobao and Tmall, six overlapped, namely Shanghai, Guangzhou, Nanning, Chengdu, Kunming and Chongzuo. The top 15 cities for imported fruit delivery on Taobao and Tmall are shown in Supplemental Figure 2B.

**Hot words used in e-retail fruit promotion**

The SKU label is important for online promotion, with a previous study showing a positive correlation between pre-purchase browsing and online purchasing (Kim and Eastin, 2011). In practice, the e-retail shops accumulate a series of words to tag and promote their fruit, which are then found during the potential consumer's browsing and decrease searching time. At the time of the study, a maximum of 30 Chinese characters were allowed for the SKU label on both Taobao and Tmall. In Chinese, the common name of most fruit has 1 to 3 characters, leaving a good amount of space for sellers to give their fruit the best chance to be noticed in the large pool of SKUs by their potential consumers. For all of the SKUs that we studied, the wording used in the SKU was collected and analyzed by frequency statistics. The top 20 words for the 14 fruit at Taobao and Tmall are listed in Table 2.

'Fresh' and 'free delivery' were the most popular words on both Taobao and Tmall platforms, although free delivery was regarded as a standard e-retail service in China. The most used package-size promotion was '5 kg' described as 10 jin. Region of production, which was usually indicated at the provincial level, was heavily mentioned, suggesting a strong agricultural-product characteristic of the fruit, where place of origin is psychologically connected with authenticity and quality. Our result was supported by two studies carried out in Italy which found origin, seasonality and freshness to be the preferred attributes in fruit and berry purchasing (Massaglia et al., 2019; Girgenti et al., 2016).

Interestingly, 'pregnant woman' topped the target consumer and consumption scene vocabulary, far ahead of a few other words in this category. 'Pregnant woman' was frequently used for more expensive fruit, such as cherry. 'Darling' ranked 66$^{th}$ and 89$^{th}$, and 'gift' ranked 83$^{rd}$ and 60$^{th}$ for the Taobao and Tmall promotion words, respectively. It is also worth noting that some frequently misspelled words were on the keyword list, as the seller attempted to best match the searching requirement for their SKUs.

**Country of origin of major e-retail fruit**

On the Taobao platform, citrus, cherry and kiwi were the best-selling imported fruit, followed by avocado, and then apple, pear and mango in lower quantities. Most of the popular imported fruit were dominated by one or two leading export countries with a few exceptions. Cherry was mostly from Chile, kiwi from New Zealand, and avocado was mainly from Mexico, Chile and Peru. Mango was mainly from Vietnam. Citrus had the largest pieces sold on Taobao, and the main sources were the United States, Thailand, Israel, South Africa and Australia. This could be because there were many types of citrus and different countries exported dif-

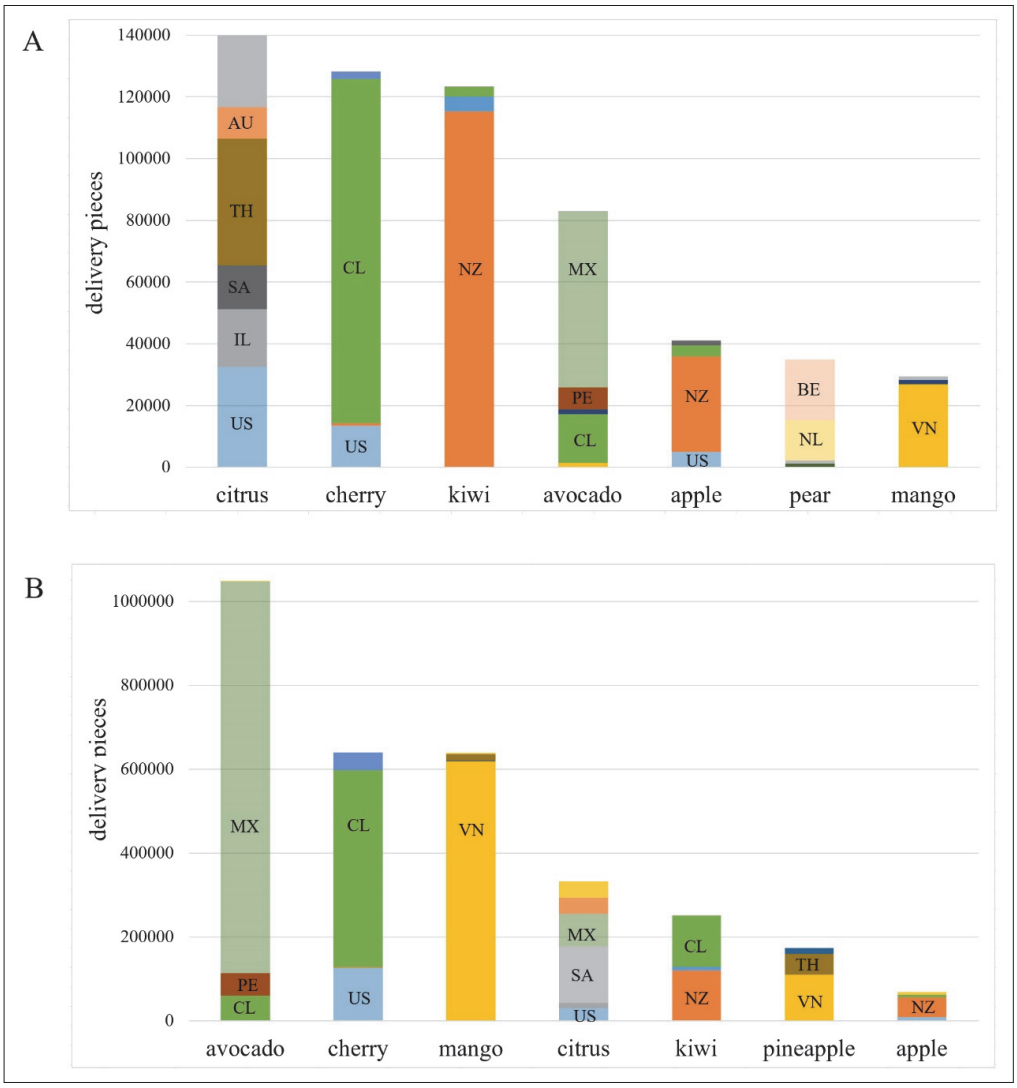



**Figure 5.** The major exporting countries for the popular e-retail fruit on (A) Taobao and (B) Tmall. AU: Australia, BE: Belgium, CL: Chile, IL: Israel, MX: Mexico, NL: Netherlands, NZ: New Zealand, PE: Peru, SA: South Africa, TH: Thailand, US: United States, VN: Vietnam.

**Table 2.** Popular words in online fruit promotion.

| | Taobao | Word frequency | Tmall | Word frequency |
|---|---|---|---|---|
| 1 | Fresh | 204,178 | Fresh | 84,069 |
| 2 | Free delivery | 98,194 | Free delivery | 37,098 |
| 3 | 5 kg | 66,278 | In season | 31,799 |
| 4 | In season | 50,318 | 5 kg | 28,093 |
| 5 | Fresh-picked | 49,128 | Full box | 16,213 |
| 6 | Pregnant woman | 48,943 | Wholesale | 16,008 |
| 7 | Full box | 24,533 | Pregnant woman | 13,000 |
| 8 | Authentic | 21,999 | Fresh-picked | 12,970 |
| 9 | Imported | 19,488 | With box | 11,898 |
| 10 | Hainan Province | 18,585 | Seasonal | 10,341 |
| 11 | Sichuan Province | 17,848 | Imported | 9,569 |
| 12 | Immediate delivery | 17,700 | Red-Fuji | 8,503 |
| 13 | Red-heart | 17,304 | Hainan Province | 8,010 |
| 14 | Red-Fuji | 17,271 | Sichuan Province | 7,771 |
| 15 | Specialty | 17,092 | Red-heart | 7,244 |
| 16 | Seasonal | 16,532 | Large fruit | 5,507 |
| 17 | Spot-goods | 13,972 | Spot-goods | 4,988 |
| 18 | Guangxi Province | 13,961 | Guangxi Province | 4,835 |
| 19 | Juicy | 12,633 | Yantai City | 4,735 |
| 20 | Shandong Province | 12,441 | Immediate delivery | 4,728 |

ferent specific products to China. Apples were mainly from the United States and New Zealand, and pears were from Belgium and the Netherlands (Figure 5A).

Tmall sold far more pieces of imported fruit than Taobao, with avocado as the best-seller, followed by cherry and mango, then citrus, kiwi, pineapple and apple. Mexico was the largest supplier of imported avocado. Chile was an important supplier of cherry, kiwi and avocado. Vietnam led for mango and pineapple. New Zealand was an important provider of kiwi and apple, and South Africa was strong in citrus (Figure 5B). The percentage of imported fruit from different countries of origin could be related to the nature of the fruit, and to whether the exporters have an already established conventional distribution channel to rely on.

## Discussion

E-commerce, digital platforms and digital communication have had magnificent and profound effects, comparable to the Industrial Revolution (Nisar and Prabhakar, 2017; Wang and Ng, 2018). Opening online businesses has become a trend for many fruit growers, production regions and distributors, and has been encouraged by the Chinese government (Xie, 2017). The present study, looking at this phenomenon from a horticultural point of view, could provide the industry with a view of fruit e-retail in China and an understanding of the fundamental changes underlying the data.

### Favored fruit characteristics in e-retail

Degree of freshness can be described as level of similarity to the original product (Péneau et al., 2006), and it is a highly valued quality attribute of fruit. 'Fresh' was by far the most used word in promotion in the present study, demonstrating its significance in fruit purchase decision-making. Freshness is evaluated by consumers using a set of parameters, mainly appearance, taste and juiciness (Péneau et al., 2006). Fruit that naturally retain their freshness for longer periods and those with a strong texture were found in our study to be favored in e-retail.

The most commonly used packaging material for online fruit was cardboard cartons, with standard sizes provided by the delivery company or purchased in bulk by the e-retailer. Elastic nets were also sometimes used to further protect the fruit. Citrus and apple are relatively tough fruit that are suited to simple packaging and transportation without cold-chain logistics. During 2 to 3 days of transportation, citrus and apple maintained good freshness scores as evaluated by consumers.

We found mango to be a popular e-retail fruit. In contrast to ready-to-eat fruit in the offline business, e-retail mango in China was usually sold with a hard texture before its climacteric. As part of their service, the sellers included a guide with the purchase instructing consumers to put an apple into the box, upon which the mango would be ready to eat after 3 to 5 days.

Kiwi was another very successful fruit in e-retail. Standardization and mechanization have been well-adopted in kiwi production compared to other fruit (Mu et al., 2018). Kiwi usually has a very uniform shape, enabling its placement in the standardized holes of thick elastic cushion, followed by packaging in cardboard cartons. Other successful fruit in e-retail in China included avocado, cherry and blueberry. Like mango, avocado was usually delivered when it was hard and texturally strong. On the other hand, cherry and blueberry were highly priced, supporting time-efficient delivery. Overall, the successful fruit in our e-retail survey were either tolerant to low-cost packaging and transportation or expensive enough to support high-end third-party logistics.

### The challenging fruit in e-retail

In our study, packaging and transportation costs made up a large proportion of the e-retail fruit business cost, as free delivery was an almost standard e-retail service. Cost efficiency was of high importance to e-retailers, and cold-chain logistics was not available with most third-party highway transportation (Zhang et al., 2019).

Peach, grape, banana, strawberry and lychee took a significantly decreased share of Alibaba e-retail compared to their corresponding proportion of total production. Most of these fruit can undergo significant losses in freshness, flavor and appearance within 48 hours. Peach made up 10% of the total production of the 14 fruit, but its corresponding share on Alibaba was 5% in 2019. Peaches usually have a soft texture, especially the types preferred by Chinese consumers (Li and Wang, 2020). Moreover, the quality of peaches suffer greatly from early harvest (Remorini et al., 2008). As a consequence, the delivery radius of e-retail peach was rather concentrated around neighboring cities.

Grapes constituted 10% of the total production of the 14 fruit in 2019, but only occupied 1% of the volume of all 14 e-retail fruit. The sale unit of grapes in China has been largely based on integral clusters, with the size and shape of the cluster being important attributes among consumers (Zhou et al., 2015). Unfortunately, integral grape clusters do not suit e-retail packaging. The boxing of grapes calls for a change in the conventional 'whole bunch sale' concept, which then needs to be promoted to consumers. Difficulties in strawberry and lychee logistics might be assumed from their highly perishable nature and short shelf lives (Kumar et al., 2012; Oregel-Zamudio et al., 2017). Thus, their e-retail could remain small in volume until the emergence of revolutionary cultivar or business solutions.

### Chances for imported fruit

Imported fruit took a significant portion of the surveyed e-retail. 'Imported' ranked as the 9$^{th}$ and 11$^{th}$ most popular word in the name of the 14 e-retail fruit SKUs on Taobao and Tmall, respectively, suggesting high popularity of imported fruit in e-retail. At the time of our study, imported fruit was believed to be of higher quality than domestic fruit (Gale and Huang, 2016). When the elective information of fruit diameter and single-fruit weight was compared between domestic and imported fruit, these quality data were more often part of the imported fruit SKU, especially for the expensive cherry and blueberry.

Imported tropical fruit refers mainly those fruit that China cannot adequately produce due to climatic conditions, such as banana, durian, mango and avocado. They are thus imported in large quantities (Lei et al., 2018). During the study period, banana constituted 61.83% of the total fruit imported into China, mainly from Ecuador and the Philippines. However, it was seldom tagged as imported. A similar situation was seen with pineapple, with China being its third-largest importer worldwide. Depending on the nature of the fruit, the segmented market, and whether mature conventional distribution channels could be relied on, tropical fruit imported on a large scale had different proportional distribution by e-retail.

The imported temperate fruit and berries were either produced during the off-season of China's local supply, such as cherry from Chile, or in almost the same season as local

products but targeting the high-end market, such as apple, pear and grapes from the United States, the Netherlands, Australia, New Zealand and South Korea. Imported temperate fruit belonged to a high-priced niche. In general, in China, fruit imported from developed or middle-income countries are regarded as being of high quality (Tian and Yu, 2016).

Cherry was a very successful Chilean fruit export to China (Donoso et al., 2017), and Chinese consumer preferences and influential factors in purchasing decisions were studied (Chiang et al., 2018). Internet and e-retail had the advantage of being able to build a consumer base for high-priced fruit, especially those in third- and fourth-tier cities, whereas this was more difficult for conventional offline shops.

Exporters and their cooperating distributors' intentions also had an effect on the online fruit business. Among table grape imports, those from Chile, Peru and Australia amounted to 10,683.5, 6,566.8 and 5,842.9 tons in 2019 (China Customs, 2020), and their Alibaba e-retail SKU numbers were 1653, 3572 and 431, respectively, indicating that more Peruvian grapes were put online.

## Conclusions

In summary, during the period of this study, fruit e-retail made up an important share of the fruit business in China. Unique features were developed for preferred fruit type, seasonal popularity, price, and package size. A specific vocabulary was revealed in fruit e-retail promotion. Our results confirmed the horticultural aspects of fruit e-retail, which consists of more than just moving fruit online. Further studies on the segmented e-retail fruit market, and consumers' fruit cultivar preferences and purchasing behavior, will help the industry better meet consumer requirements.

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### Declaration of competing interest

The authors declare that there are no competing interests.

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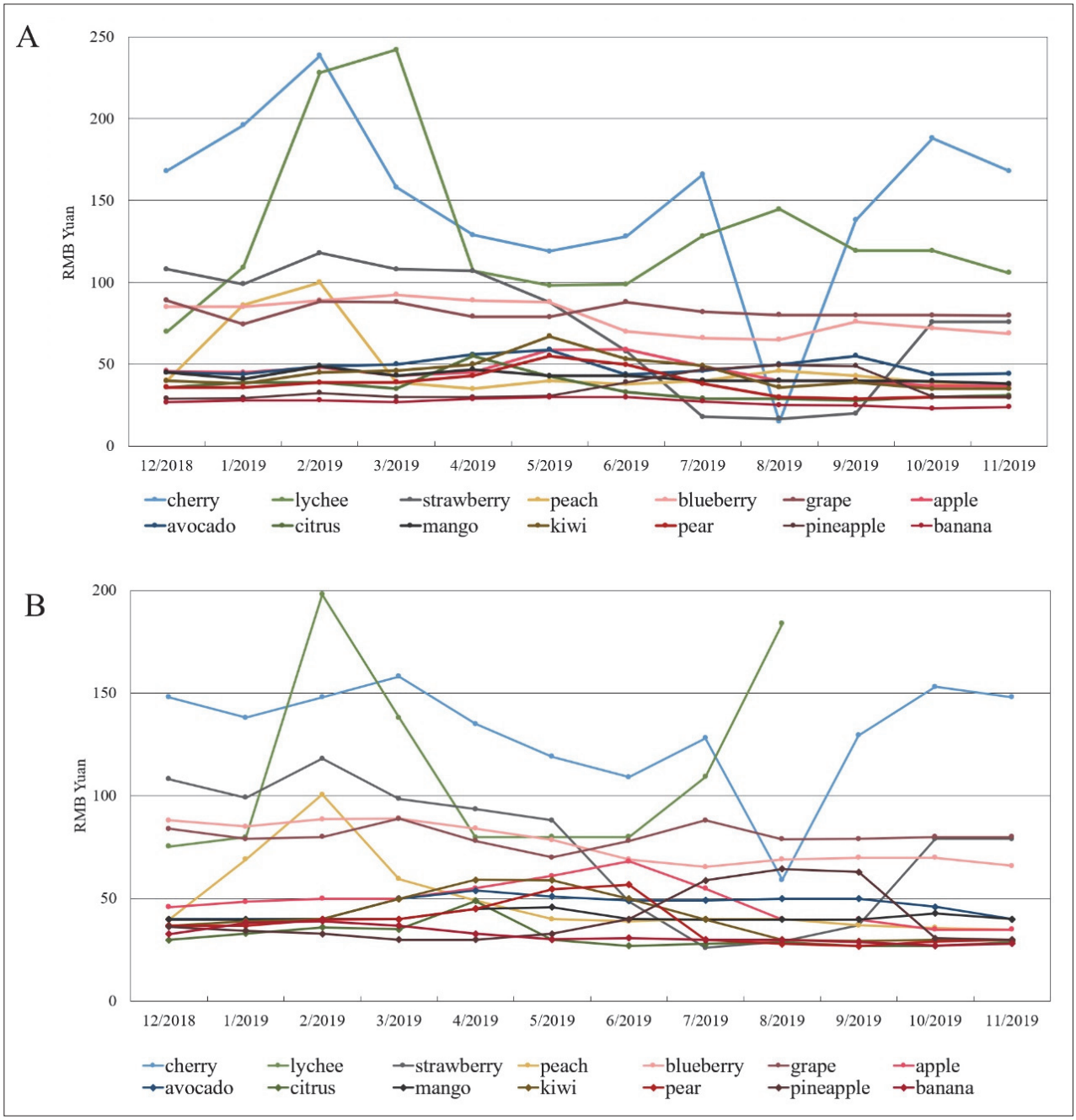
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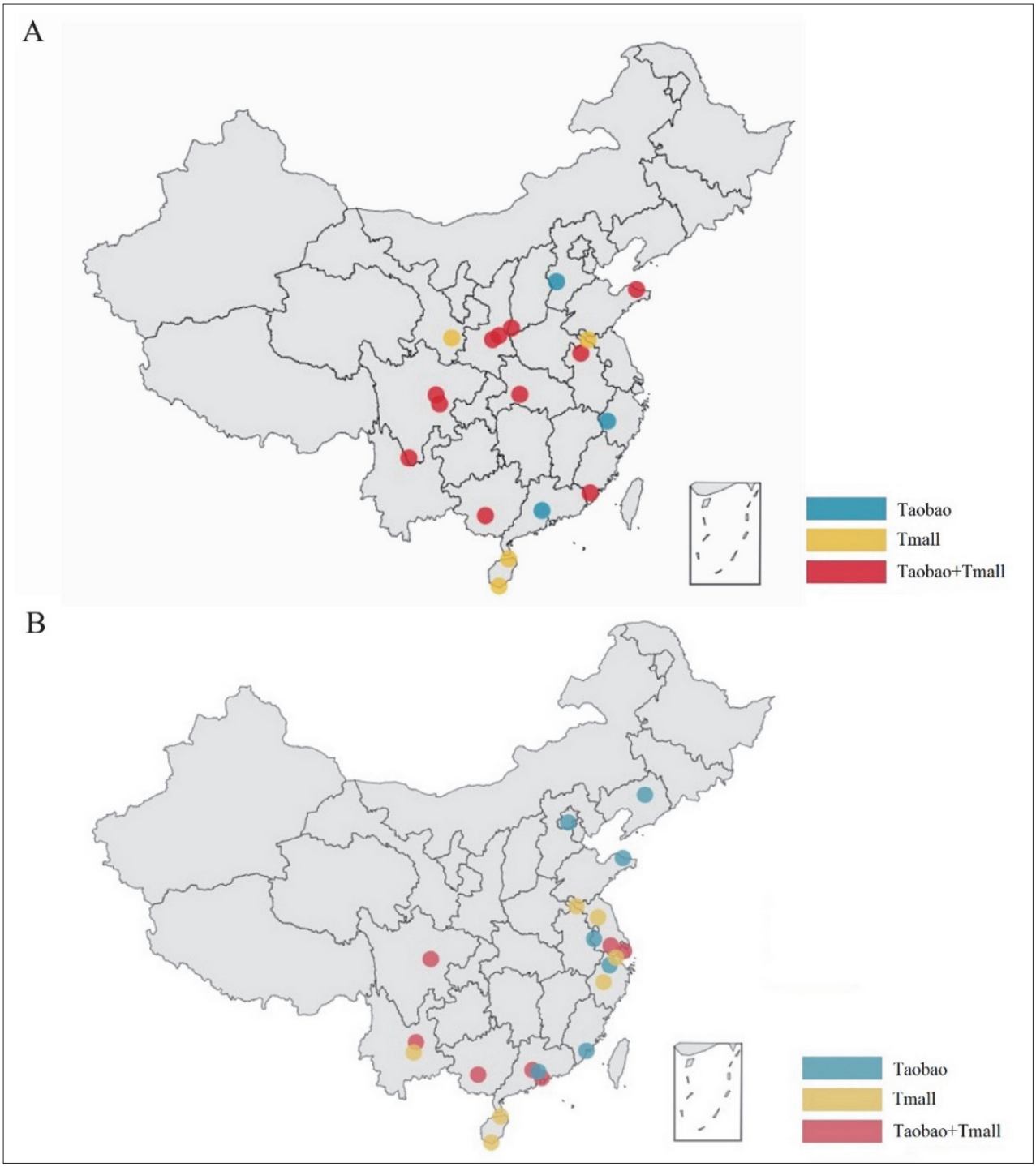
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Addresses of authors:
Yijun Chen[1], Fei Dang[2], Yunze Li[1], Yuanxing Rao[2], Ruilong Hao[1], Adele Lu Jia[2,*] and Huiqin Ma[1,**]
[1] Horticulture Policy and Economy Research Center, College of Horticulture, China Agricultural University, Beijing 100193, P.R. China
[2] College of Information and Electrical Engineering, China Agricultural University, Beijing 100083, P.R. China
Corresponding authors:
* E-mail: ljia@cau.edu.cn
** E-mail: hqma@cau.edu.cn

## Supplemental Information




**Supplemental Information – Figure S1.** Annual price changes for the 14 fruit in e-retail on Alibaba platforms Taobao (A) and Tmall (B).




**Supplemental Information – Figure S2.** Top 15 delivery cities for e-retail fruit. (A) All 14 fruit types; (B) Imported fruit.