BIOCHEMICAL CHARACTERISTICS OF CHINESE DATE FRUITS AT DIFFERENT MATURITY STAGES

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Abstract

The climate changes from the recent decades, and the decline of stone fruit plantations (peaches and apricot) in the sandy soil area, have led the fruit researchers from Research Development Station for Plant Culture on Sands Dăbuleni to look for another line of fruit species, namely exotic fruit species. One of these species is the Chinese date, which in the seven years of study in the experimental lot at Dăbuleni, fruiting from the second year after planting and managed to become known as a fruit produced on the sands of Dăbuleni, or named "the Dăbuleni jujube". Although the research station only owns 1.5 ha demonstration plot, it has managed to sell jujube fruits to consumers across the country through online commerce. The fruits were sold in various stages of ripening, panda and completely brown fruits. Thus, the purpose of this paper is to present the nutritional values of Chinese date fruits at different maturation stages for six genotypes. At the end of the study, the vitamin C content in the fruit showed the highest values recorded in the Xuan Cheng Jiang genotype (305.41 mg/fresh fruit) in the fully brown stage, and in the „panda stage" the Lang genotype recorded the highest vitamin C content (283.51 mg/100g fresh fruit).

***Key words**: **jujube, vitamin C, fruits panda stage**.*

INTRODUCTION

The Chinese date originated in China, with archaeological studies dating it back to the Neolithic period, 7000 years ago. Now is widespread in the wild flora on all continents except Antarctica and is becoming increasingly important, especially in arid and semi-arid regions (Liu M., 2006; 2015; 2019; 2020). The Chinese date is drought tolerant (according to Hager and Edward, 1989, cited by Yao S., 2013), and according to Fairchild, 1918, it tolerate very high temperatures of 48.9 ºC in the summer, and during the winter, the plant withstands temperatures down to -27ºC. Over 700 different genotypes are known in the world, the vast majority being cultivated in China. In Romania, the first biotypes of Chinese date were identified in Dobrogea, next to archaeological sites from the Byzantine period, where they were apparently brought by Roman and Greek colonists on the so-called "Silk Road" (Stanică F. et al., 2025, Diaconu A., 2025). The fruit of the Chinese date is a drupe that the locals of Dobrogea call "Dobrogean olive", but unknown to the majority of consumers (Stanică F., 2006). The fruit or "jujube", brown in color when ripe, can be consumed fresh or dehydrated. It is an important source of minerals and vitamins that can be processed into various confectionery preparations (Stanică F., 2008. In the recent decades, the studies, have shown that jujube fruits contain a large amount of

various bioactive compounds, depending on the variety, recording values of 330-880 mg ascorbic acid/100g of fresh product. The content of vitamin P exceeds 1,000 mg/100 g. The fruit also contains vitamins from the B group. The content of microelements is also high: Fe 0.355%, Ca 0.246%, Mg 0.057%, Zn 5.044 ppm, Mn 3.85 ppm, Cu 2.364 ppm. The fruits contain up to 500 nmol/g of dry matter, adenosine 3-5 monophosphate (10 times more than any plant analyzed to this date) and, in addition, large amounts of oleanolic and ursolic acid (Wang J., 2011). These phytoconstituents play an important role in suppressing various diseases, exerting antioxidant, anti-inflammatory, anti-obesity, cardioprotective, hepatoprotective, antidiabetic, antimicrobial, anticancer, and gastrointestinal-protective effects. The Chinese date plant makes very good use of poor, light soils, salty lands and areas with pronounced drought and excessive temperatures during the summer, which are not suitable for the cultivation of other fruit species. The recent studies show that in the southern regions of Romania, the Chinese date palm finds favorable conditions for growth, so we can say that the jujube could be one of the fruits of the future of Romania (Stanică F,. 2025). So, in this paper we will present the nutritional values of Chinese date fruits at different maturation stages for six genotypes grow in the sandy soils of Oltenia region.

MATERIALS AND METHODS

The study was conducted during 2023-2024, in an experimental lot, at the Research and Development Station for Plant Culture on Sandy Soils Dăbuleni, located on the North bank of the Danube, in the Southern area of Romania. The experimental lot was established in the spring of 2019, with six genotypes of Chinese jujube: Li, Lang, Tigertooth, L5, Fellini, Xuan cheng jian, planted on raised beds mulched with Agrotextil, irrigation was carried out by drip irrigation. In order to evaluate the fruit quality of these genotypes at different stages of development in the pedoclimatic conditions of the Southern part of Romania, the following biometric determinations of the fruits were made: average fruit weight, the size index, the shape index, the index croma at full maturity stage (full brown fruit). The average fruit weight was determined by weighing a sample of 30 fruits at each harvest, the fruit diameter and height were determined by measuring with an electronic calyper a sample of 30 fruits at each harvest. The size index was calculated using the formula = (height + 2 * diameter) / 3, and the shape index was calculated using the formula (height + diameter) / 2. The biochemical determinations were performed according to Croitoru M., 2021 as: total dry matter (using the gravimetric method); the soluble solids (using the refractometric method); vitamin C content (using the iodometric method), carbohydrate content (using the Fehling Soxhlet method). The fruits color indices were measured using the Hunter system, where L*(brightness); a*(redness +, greenness -); b*(yellowness + or blueness-) with the PCE-XXM20 colorimeter. For L*a*b* values the hue angle (h^0) was calculated as: $h^o = \tan^{-}(b^*/a^*)$ (Abbott, 1999) where the value of 90° represents a totally yellow colour and 180°, and (Lopez & Gomez, 2004).

The study carried out between 2023-2024, the results were statistically analyzed using the analysis of variance (ANOVA). Means were compared using Duncan's multiple range test. The different letters from figures are significantly different according to Duncan test ($P \leq 0.05$). The bars in the figure represent the standard deviation at 5%.

RESULTS AND DISCUSSIONS

The biometrics fruits characteristics. The fruits weight. For the studied genotypes, the means values over the study period varied between 26.28 g/fruit (`Lii` genotype) and 7.69 g/fruit (for the `Fellini` genotype), (Table 1). From a statistical point of view, the studied genotypes were classified in four classes

with differences between genotypes between 26.37% and 11.70%.

The fruits size and shape index. In the study period, the size index values recorded, highlight the `Lii` genotype (26.28) with statistically assured differences versus the other studied genotypes, varying between 36.01% and 11.66%.

The fruits shape index. Is a mathematical index that shows the shape of the fruit. Thus, the shape index with value 0.9-1.0 indicate round fruit, the smaller value than 0.9 indicate oblong fruits, and values over 1 flattened fruit (by Botu and Botu, 1997). The average values recorded during the study period show that the shape index reached values above 1 in the case of genotype `Li`, `L5` and Fellini. Mean values less than 0.9 of the shape index were recorded for the `Lang`, `Tigertooth` and `Xuan cheng jian` genotype. The L* (brightness) color fruits indicator recorded the highest values to the `Lang` genotype (31.01), and the lowest values were recorded in the `Fellini` genotype (24.18). The values recorded during the study period classified the studied genotipes in two statistically . At the hue angle (h°), (Table 1), in the studied period all genotypes recorded values between 7,88 (`Fellini` genotype) and 19,41 (`Lang` genotype).

The biochemical fruits characteristics

Total dry matter recorded values ranging from 16.8% for the `Tigertooth` genotype to 28.54% for the `Fellini` genotype at the green stage (Fig. 1). At the panda fruit and fully brown fruit stages, the `Fellini` genotype recorded the highest values in terms of total dry matter content (Fig. 2 and 3) and soluble dry matter content (Fig. 4 and 5). It is worth noting that at the full brown fruit stage all genotypes recorded the soluble solids content above 24% (fig. 6).

Similar values were also obtained by Chen et al., 2019, in different date varieties grown in four districts of the Xinjiang Uygur Autonomous Region of China (58.34-76.5% water and 23.5-41.66% total dry matter). The results obtained are similar to those determined by Chen et al., 2019 under different conditions in China (27.17%-31.70% soluble solids content at the fully brown stage). The authors Li et al., 2007; Wu et al., 2012 reported that the highest soluble carbohydrate content was recorded at the fully brown ripe stage, also. The glucides content, in our study increased significantly and gradually from the green to the full brown stage in jujube fruits (fig. 10). The glucides are important nutrients in date fruits, and their content directly determines the sweetness of the fruits. Among carbohydrates, fructose, sucrose, and glucose were determined in all jujube fruit varieties, which was consistent with the results published by Guo, et al., 2015a and Kao and Chen, 2015. Sucrose is the dominant carbohydrate component in date fruits. It has been reported that sucrose initially accumulates in the leaves and can be transferred to the fruit pulp. Later, in the fruit development process, sucrose is further hydrolysed into glucose and fructose which results in the accumulation of sweetness in jujube fruits (Bastos et al., 2016).

Table 1. The biometrics characteristics of full brown fruits

The biometrics characteristics	Genotipes					
	Li	Lang	Tigertooth	L5	Xuan cheng jiang	Fellini
The fruits weight (g)	26,28 a	19,17 b	18,64 b	9,60 c	18,91b	7,69d
The fruits size	37,91 a	35,54 b	35,48 b	27,27 c	35,49b	24,31 d
The shape index	1,48 a	0,87 a	0,83 a	1,36 a	0,96 a	1,22 a
L*	25,69 b	31,01 a	25,77 b	30,52 a	24,41 b	24,18 b
h^0	8,25 b	19,41 a	8,82 b	7,93 b	7,89 b	7,88 b

The authors indicated that Chinese date have a higher vitamin C content than most fruits reported as a source of vitamin C such as kiwi, strawberries, lemon, sea buckthorn, etc. Vitamin C content to the Chinese date is a varietal character and can be influenced by growing and climatic conditions. Vitamin C content in the studied period was by 230.13 mg/100 g fresh matter to the `Tigertooth` genotype and 279.1 mg/100g fresh matter to the Fellini genotype at the full brown fruit stage (fig.9).

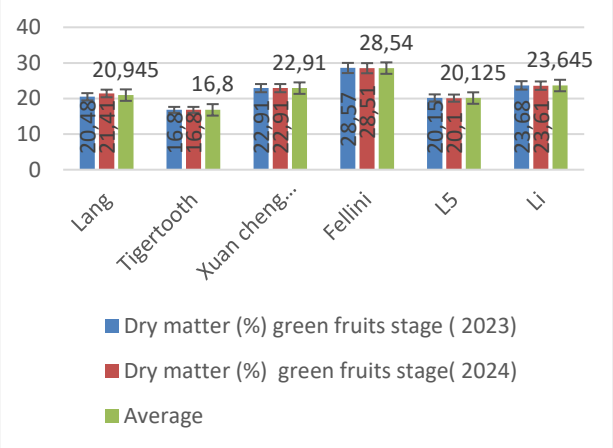

Fig 1. The dry matter content of green fruits stage in the study period

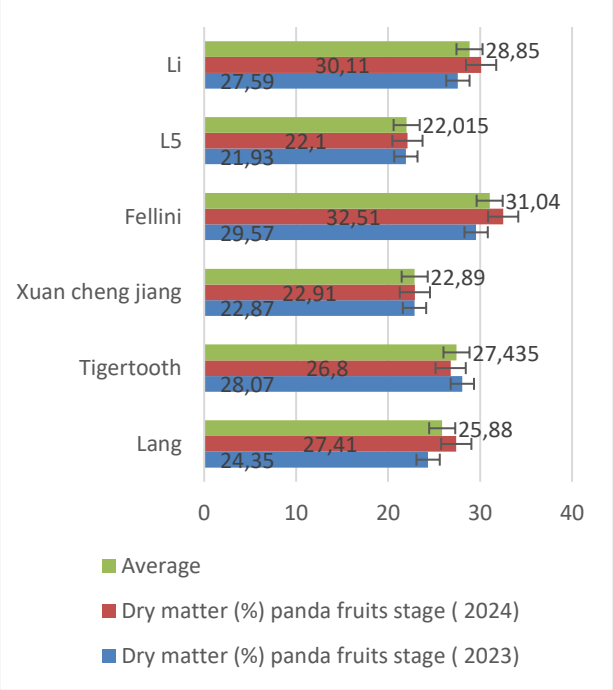

Fig 2. The dry matter content of panda fruits stage in the study period

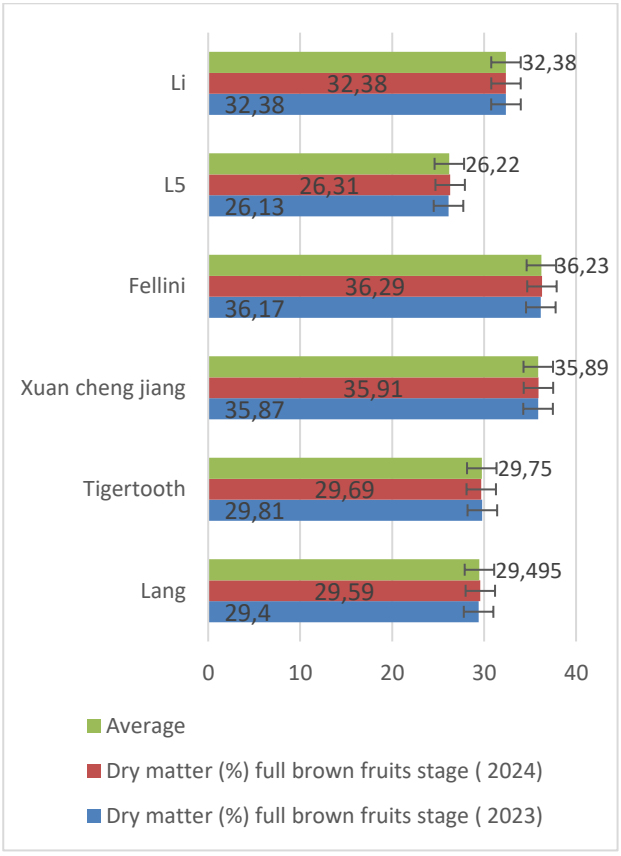

Fig 3. The dry matter content of full brown fruits stage in the study period

As in our study (Fig. 7, 8), Frenich et al., 2005, Wu et al., 2012 showed that the vitamin C content presented values of 310.32 mg/100g fresh weight at the beginning of ripening and decreased with ripening to 199.58 mg/100 g. According to the research conducted by Gündüz and Saraçoğlu, 2014 and Guo et al., 2016, genotype is the main factor determining the physical and chemical attributes of fruits, while the geographical environment and cultivation management affect the biosynthesis and metabolism of nutrients in fruits. The amount of vitamin C in date fruits presented the highest values in the green fruit phase in Li (354,67mg/100g) and L5 genotypes (345,31mg/100g) (fig.7). Cosmulescu et al., 2018 reported that ascorbic acid in two date varieties showed a content of 280.4-250.3 mg/100g at the white (green) maturity stage and 321.9-319.2 mg/100mg at the full brown maturity stage. The most studies indicate the highest value of ascorbic acid at the

ripening stage (Moradinezhad et al., 2016). Wojdylo et al. 2016 showed that the ascorbic acid content in four jujube varieties ranged between 387 and 555 mg/100 g. The authors showed that the most important organic acid, i.e. ascorbic acid, decreased significantly in content from the white (green) to the full (fig. 7,8 and 9) full brown stage by 38%. Similar results were obtained by Huang et al., 2017 showing a decrease in vitamin C during fruit ripening.

Zhang et al., 2020 reported that the reduction in ascorbic acid was limited to only 6% at the semi-red stage (panda stage). At this stage, the ascorbic acid content of the fruit was 460.83 mg/100g. This stage seems to be suitable for harvesting the fruit to preserve the vitamin C content.

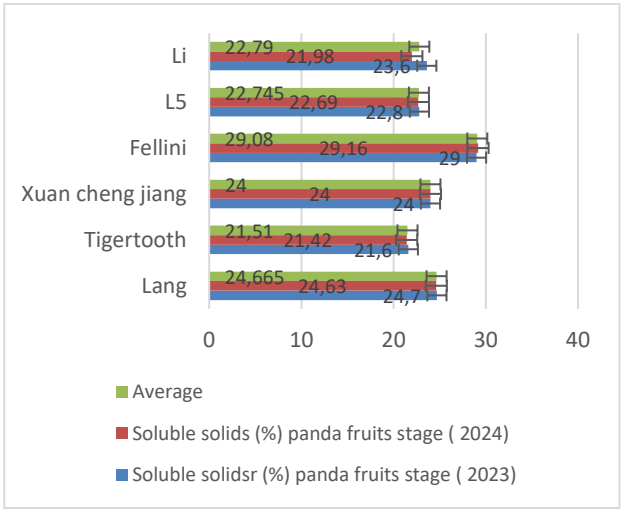

Fig 5. The soluble solids content of panda fruits stage in the study period

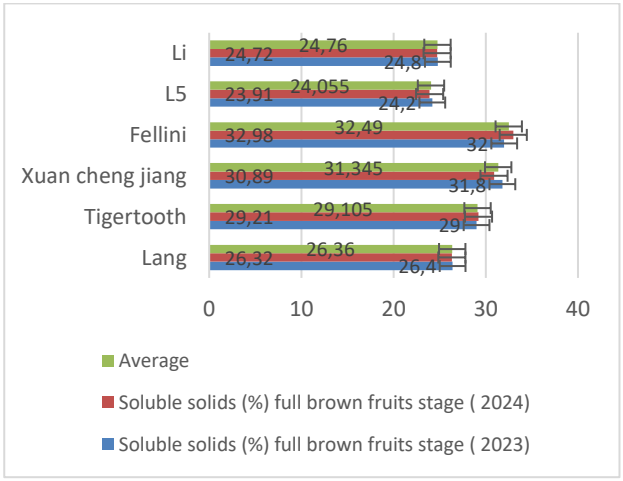

Fig 6. The soluble solids content of full brown fruits stage in the study period

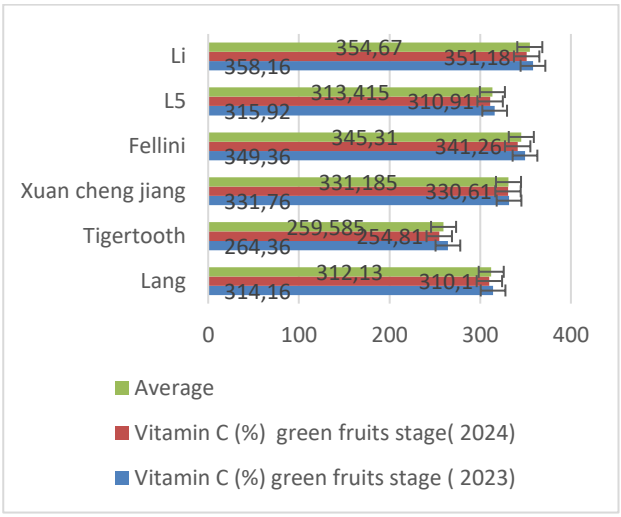

Fig 7. The vitamin C content of green fruits stage in the study period

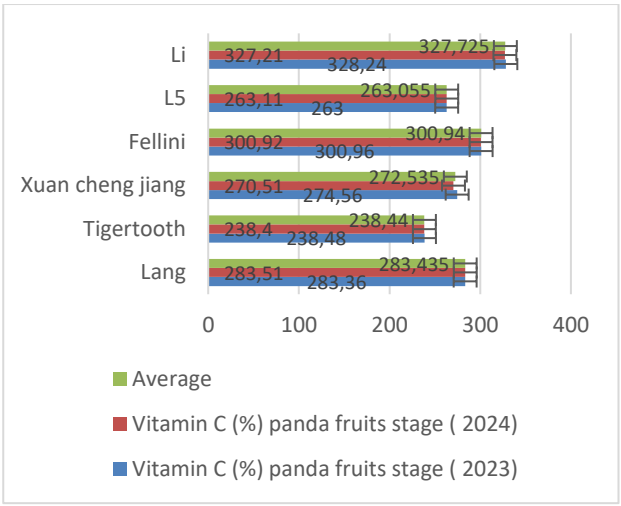

Fig 8. The vitamin C content of panda fruits stage in the study period

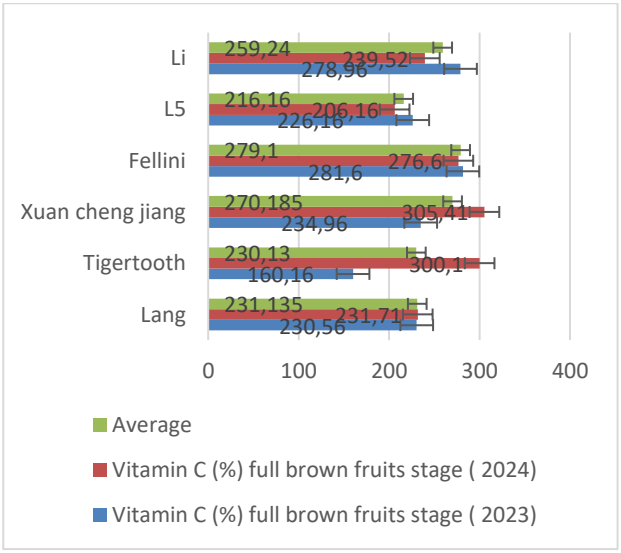

Fig 9. The vitamin C content of full brown fruits stage.

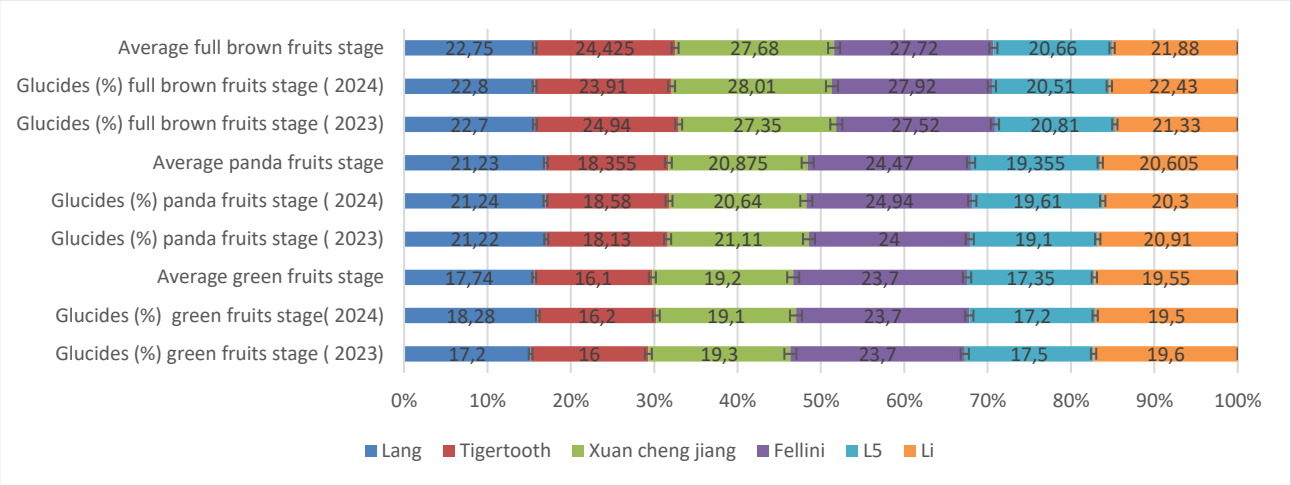

Fig 10. The glucides content of Chinese date fruits

CONCLUSIONS

The Chinese date (Ziziphus jujuba) so far demonstrated that it makes very good use of the climatic and soil conditions specific to the sandy soils of South-western Oltenia.

The results obtained regarding the chemical composition of the fruits highlighted the influence of the ripening stage and genotype on the quality of the fruits.

• The content of soluble dry matter, total dry matter and glucides showed increasing values throughout the three ripening stages from green to full brown.

• Vitamin C content showed the highest values in the green fruit stage and fruit ripening decreased vitamin C content in all genotypes studied. So, we think that the best time to harvest fruits with a high vitamin C content is panda stage maturity

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