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Effects of Different Plant Hormone Treatments and Their Mixed Treatment with Sucrose on Ripening Quality of Strawberry Fruits

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Abstract: Sucrose is an important substance that promotes the ripening of strawberries, while the ripening of fruits is regulated by many different plant hormones (and plant growth regulators). In this paper, different plant hormones and their mixed treatment withsucroseare sprayed on strawberry in growing season, to explore the effects of different treatments on the ripening of strawberry fruit. Use distilled water as a control, while BA (cytokinin), ACC (1-aminocyclopropane-1-carboxylic acid), JA (jasmonic acid), 2, 4-D (plant growth regulator) are treated. The strawberry fruit in the light green period was sprayed, and the change of maturity and the physiological indicators related to maturity were counted. The results showed that different treatments had different effects on the ripening speed of strawberry fruit, and the mixed treatment effect of sucrose and jasmonic acid was the best.

INTRODUCTION

Strawberry (*Fragaria* × *ananassa* Duch), is a Rosaceae genus perennial herb. In the world of small berry production, strawberry ranks firs [1]. Strawberry is the second berry in China. Its cultivation area and output are only next to that of grapes. Meanwhile its fruits are rich in nutrition and delicious, and are well received by consumers [2]. The appearance of strawberries is heart-shaped, and strawberry contains a special rich fruit aroma, high nutritional value, which calcium, phosphorus and iron are 2-4 times more than apples and grapes, and V_C content is higher than the apple l0 times, known as "fruit queen" [3].

Research on the regulation mechanism of fruit development and maturation has always been a key issue and hot issue in the fruit tree discipline. For many years, most of the research on the regulation mechanism of fruit tree fruit development and maturation has focused on the study of some physiological and biochemical metabolic processes during fruit development. These studies laid the basic theoretical foundation for the regulation of fruit development and maturation. For example, according to the characteristics of respiratory changes during fruit development and maturation, the fruit can be divided into two types: respiratory hopping and non-jumping [4]. The climacteric fruit is thought to be regulated by the phytohormone ethylene, and the maturation mechanism of the non-jumping fruit has not been well understood. Strawberry is not only one of the important fruit tree varieties, but also an important material for studying the molecular basis of fruit tree fruit development. Strawberry is a non-respiratory climacteric fruit. Recent studies have shown that the phytohormone absorptive acid (ABA) may play an important role in the regulation of strawberry fruit ripening [5]. However, based on strawberry RNA transcription level and bioinformatics analysis, sucrose metabolism and plant hormone metabolism may be more closely related to strawberry fruit development and maturation regulation [6].

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MATERIALS AND METHODS

Materials Collection

In this experiment, the well-grown strawberry variety 'Fragaria ananasa Duch.' was used as the experimental material. The material was taken from the Chongzhou Strawberry Base in Chengdu, Sichuan Province in 2016-2017.

Experimental Design

Using 460 μM JA, 50 mg/L, 0.5 mMACC, 1 mg/L 2,4-D and their mixing with 100 mM sucrose as treatment, and distilled water as a control, select the light green fruit with the same growth state and size (green gradually receded, about 17 days after flowering), and insert it from the tip of the fruit to the heart. About 200 μL, the needle is slowly pulled out while injecting. The treatment consisted of 3 repetitions, each of which repeated 8 strawberry fruits, and the fruits were picked when they are fully ripen, and the strawberries were ground into powder with liquid nitrogen, mixed evenly, and stored in an ultra-low temperature freezer at -80 °C for use in determining the physiology index.

RESULTS AND DISCUSSION

Effect on Ripening Related Physiological Indicators of Strawberry Fruit

Different treatments had a certain effect on the anthocyanin, total sugar, total acid and sucrose content of strawberry fruit. The treatment of sucrose alone could significantly increase these ripening-related physiological indexes, and its combined effect with JA was more obvious. It is speculated that it has a certain impact on strawberry ripening.

TABLE 1. Content of anthocyanin, total sugar, total acid and sucrose in strawberry fruit

	Anthocyanin (mg/g)	Titrate acid (mg/g)	Total sugar (mg/g)	Sucrose (mg/g)
CK	2.015±0.11845^{d}	2.78033±0.320484^{ab}	8.3786±0.14939^{a}	18.0646±0.28335^{e}
SUC	2.7317±0.27367^{a}	2.74267±0.471979^{ab}	8.1881±0.20194^{a}	19.562±0.11815^{de}
BA	2.6317±0.05981^{a}	2.67233±0.216769^{ab}	8.331±0.21528^{a}	25.5208±0.15049^{ab}
BA+SUC	2.614±0.02191^{a}	2.551±0.24893^{ab}	8.5022±0.2413^{a}	19.3442±0.67551^{de}
JA	2.0133±0.01366^{d}	2.73767±0.143718^{ab}	8.0476±0.32537^{a}	21.6155±0.26315^{cd}
JA+SUC	2.385±0.03271^{b}	1.973±0.249352^{b}	7.8814±0.24988^{a}	22.4703±0.36689^{cd}
ACC	2.2988±0.05055^{b}	2.95733±0.1723^{a}	7.9432±0.25897^{a}	24.4541±0.69858^{bc}
ACC+SUC	2.1633±0.04844^{c}	2.273±0.048191^{ab}	8.2857±0.22597^{a}	19.5491±0.44563^{de}
2,4-D	2.32±0.02966^{b}	2.542±0.147146^{ab}	7.7091±0.29379^{a}	27.6109±2.35846^{a}
2,4-D+SUC	2.1675±0.10935^{c}	2.98767±0.462965^{a}	8.162±0.25098^{a}	22.3773±0.35992^{cd}

Effect on Ripening Related Appearance Indicators of Strawberry Fruit

The horizontal and vertical diameter, quality and hardness of the fruit are the most direct indicators reflecting the maturity of strawberry fruit. The results showed that sucrose could not significantly change the size and hardness of strawberry fruit, but other treatments changed the size and hardness of strawberry fruit to varying degrees.

TABLE 2. Horizontal and vertical diameter, quality and hardness of strawberry fruit

	Horizontal diameter (cm)	Longitudinal diameter (cm)	Weight (g)	Hardness (g)
CK	3.3432 ± 0.04861^{a}	3.89368 ± 0.059791^{b}	17.6987 ± 0.695^{ab}	1.8127 ± 0.0688^{a}
SUC	3.1976 ± 0.04555^{abc}	3.89557 ± 0.06854^{b}	16.4869 ± 0.62324^{b}	1.8185 ± 0.06329^{a}
BA	3.2546 ± 0.03417^{abc}	$4.00596 \pm 0.069521^{ab}$	17.4656 ± 0.55931^{ab}	1.6981 ± 0.06141^{abc}
BA+SUC	3.3279 ± 0.05458^{a}	4.15364 ± 0.07355^{a}	18.9764 ± 0.79843^{a}	1.7503 ± 0.06657^{ab}
JA	3.2865 ± 0.0438^{abc}	$4.03341 \pm 0.060206^{ab}$	17.9885 ± 0.64831^{ab}	1.8035 ± 0.0721^{a}
JA+SUC	3.1417 ± 0.04466^{c}	3.87093 ± 0.093932^{b}	15.8609 ± 0.63952^{b}	1.6704 ± 0.08211^{abc}
ACC	3.1598 ± 0.04903^{bc}	3.90256 ± 0.077927^{b}	16.5303 ± 0.786^{b}	1.6437 ± 0.08203^{abc}
ACC+SUC	3.2366 ± 0.04737^{abc}	$3.99852 \pm 0.061904^{ab}$	17.8555 ± 0.7495^{ab}	1.5534 ± 0.06387^{bc}
2,4-D	3.2395 ± 0.04548^{abc}	4.03309 ± 0.06747^{ab}	17.2018 ± 0.62178^{ab}	1.5391 ± 0.08541^{bc}
2,4-D+SUC	3.2973 ± 0.05299^{ab}	$3.95048 \pm 0.061874^{ab}$	17.3617 ± 0.5987^{ab}	1.4917 ± 0.07897^{c}

CONCLUSIONS

The ripening of strawberry fruit is regulated by many plant hormones, and current research is often limited to a single factor. The internal regulation network of the fruit often does not have only one factor, but multiple factors regulate an apparent phenomenon. This experiment uses a mixture of sucrose that regulates the ripening of strawberry fruit with other plant hormones.Furthermore, we can find out whether such a mixed treatment can have different changes in strawberry fruit ripening. The results showed that different treatments produced different effects on strawberry ripening, and the mechanism of action could not be summarized, indicating that there is a complex relationship between the internal regulation networks of plants.

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