

柿自然脱涩能力与单宁细胞发育规律的研究*

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摘要 研究了三种不同甘、涩类型柿果实中可溶性单宁含量、单宁细胞和薄壁细胞发育规律,结果表明:完全甜柿和不完全甜柿的主要脱涩期明显不同,前者在果实发育的早期,后者在近熟期;完全甜柿自然脱涩主要是由于薄壁细胞的持续增大和单宁细胞的早期停止发育,造成单宁细胞占果肉面积比下降所致,而不完全甜柿的树上脱涩主要依赖果实成熟前单宁的凝固作用。在涩柿中这两种机制都不存在,因而不能自然脱涩。在杭州地区,细胞发育及脱涩过程略早于原产地。

关键词 柿、单宁细胞、脱涩、单宁凝固

柿(*Diospyros kaki* L.)根据其在树上自然脱涩能力的大小及果肉的颜色,通常被分为完全甜柿(PC甘)^[1]、不完全甜柿(PV甘)、不完全涩柿(PV涩)和涩柿(PC涩)。前两种类型成熟前可在树上自然脱涩,后两种必须经过采后人工脱涩处理才能成为可食状态。对于甜柿自然脱涩的机理,日本学者已经作了大量的研究^[1~6]。目前日本甜柿已在国内许多地方引种栽培,由于地理和气候条件的差异,果实的生长规律与原产地有所不同^[7],而对由此带来的单宁细胞发育规律的变化,以及不同甘、涩类型柿果单宁性质的差异,国内尚无报道。本文通过对引种于杭州地区的两个PC甘品种、两个PV甘品种和一个涩柿品种单宁细胞发育过程的研究,试图进一步揭示甜柿自然脱涩的机理及其脱涩规律与原产地的差异。

1 材料和方法

1.1 试验材料

试验用柿果均采自杭州大观山果园6年生柿树。品种包括PV甘品种富有、松本早生富有,PV甘品种赤柿、西村早生和PC涩品种火柿。另有两个品种作了部分试验。每个品种选3株树,花期结束后每10d在树冠固定位置采果5~10个,用于可溶性单宁含量测定和组织切片制作。

1.2 试验方法

1.2.1 可溶性单宁含量测定 取果肉鲜样,加80%甲醇捣成匀浆,在70℃水浴上提取0.5h后用Folin-Denis试剂比色测定。

1.2.2 组织切片方法 采用石蜡切片法,FeCl₃整染、固绿复染。

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1.2.3 细胞计数和测量 用目镜测微计对单宁细胞和薄壁细胞计数并分别测量30个细胞的长、短径,计算出单细胞面积,再折算成单位果肉面积的细胞数和单宁细胞所占的面积比。

2 结果与讨论

2.1 可溶性单宁含量的变化

三种甘涩类型柿果的可溶性单宁含量均在5月下旬至6月中旬达到最大值,此后都呈下降趋势(图1)。但下降速度存在着明显差异,PC甘类型的富有和松本早生富有在6月底就降至1.5%以下,到7月下旬降至0.5%左右,基本完成脱涩。PV甘类型赤柿和西村早生以及PC涩类型的火柿虽然在6月份也有一段单宁含量下降较快的过程,但下降幅度远低于PC甘类型。到7月20日,后两个类型的可溶性单宁含量仍在2.6%以上,直到7月下旬至8月中旬,PV甘类型柿果的可溶性单宁含量才急剧下降,也完成了脱涩过程。而PC涩类型品种火柿到9月28日果实完全成熟时可溶性单宁含量仍高达2.7%。这种趋势与笔者^[7]以前的研究结果一致,也和米森敬三等^[8]报道的结果相似,只是脱涩时间更早,如果把0.2%的单宁含量作为完全脱涩与否的界值,富有在8月20日就达到这个数值,比原产地提前了10d左右。

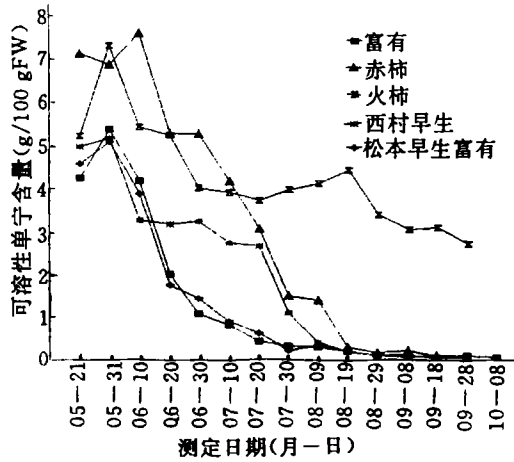


图1 果肉可溶性单宁含量的变化

2.2 不同甘、涩类型柿果单宁细胞发育过程的差异

三种甘涩类型在柿果发育的自始至终,薄壁细胞都随着果实的生长而不断增大,而单宁细胞的增大情况却有明显差别(图2、3)。PC甘类型富有和松本早生富有尽管是中晚熟品种,但其单宁细胞从6月中旬开始就停止增大,此后与其它类型相比,单宁细胞的最终绝对数日虽然

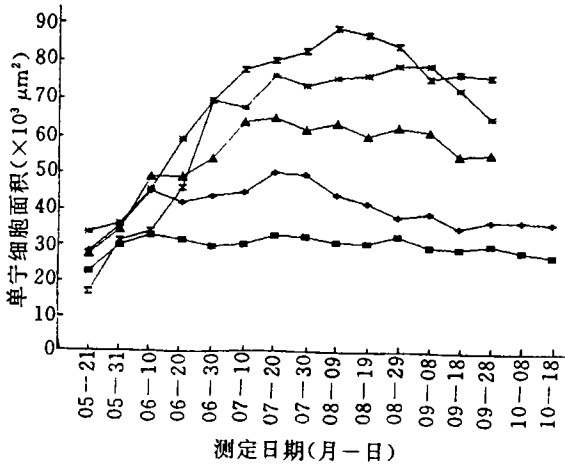


图2 果肉单宁细胞面积的变化

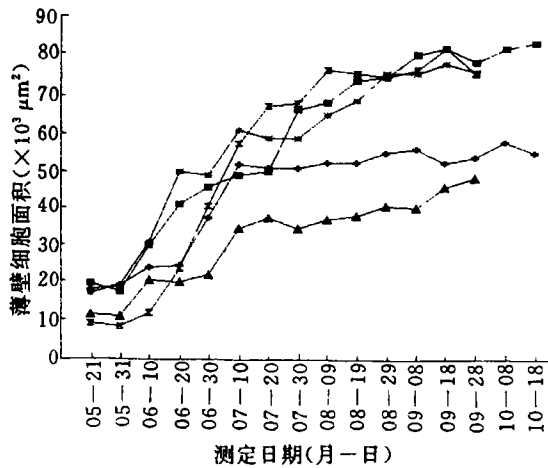


图3 果肉薄壁细胞面积的变化

相差不大,但单个细胞的体积却小得多。因此,如果以果肉组织断面面积计算,则单宁细胞在果肉中所占的相对面积已下降(图 4、5),到 8 月 19 日,单宁细胞面积只占果肉面积的 3%左右。而另一方面,PV 甘类型西村早生和赤柿、PC 涩类型火柿的单宁细胞分别持续增大到 7 月中旬和 8 月上旬,直到 8 月底,单宁细胞面积占果肉面积的比例都仍高达 11%以上。显然,PC 甘类型的自然脱涩与果实生长过程中对单宁细胞的稀释作用直接相关,而其它类型中这种机制不起主导作用。

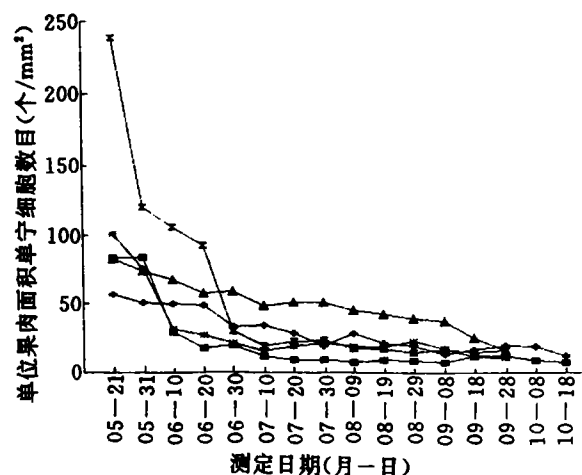


图 4 单位果肉面积单宁细胞数目的变化

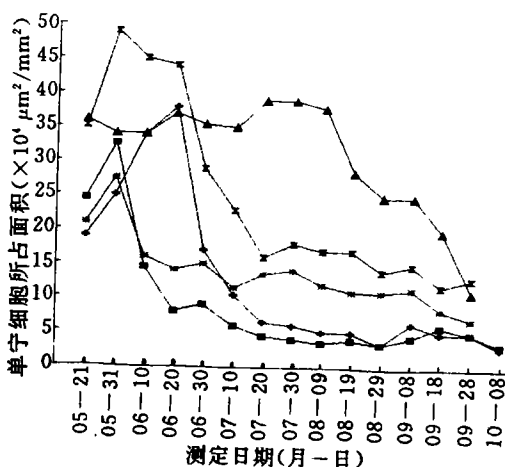


图 5 果肉单宁细胞所占面积的变化

2.3 PV 甘类型的自然脱涩机理

从 8 月 9 日的切片中可以看出:西村早生、赤柿和山富士等 PV 甘品种的果肉中单宁细胞变形,出现成团或成串堆积、相互间难以分清界限的现象(图版 I-C₁~E₁),这可能是单宁发生凝固作用的结果,此现象出现在时间上与可溶性单宁含量急剧下降正好吻合。因而认为,可溶性单宁含量的下降可能是这种凝固作用造成的。在 PC 甘品种富有和松本早生富有 8 月 9 日的切片中没发现(图版 I-A₁,B₁),却在 8 月 29 日的切片中发现了这种凝固现象(图版 I-A₂,B₂),尤以松本早生富有较为明显。只是这两个品种在单宁凝固之前就已完成主要脱涩过程,说明在这类品种中单宁凝固作用不是自然脱涩的主要原因,不过,它们完全脱涩时间与凝固期非常接近,表明 PC 甘品种中单宁的凝固作用与自然脱涩也有一定关系。但在 PC 涩品种中始终没有出现这种凝固现象(图版 I-F₂,G₂)。单宁凝固时出现单宁细胞的堆积现象可能与果肉中单宁细胞的不均匀分布有关,但相邻单宁细胞何以不受细胞壁的束缚而溶为一体,目前尚难以解释。Sugira^[8]在对柿果实中气体的研究中发现 PV 甘品种果实在成熟前产生大量乙醛和乙醇,而 PC 甘和 PC 涩品种大多无此现象。由于这类气体是单宁的凝固剂,从而从另一个方面也证明了 PV 甘果实中单宁凝固作用的存在,米森敬三^[9]研究了柿果肉中单宁的凝固现象,证明在日本京都富有果实中单宁凝固的时间在 9 月 4 日左右。而本实验表明在杭州地区凝固的日期要略早一些。由于 PC 涩品种既无 PC 甘品种那种对单宁的稀释效应,又不存在单宁的凝固作用,因而不具备自然脱涩能力。

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Relationship between the Capacity of Deastrigency and Development of Tannin Cell in Persimmon Fruits

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Abstract Content of soluble tannin, development of tannin, and parenchymatous cells in three different type fruits of persimmon were studied. Results showed that pollination constant non-astringent (PCNA) type fruits removed astringency in the early stage of fruit development, whereas pollination variation non-astringent (PVNA) ones did it at pre-mature time. Natural removal of PCNA type fruits referred to constant development of parenchymatous cells and cease of enlargement of tannin cells which resulted in the decrease of relative area occupied by tannin cells. In contrast with PCNA type, PCNA type remove its astringency by coagulation of tannin cells before ripeness. These mechanisms were not present in astringent fruits of persimmon. The courses of cell development and astringency removal was earlier in Hangzhou area than that in provenance.

Key words persimmon, tannin cell, de-astringent, coagulation

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