plasm of egg cell, and the other shaped in lentoid joint to the secondary nucleus membrane. 20. One sperm nucleus is in the cytoplasm of egg cell, and the other is fusing with secondary nucleus. 21. One sperm nucleus joint to nucleus membrane of egg just now. 22. Lentoid sperm nucleus joint to nucleus membrane of egg further. 23. The nuclei of egg and sperm begins to fusion at the site of nuclei membrane fusion, sperm nucleus is lentoid. Plate Ⅲ: 24 - 27. Chromatin in sperm nucleus relaxes gradually to egg nucleus, and the shape of sperm nucleus changes from lentoid to flat bit by bit. 28 - 30. The nucleus resulted from karyogamy is spherical, in which male chromatin relaxing can be seen. The other sperm nucleus is fusing with the secondary nucleus, and appearing nucleolus. 31, 32. The chromatin from female or male nucleus can not be distinguished in zygocyte, male nucleolus appear. At this time, primary endosperm nucleus has divided into two endosperm free nuclei. 33. Two cell pre-embryo. 34, 35. Sperm moves to secondary nucleus. 36. Sperm nucleus on the surface of secondary nucleus. 37, 38. Ellipsoidal sperm nucleus joint to the nucleus membrane of secondary nucleus with different side. Plate Ⅳ: 39. The fusion of nucleus membrane of sperm and egg, and of sperm and secondary nucleus occurs at the same time, while the chromatin of sperm nuclei relaxes to egg nucleus and secondary nucleus. 40. The chromatin of sperm nucleus relaxes to secondary nucleus, and male nucleolus begins to appear. 41 - 43. Male nucleolus augments gradually in primary endosperm nucleus. 44. Male and female nucleolus is fusing in primary endosperm nucleus. 45. Mitosis prophase of primary endosperm nucleus, while male and female nucleus haven't fused in zygocyte. 46. Mitosis metaphase of primary endosperm nucleus. 47. Mitosis anaphase. 48. Mitosis telephase, formed two endosperm free nuclei.

番茄硬度的电子鼻评价与预测的研究

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Firmness Evaluation and Prediction of Tomato Using Electronic Nose

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关键词: 番茄; 硬度; 电子鼻; 评价; 预测

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番茄硬度的评价一般通过有损检测进行。试验采用 (德国 PEN2) 电子鼻信号对番茄 (*Lycopersicum esculentum* Mill) '浙杂 202' 硬度进行评价与预测, 为番茄采收时的成熟度分级提供依据。采果于浙江省农业科学研究院园艺研究所实验农场。根据外表颜色, 分为半熟期、成熟期和完熟期。番茄运至实验室后, 剔除有病和外表有损伤的果实, 取 3个熟期质量和大小基本一致的番茄各 20个。

用刺入法在美国产 Instron万能试验机上测量硬度。将番茄果实沿赤道平面切取 7 mm厚的薄片, 选取番茄果皮内侧果肉处角度间隔为 120 的 3点作为测量点, 计算机于此过程中自动采集, 记录刺入力。刺入探针直径 6 mm, 刺入果肉深度 3 mm, 刺入速度为 5 mm · s^{-1}。选取每个番茄 3个刺入点, 刺入过程中所需最大力的均值计算硬度, 硬度值 F_i (MPa) =最大力的均值/探头断面面积。将番茄按硬度分为 3个等级: $F_i > 0.95$ MPa的为半熟期, 0.38 MPa$\geq F_i \geq$ 0.28 MPa的为成熟期, $F_i < 0.28$ MPa的为完熟期。

图 1显示了电子鼻对不同成熟度番茄的主成分分析 (PCA) 结果, 前 2个主成分的累计贡献率为 98.88%。电子鼻可以较好地区别番茄的硬度差异。通过偏最小二乘法分析 (PLS), 建立电子鼻信号预测硬度的校准模型, 并采用完全交叉确认的方式对所建立的模型进行检验, 图 2显示检验结果, 用此模型预测的硬度与实际硬度之间的相关性为 0.936, 预测标准误差 (SEP) 为 0.147 MPa。

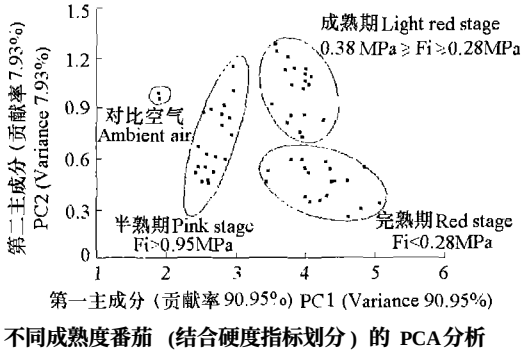

图 1 不同成熟度番茄 (结合硬度指标划分) 的 PCA分析

Fig. 1 PCA score plot of tomatoes at different mature stages according to firmness

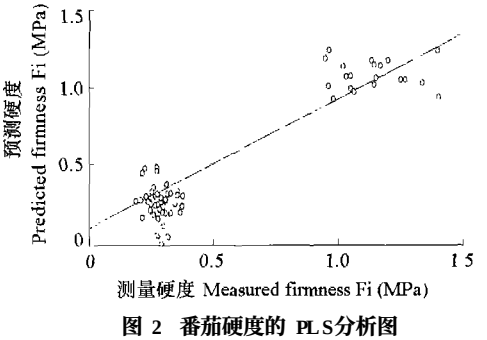

图 2 番茄硬度的 PLS分析图

Fig. 2 Predicted firmness (PLS model based on E-nose measurements) vs measured firmness of tomatoes

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