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学 位 論 文 要 旨
Dissertation Abstract

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学位論文題目：　Resistance to Gas Diffusion in Internal Tissues of Citrus Fruit
Title of Dissertation　(カンキツ果実の組織内ガス拡散抵抗)

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Japan is a major citrus fruit-producing country, and Ehime Prefecture is one of the main citrus fruit producing regions in Japan. As many as 20 major citrus varieties are cultivated in Ehime. To further develop postharvest technology for quality preservation such as modified atmosphere packaging (MAP) and controlled atmosphere (CA) storage, creating an optimum gas concentration around fruit and vegetables have to be precisely achieved. However, the external atmosphere of fresh products in MAP and CA storage differs from the internal atmosphere. Therefore, we can expect to improve MAP and CA storage techniques by establishing a prediction and control method for internal atmosphere. Because the gas exchange rate and resistance to gas diffusion in plant organs determine the internal gas concentration, knowledge of resistance to gas diffusion is essential in predicting the internal gas concentration when the storage gas condition is known.

(Chapter 1) The objective of this study is to determine intercellular space volume (V_{in}) by pycnometric method and to develop a simple prediction method for V_{in}. The pycnometric method is time consuming because ground samples are required. Accordingly, the prediction method can be simply applied to V_{in} determination of citrus fruits. In determining V_{in}, physical measurements of eight species of citrus fruits of different sizes were conducted to obtain their mass (m), vertical and horizontal diameters (vd, hd), total volume (V_t), and real density (P_t). The results showed that each species produced various V_{in}, which its availability depends on fruit size; in other words, the larger the size of the fruit, the larger the V_{in}. However, the levels of porosity (Ø) in each species were not fully proportional to the fruit size. The model used in developing the simple prediction method for V_{in}, $\mathbf{V_{in} = V_t - \frac{m}{1.0647}}$, where V_{in} and V_t are in cm^3 and m is in g, exhibited a high of determination coefficient (R^2=0.999), modelling efficiency (EF=0.999), index of agreement (d=0.999) and paired t-test coefficient(0.365). It was concluded that the model is applicable for predicting V_{in} of citrus fruits.

(Chapter 2) The purpose of this study is to investigate the effect of various sizes of citrus fruit on the resistance to gas diffusion. To measure the resistance (R) to gas diffusion in citrus fruit the study employed ethane efflux method, in which the evolution phenomenon of ethane was measured by applying Fick's Law. The results show that resistance of ethane (C_2H_6) gas is dependent on citrus size. Specifically, the larger the size of fruit, the greater the resistanc*e* value, i.e. M size had R=4.33x10^5 s/m, L size had *R*=4.99 x10^5 s/m and 3L size had *R*=6.84 x10^5 s/m. This finding indicates that the fruit sizes can be considered as an important factor in designing control atmosphere (CA) storage condition for citrus.

(Chapter 3) The aim of the third study is to propose an improved method for measuring the resistance of citrus Iyo fruits (*Citrus iyo hort. Ex Tanaka*) to gas diffusion and to calculate the effect of temperature and fruit size on resistance, the conversion to resistances for O_2 and CO_2 gases and the average value and variation in resistance. In developing the method, we modified an existing method of ethane efflux proposed by CAMERON and YANG. The results showed that our proposed method is suitable for measuring resistance and can shorten the time required to measure resistance. Resistance values of ethane depend on citrus size and temperature in which the larger the size of fruit the larger the resistance value, i.e., M size had 3.21×10^5 s/m, L size had 4.56×10^5 s/m and 3L size had 6.96×10^5 s/m. Also, the higher the temperature the lower the resistance value, i.e., 5.03×10^5 s/m at 5°C, 4.34×10^5 s/m at 10ºC and 3.50×10^5 s/m at 20ºC. The average values and variation in resistance for ethane and its conversion for O_2 and CO_2 were 3.19×10^5 (standard deviation, 7.48×10^4), 3.29×10^5 (standard deviation, 7.73×10^4) and 3.86×10^5 (standard deviation, 9.06×10^4) s/m, respectively, for size L at 20ºC.

Key words : Resistance, citrus, modified atmosphere packaging (MAP), controlled atmosphere storage (CAS)