EFFECTS OF PLAYING ON THE PRACTICAL PERFORMANCE OF REED USED FOR WOODWIND INSTRUMENTS

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Introduction

Woodwind instruments such as clarinet and oboe are equipped with vibrating plates called "reed" made by a kind of reed (*Arundo donax*). Many musicians claim that the quality of reed changes irreversibly by prolonged playing [Stein 1958; Obataya 1996a], but the mechanism of such irreversible change has not been clarified yet.

Since woodwind instruments are played by the exhaled air of players, the materials of those instruments are exposed to alternate wetting and drying. It should be noted that the reed contains large amount of water soluble extractives, and the extractives affect the vibrational properties of reed [Obataya et al. 1999]. Therefore, the loss of extractives due to playing i.e. wet-dry cycles may affect the quality of reed.

Another explanation for the irreversible change in reed property is the recovery of cell collapse. It has been reported that serious cell collapse is induced in the reed during drying, but the collapsed cells can be recovered by alternate moistening and drying [Obataya 1996b; Obataya et al. 2004]. Such a recovery may indirectly affect the performance of reed.

In this study, the effects of wet-dry cycles and moist-dry cycles on the mechanical properties of reed were investigated.

Materials and Methods

Arundo donax harvested for the production of clarinet reed was used. Specimens of 70 mm(L) × 5 mm(T) × 0.5 mm(R) were prepared from peripheral part and inner part of the internodes. For wet-dry cycle and moist-dry cycle test, 9 and 15 specimens were selected, respectively.

The specimens for wet-dry cycles were dried on P_2O_5 under vacuum, and their absolute dry mass was measured. The specimens were then equilibrated at 25°C and 60% relative humidity (RH) for more than 3 days to determine their mass and vibrational properties. Next, the specimens were soaked in water under reduced pressure for 2 hours (wetting), followed by drying at 25°C and 60% RH. And then the vibrational properties of those specimens were determined. That wet-dry process was repeated 14 times. Finally, the specimens were soaked in water for 1 week to remove the water soluble extractives, and their absolute dry mass was determined.

The specimens for moist-dry cycles were moistened at 25°C and 100% RH in a desiccator under reduced pressure for 1 day (moistening). The specimens were then dried at 25°C and 60% RH for 1 day to determine their mass and vibrational properties. That moist-dry process was repeated 6 times.

Results and Discussion

Figure 1 shows the change in extractives content (EC) due to wet-dry cycles. The EC decreased by increasing number of wet-dry cycles. Due to these loss extractives, the mass of specimens decreased.

The dynamic Young's modulus (*E'*) and the loss tangent (tanδ) of specimens decreased by wet-dry cycles. These changes are plotted against EC in Figure 2. Changes in *E*' and tanδ showed linear relationship with EC. That is, the loss of extractives is responsible for the changes in vibrational properties of reed during wet-dry cycles.

Changes in thickness of reed specimens are shown in Figure 3. The specimens became thicker by wet-dry cycles. Such a thickening was due to the recovery of cell collapse which had remained in the specimens.

For musicians, the rigidity of reed (vibrating plate) is an important factor affecting their performance. Since the bending rigidity (*E'I*) of reed depends on its thickness as well as *E'*, we need to consider the abnormal thickness swelling due to the recovery of cell collapse. Figure 4 shows the changes in the *E'I* and resonant frequency (f_r) of the specimens during wet-dry cycles. In many cases, the *E'I* dropped in the early stage of wet-dry cycles, because of the loss of extractives accompanied with significant reduction in *E'*. In some specimens, the *E'I* was once reduced and then turned to increase by wet-dry cycles. Such an increase in *E'I* was due the abnormal thickening resulting in the increase in second moment of area *I*. On the other hand, the f_r values is proportional to the square root of *E'I*/*m*, and the decrease in *m* due to the loss of extractives was large enough to cancel the drop in *E'I*.

Consequently the f_r always increased during wet-dry cycles as shown in Fig.4 (b).

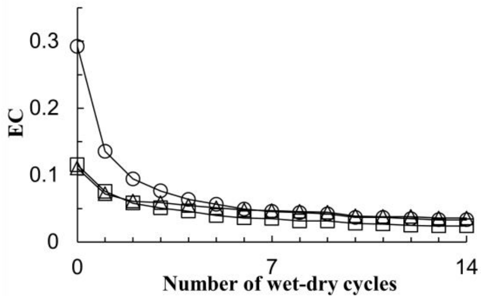

Fig.1. Change in extractives content (EC) of different reed specimens during wet-dry cycles. *Circles*, ρ = 390 kg/m^3; *Triangles*, ρ = 483 kg/m^3; *Squares*, ρ = 563 kg/m^3

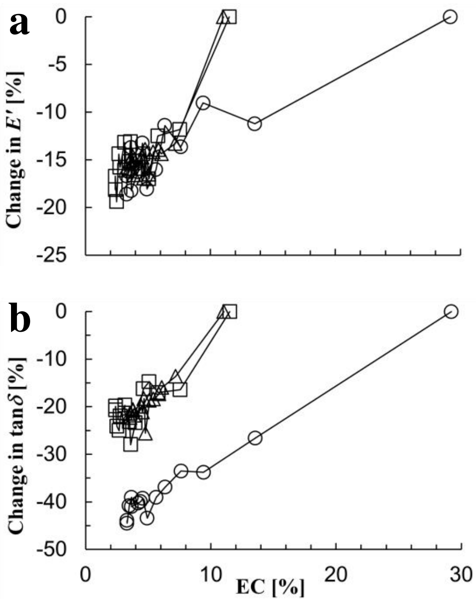

Fig.2. Change in (**a**) dynamic Young's modulus (*E'*) and (**b**) loss tangent (tanδ) of *Arundo donax* specimens during wet-dry cycles plotted against extractives content (EC). See Fig.1 for legends.

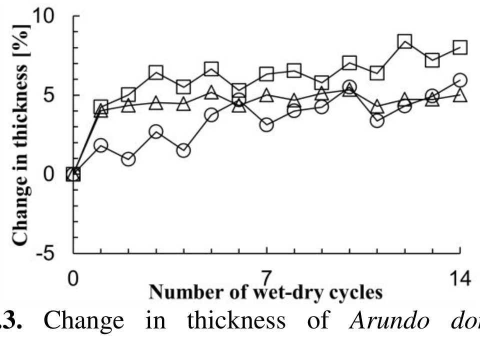

Fig.3. Change in thickness of *Arundo donax* specimens during wet-dry cycles. See Fig.1 for legends.

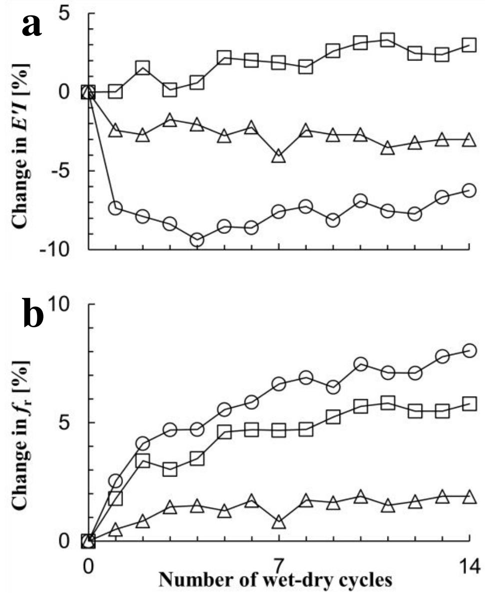

Fig.4. Changes in (**a**) bending rigidity (*E'I*) and (**b**) natural frequency (f_r) of *Arundo donax* specimens during wet-dry cycles. See Fig.1 for legends.

The changes in vibrational properties and dimension during moist-dry cycles were qualitatively similar to those of wet-dry cycles, whereas the former is slighter than the latter. All those results suggested that the practical performance of woodwind reed would change irreversibly during continuous usage.

The recovery of cell collapse is a particular phenomenon in reed, but the loss of extractives can occur in the other woody materials. It should be noted that the extractives affect the mechanical properties of wood, and that these can be lost from the wood cell wall by moist-dry cycles, even in the absence of liquid water. Thus, the effects of moist-dry and wet-dry cycles are to be considered when the material contains water soluble and/or deliquescent extractives.

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