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Haskaop Harvester *

— Part 2: Separation of Haskaop Berries and Leaves —

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Abstract

In order to separate haskaop berries from other materials during harvest by vacuum suction, a vertical separation column was built where specific weight separation would take place. The results showed that the most suitable configuration of the separation column without damage to berries was one with an inlet pipe through the berry bin. This generated vertical air flow throughout the separation column. Thus, leaves were always suspended in the column. When berries entered the column, air velocity decreased, and berries fell into the berry bin. The required air velocity in the transportation pipe was more than 22 ms^{-1} to move the heaviest berries. The required air velocity in the separation column was more than 4 ms^{-1} where the heaviest leaves could remain aloft and be separated from the berries.

[Keywords] haskaop, berries, leaves, separation, separation column

I Introduction

When haskaop berries (Fig. 1a) are harvested by vacuum suction, leaves (Fig. 1b) and other trash are removed from the tree together (Konno *et al*., 2009a). In order to collect the berries alone, we designed and built a separation column. In the previous paper (Konno *et al*., 2010), the drag coefficients (Wakabayashi, 1949) of the haskaop berry and leaf were determined to be different, and so the terminal velocity of the haskaop berry calculated to be 9.1-19.1 ms^{-1}, and that of the leaf was 1.21-2.35 ms^{-1} (Table 1). From these results, an experimental separation column was constructed (Fig. 2). An air velocity of 5 ms^{-1} for instance in the column should permit the separation of the berries from leaves by specific weight separation. Therefore, this paper deals with the development of a prototypical separation device for the haskaop berries without damage.

II Equipment and Procedures

Two kinds of the separation columns (No. 1 and No. 2) were built (Fig. 3). A vacuum cleaner (1.2 kW) was used as the vacuum suction. In order to vary the air velocity in the column, air plugs with different hole sizes (Fig. 4) were placed in the air passage (Fig. 3). The No. 5 air plug had no

Fig. 1 (a) Haskaop berries; (b) haskaop leaves.

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Fig. 2 Experimental separation column.

hole. The air velocity was measured by a commercial hot-wire anemometer. At each air velocity, 10 units each of the berries and leaves were fed into the throw port. At the leaf outlet (dust tank) and the berry outlet (berry bin in Fig. 3), the number of acquired specimens was counted.

The mass of the individual haskaop berry was in the range of 0.2-1.0 g(unit)$^{-1}$ (Konno *et al*., 2009b). We classified these berries into 4 groups [0.2-0.4, 0.4-0.6, 0.6-0.8, and 0.8-1.0 g(unit)$^{-1}$] (Table 2). Ten berries of each mass group were fed into the throw port.

The mass of the haskaop leaf varied as 0.05-0.5 g(unit)$^{-1}$ (Konno *et al*., 2009b). We also classified these haskaop leaves into 4 groups [0.05-0.1, 0.1-0.2, 0.2-0.4, and 0.4-0.5 g(unit)$^{-1}$] (Table 2). Ten leaves of each mass group were also fed into the throw port.

III Results and Discussion

1. The configuration of separation column

The No. 1 separation column (Fig. 3a) was built first. The throw port is in the middle of the column. Berries fell easily down into the berry bin; however, when leaves were provided to the column, only the leaf that flew around point A (Fig. 3a) by chance fell down into the berry bin because there was air flow with low velocity (≤2.35 ms^{-1}) at the point A and the leaf could not be suspended in the separation column. Therefore, the No. 1 separation column had a weakness in which the separation of the leaves was uneven.

Table 1 Drag coefficient, terminal air velocity and required a velocity of haskaop berries and leaves

	Drag coefficient C_D	Terminal air velocity v_t, ms^{-1}	Required air velocity v_t, ms^{-1}
Horizontal berry	0.959-2.21	9.1-13.8	22(pipe)
Vertical berry	0.322-0.977	11.0-19.1	22(pipe)
Leaf	0.622-2.36	1.21-2.35	4(column)

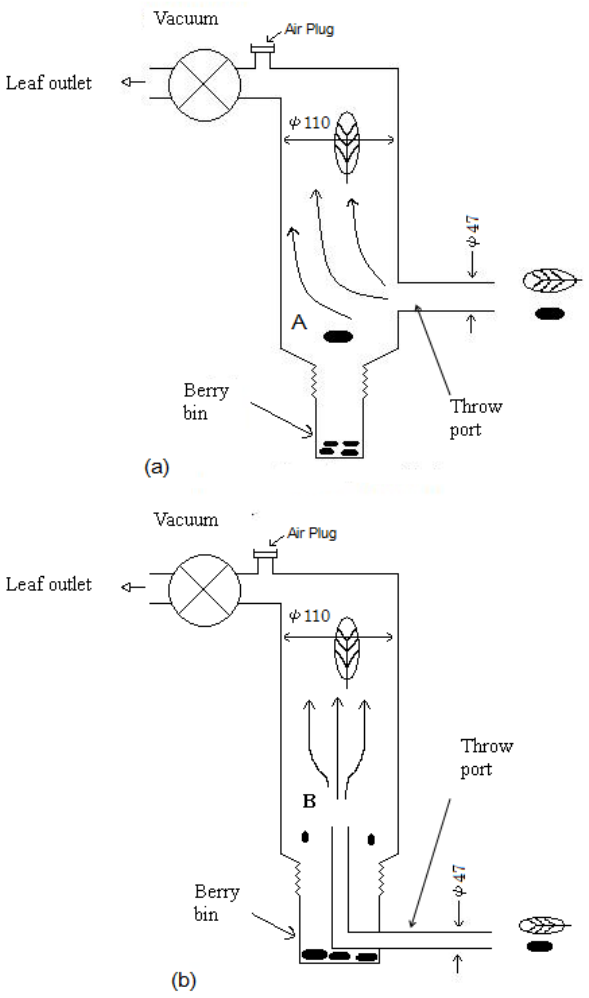

Fig. 3 Experimental separation columns. (a) No. 1 column; (b) No. 2 column.

Fig. 4 Air plugs for adjustment of air velocity [L-R, No. 1 (35 mm hole), No. 2 (30 mm), No. 3 (25 mm), No. 4 (20 mm) and No. 5 (0 mm)].