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Effects of Root Washing, Culling, and Extraction Method on TK Rubber Yield and Purity

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INTRODUCTION

Natural rubber is a critical raw material primarily produced in Asia from a single plant species (*Hevea brasiliensis*)[1]. A lack of biological and geographic diversity and increasing demand makes it imperative that alternative sources of NR are developed. *Taraxacum kok-saghyz* (TK) is a rubber-producing dandelion that produces rubber in its roots with properties nearly identical to rubber from *H brasiliensis and* is being developed as an alternative source of natural rubber at OSU by the Program of Excellence in Natural Rubber Alternatives (PENRA).

Planting, harvesting, and post harvest treatments for TK roots are currently under development. Harvested, field grown TK roots typically contain both soil and non-TK plant material as contaminants. Both of these could adversely affect rubber recovery and purity. However, the extent of this contamination and its effects on rubber yield and purity is not known.

In this study, TK roots harvested in December 2016 from fields planted in Spring of 2016 were separated into four groups and TK natural rubber (TNR) was recovered using mechanical (Eskew)[2] and enzymatic (PENRA III)[3] processes. One group consisted of the roots as they were harvested while another group consisted of the same roots washed with water. A third group consisted harvested roots culled to remove non-TK material and a fourth group was both culled and washed.

The four groups were boiled in water to remove inulin and water extractable material and the TNR was separated using the mechanical (Eskew) or enzymatic process (PENRA III). The relative yields and purities of the TNR obtained were compared.

MATERIALS AND METHODS

A representative sample of TK roots was harvested on 12/2/2016 from a large field planting of TK in western Ohio. The roots were separated into four groups and dried at 54˚ C. One group was washed with water to remove soil (Fig. 1), one was culled to remove non-TK material, and another was both washed and culled.

The four groups of the dry TK roots (100 g) were extracted 6 times with a 1:10 volume of 90˚ C water. The hot water extracted roots were then processed to separate TNR using either a mechanical (Eskew)[2] or enzymatic (PENRA III)[3] process.

For the mechanical process, extracted roots (160 g wet) were diluted with DI water (1 L) and pebble milled for 20 min. Rubber was separated by flotation, resuspended and milled a second time. The TNR was collected by flotation, dried at 60˚ C and weighed.

For the enzymatic process, extracted roots (160 g wet) were amended with acetate buffer (pH 5.0), cellulase (XC150 + Accellerase 1500) and/or pectinase (XPE60) and incubated at 50˚ C and 150 RPM for 48 hours. The milled slurry was placed in 50 ml centrifuge tubes and centrifuged at 500xg to separate rubber and bagasse. The separated TNR was resuspended in DI water and centrifuged a second time, then dried at 60 C and weighed.

Rubber purity for all samples was determined by dissolving the dried TNR in mineral spirits at 150˚ C and passing the solution through a 40 um stainless steel screen. The material that did not pass through the screen was dried and its mass was determined gravimetrically[4]. The amount of pure TNR recovered was calculated by multiplying the yield of recovered material by the purity.

RESULTS

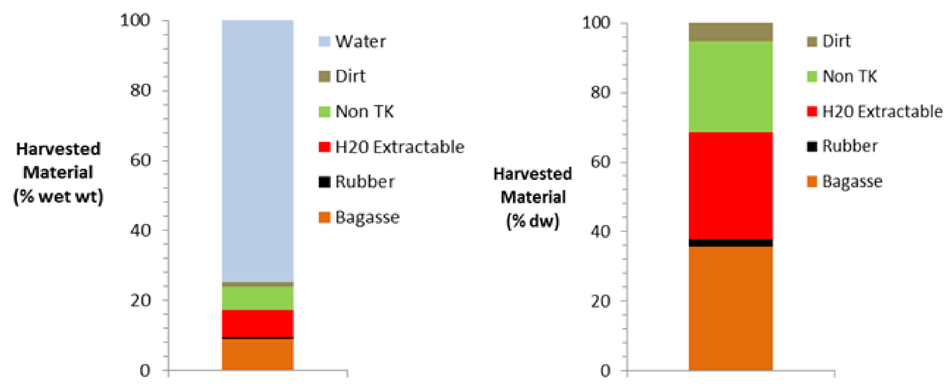

Figure 2. Components of field harvested TK roots on a wet (left) and dry basis (right).

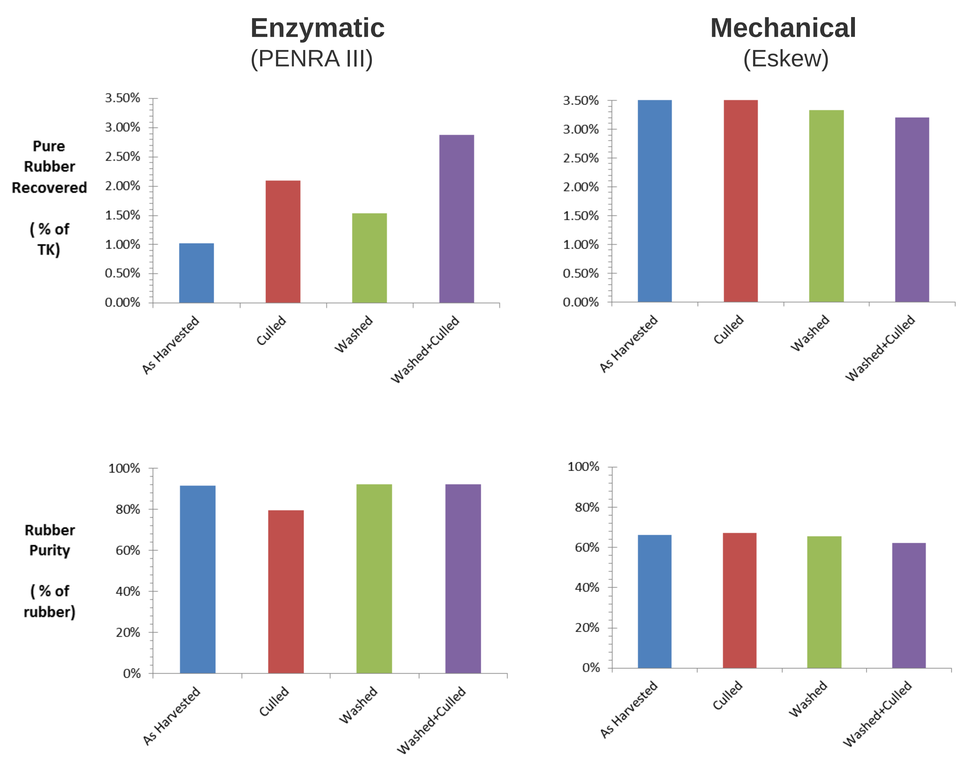

Figure 3. Effects of washing, culling and processing method on TK natural rubber recovery and purity. Values are % pure dry rubber per gram of TK roots.

The harvested material had a moisture content of 76% (wet basis) and contained 5% soil, 26% non-TK material, 31% hot water extractable material, and 2.2% TNR on a dry weight basis (Fig. 2).

The amount of pure TNR recovered using the mechanical process was greater than that recovered using the enzymatic process and there was less impact of washing and culling. Yields of pure TNR from the mechanical process ranged from 3.1% to 3.5% (Fig. 3).

For the enzymatic process, the amount of TNR recovered was dramatically affected by washing and culling the roots (Fig. 3). The TNR recovered ranged from 1% to 2.9% corrected for the amount of TK roots in the samples. Less TNR was recovered from washed and culled roots when pectinase alone was used (2.6%), than when cellulase and pectinase were used (2.9%).

The purity of the material recovered using the enzymatic process was greater than 92% for 3 of the 4 treatments (Fig. 3). However, much less pure TNR was recovered when the roots were not washed or culled (Fig. 3).

The purity of the mechanically processed TNR was less than 70% (Fig. 3). Washing and culling had little effect on recovery or purity of TNR using the mechanical process (Fig. 3).

Figure 1. Field harvested TK roots used in this study. As harvested (left) and after washing (right).

CONCLUSIONS

Washing and culling TK roots had a dramatic effect on the amount of TNR recovered when an enzymatic process was used, but not when a mechanical process was used. For the enzymatic process, the greatest recovery (2.9%) and purity (92%) was obtained with washed, and washed and culled, TK roots. However the purity of the recovered TNR was less affected by culling and washing.

The amount of TNR recovered using the mechanical process (3.6%) was greater than that recovered using the enzymatic process (2.9%). However, the purity of mechanically processed TNR was low (<70%).

ACKNOWLEDGEMENTS

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(4) ASTM D1278-91. Standard Test Methods for Rubber from Natural Sources