OHIO AGRICULTURAL RESEARCH AND DEVELOPMENT CENTER

Compositional Analysis as a Tool to Improve the Processing of *Taraxacum kok-sahgyz* Roots

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INTRODUCTION

Natural rubber (NR) is an essential raw material used throughout the world. In 2014, the US imported $9.6x10^8$ kg of NR at a total cost of US$2 billion (1, 2). Currently there is no NR produced domestically for commercial purposes and nearly 100% of it is produced in Asia from a single plant species (1, 2). This lack of biological and geographical diversity, coupled with burgeoning demand, makes it imperative that alternative, domestic rubber sources are developed. Ohio, the center of the US rubber industry, has addressed this need through the creation of an academic/industry consortium called PENRA led by OARDC. The goal of PENRA is to develop a rubber-producing dandelion, *Taraxacum kok-saghyz* (TK), as a commercial viable alternative source of high molecular weight NR. A pilot processing plant at OARDC has been funded by the state. However, the current process produces rubber that does not meet industrial purity specifications and value added uses for the inulin syrup and bagasse coproducts have not been fully explored. In order to commercialize TK, improved processes for the recovery of natural rubber and coproducts are needed.

AIM

The objective of this research is to generate a detailed reference, chemical compositional analysis of TKS roots and impurities remaining in TK NR produced by the current PENRA process. This will inform the design and development of processes to improve rubber purity and recover NR that meets industry standards. Also, compositional analysis may identify and quantify valuable co-products in TK roots.

METHODS

TKS roots were harvested from field plantings in Ohio in 2014. Roots were washed, dried, then chopped and flattened into 2 cm pieces, combined and thoroughly mixed generating a batch of 188 kg dry roots. A 3 kg representative subsample was taken and used to generate a reference compositional analysis. The current PENRA process (III) was use to extract rubber from the remaining dry roots (185 kg). "Dirt" content in the separated rubber was measured according to ASTM-D1278-91a and the non-rubber fraction (impurities) were recovered. Wet chemistry methods (Fig. 1), based on NREL protocols for biomass compositional analysis (3), were used to identify and quantify components in the whole TK roots and in the impurities. Additionally, SEM micrographs of TK NR from different steps of the PENRA III process were taken. Rubber molecular properties were characterized by gel permeation chromatography.

Figure 1. Flow chart for the analysis of TK roots and impurities in TK NR.

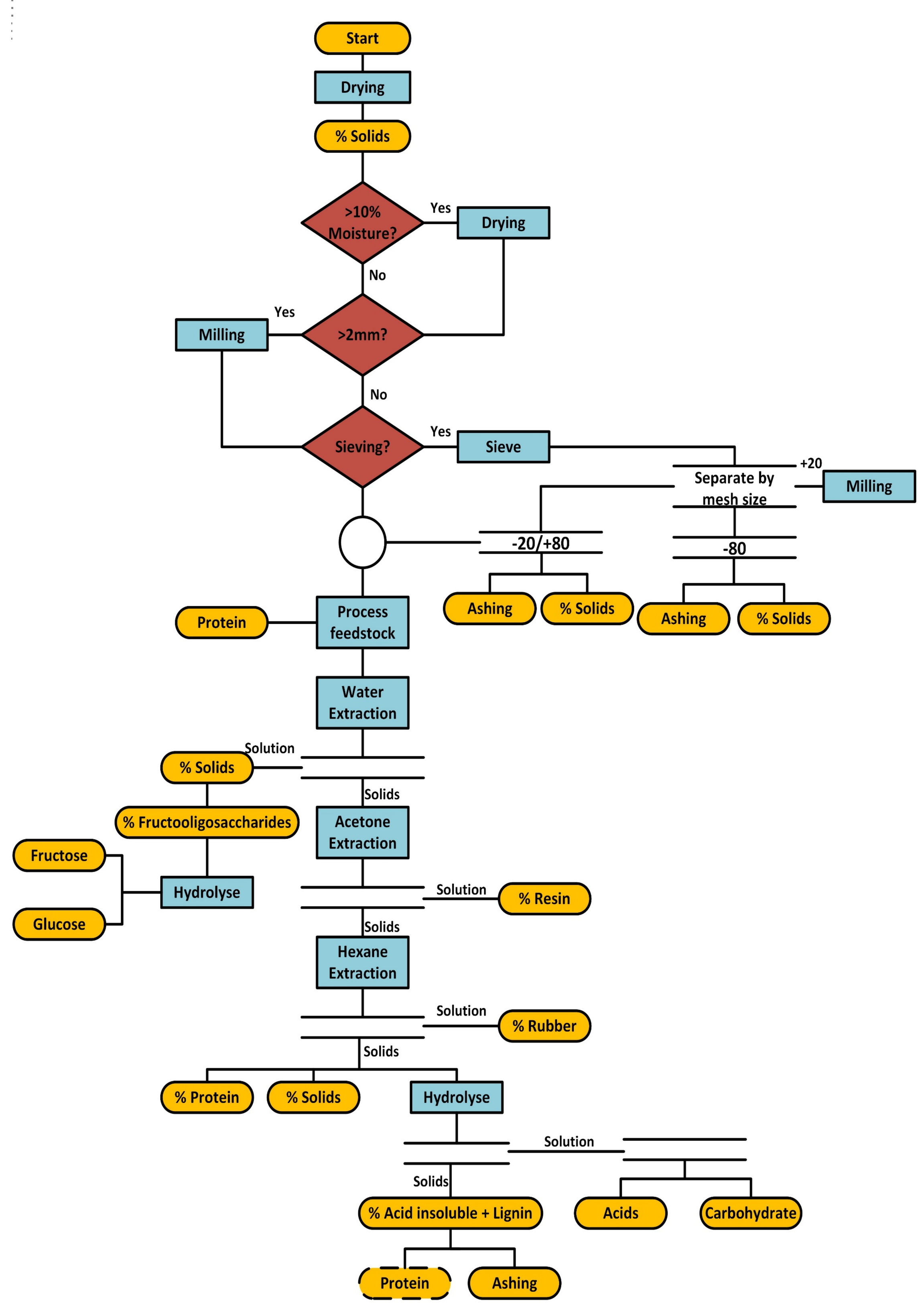
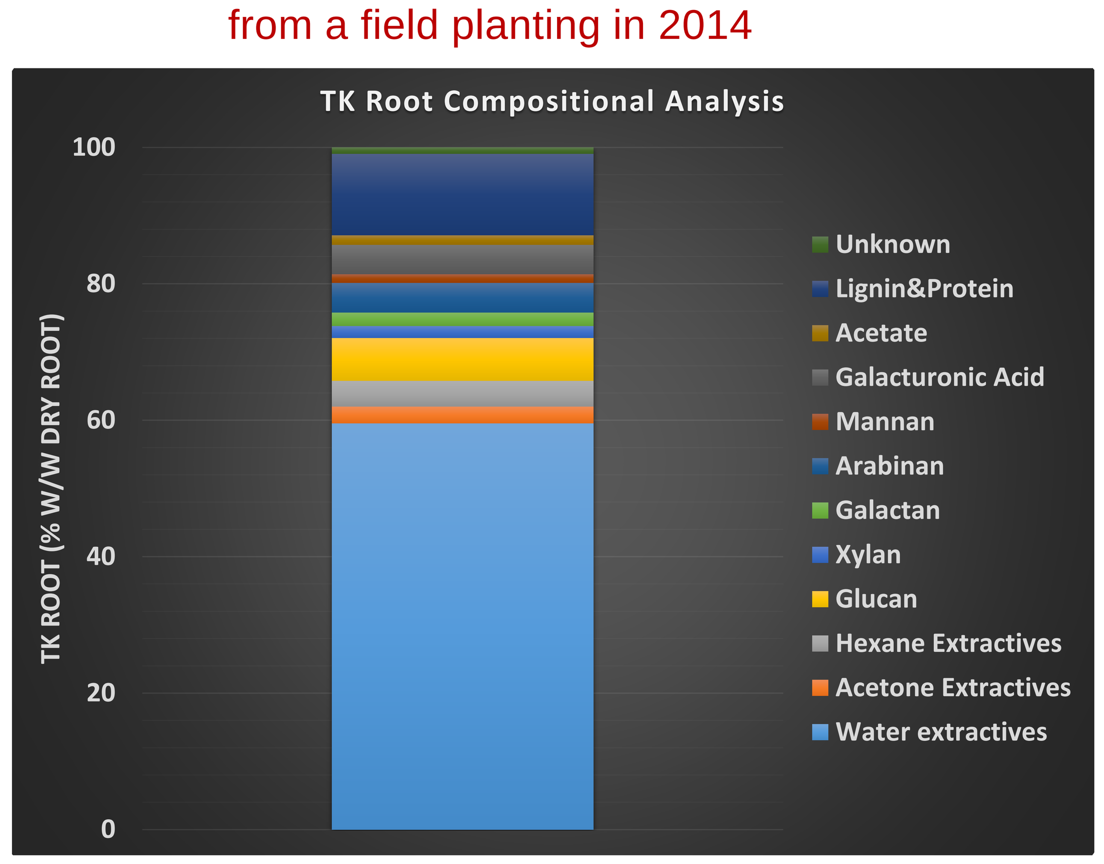


Figure 2. Compositional analysis of TK roots harvested from a field planting in 2014



RESULTS

The compositional analysis for TK roots and rubber impurities had a greater than 99% and 83% mass closure, respectively.

NR represented 3.8% w/w dry root (Fig. 2) with Mn 249,409 g/mol, Mw 1,059,213 g/mol, Mz 3,263,053 g/mol, and polydispersity of 4.3 Mw/Mn.

Water soluble extractives were the major component in TK roots at 60% w/w dry root (Table 1). The most abundant water soluble subfraction was soluble sugars representing 32% w/w dry root (53% w/w water extractives). Inulin (a valuable food thickener and sweetener) was the main soluble sugar at 17.5% w/w dry roots (Table 1). Insoluble components included cellulose (glucan), hemicellulose (xylan, mannan, arabinan, acetate, galactan, galacturonic acid), lignin and proteins, at 6%, 15%, and 12%, w/w dry root, respectively (Fig. 2).

Table 1. Main water soluble compounds in TK roots

Component	% w/w dry TK root
Ash	11
Water extractives	60
Water soluble sugars	32
Inulin	17.5
Nystose	1
1-Kestose	1.2
Sucrose	9.8
Glucose	0.5
Fructose	1.7
Water soluble cations	1.6
Water soluble anions	0.7

Figure 3. Compositional analysis of impurities recovered from TK NR produced by PENRA in 2014

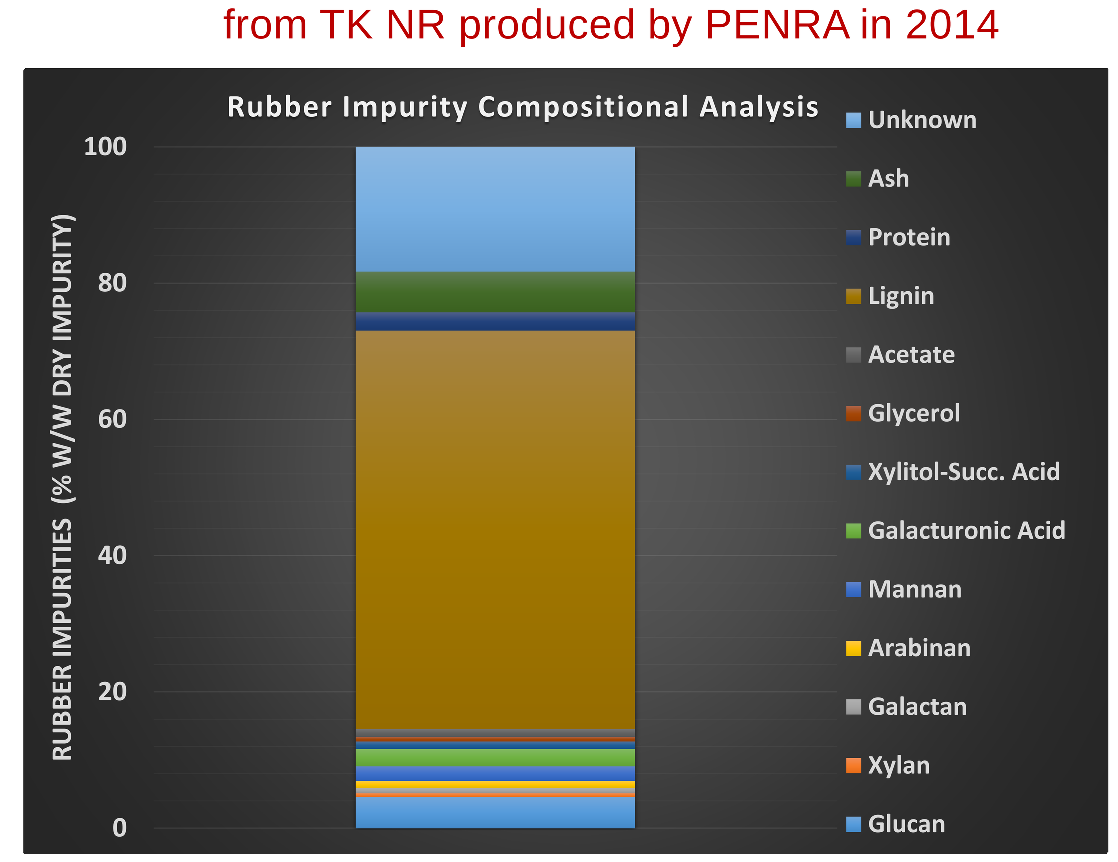
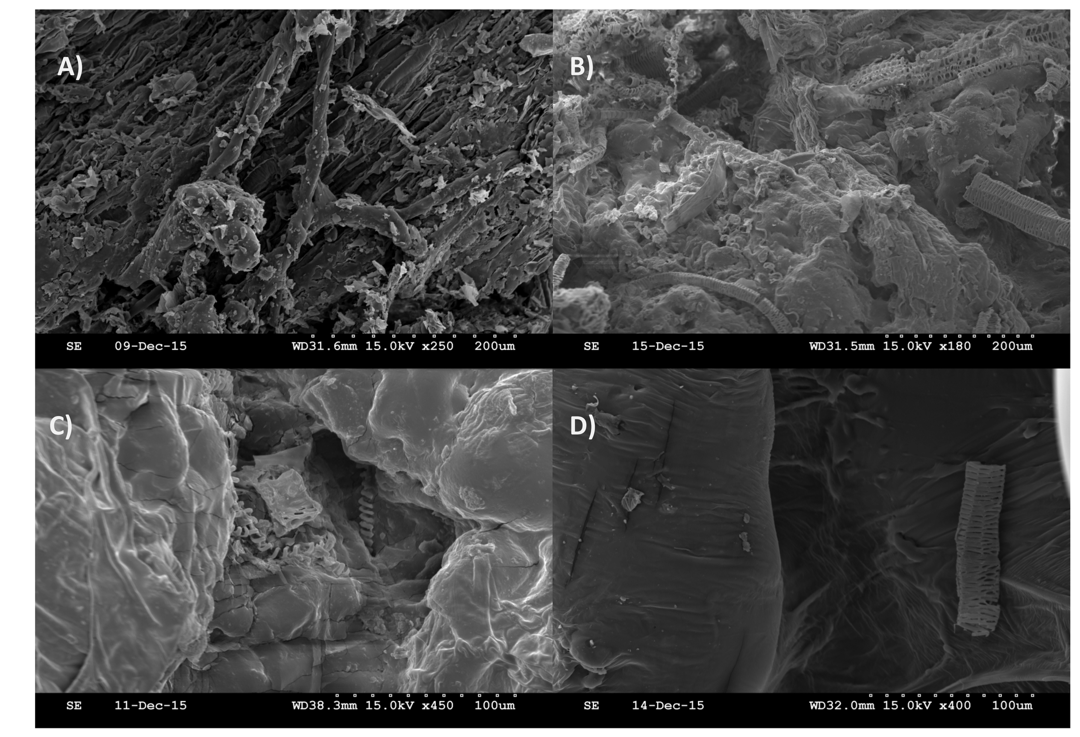


Figure 4. SEM pictures of TK NR from different steps of PENRA process



A) NR rubber in TK root; B)TK natural rubber after PENRA III enzymatic hydrolysis; C) TK natural rubber after PENRA III enzymatic hydrolysis and pebble milling; D) TK natural rubber purified by PENRA industry partners by solubilization, filtration, and solvent stripping.

The compositional analysis of rubber impurities showed that the main rubber contaminant was acid insoluble organic matter (mainly lignin and proteins) at 58%. Other important rubber contaminants components were hemicellulose (8%) and cellulose (4%) (Fig. 3). The mass closure for rubber impurities was lower than for TK roots because of unidentified components.

SEM pictures for different steps in the PENRA III process confirmed that the main rubber impurities were root skin and xylem structures which are known to consist of hemicellulose and lignin (Fig 4).

CONCLUSIONS

The composition of rubber impuritites has been determined and can be used to focus additional purification approaches for their removal. A reference root composition analysis has been generated which will allow differences in root composition across germplasm, seasons and cultivation practices to be assessed, and processing to be modified to adjust to feedstock differences as needed. Future process development should target lignin and hemicellulose in order to obtain TK NR that can meet more industry standards.

ACKNOWLEDGEMENTS

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