Towards the identification and location of the biochemical drivers of natural rubber unique structure and properties

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Abstract

Hevea brasiliensis trees produce natural rubber latex that can be transformed into dry natural rubber (NR). This biopolymer displays very specific properties unequalled so far by synthetic rubbers produced from fossil carbon sources. Nevertheless, NR also comes with disadvantages including the variability of its properties, and a dynamic of structuration during storage, usually called "storage hardening" [1-3] the mechanisms of which are still not fully understood. Some results from "RUBBex", an on-going international project supported by French National Research Agency (ANR) will be presented. One of the objectives of this project is to identify and locate the main biochemical components of latex that drive NR quality consistency and the ability of raw NR structure to evolve during storage.

Fresh Hevea latex is able to segregate into four fractions by centrifugation: the cream, the skim, the C-serum and the bottom fraction (made mainly of lutoids) [4-7]. Each fraction was analyzed to provide a qualitative and quantitative description of its biochemical composition (*i.e.* lipids, proteins, minerals, carbohydrates). The fractions obtained from the same latex were remixed into several controlled combinations and the rebuilt latex was used to prepare Air Dried Sheet (ADS) rubber sheets. This protocol was performed thrice on lattices harvested from 2 genotypes (RRIM600 and PB235) at different seasons. The obtained ADS rubber samples were submitted to a large panel of analytical characterizations, either chemical (lipids, nitrogen, mineral, FTIR), structural (molar mass distribution, gel) or physical (Initial plasticity P_0, Plasticity Retention Index (PRI), Accelerated Storage Hardening Test (ASHT)).

For both genotypes, the cream was the largest fraction of fresh latex (37.5% and 51% w/w fresh latex for RRIM600 and PB235 genotypes respectively) while skim was the smallest one (9% & 11% w/w fresh latex). On a dry matter basis, skim was twice more concentrated in lipids and proteins as compared to cream. In addition, minerals were mainly found in serum and lutoid

fractions while almost not detected in rubber-containing fractions. The latex biochemical composition was compared with that of the corresponding ADS rubber. The quantitative effects of the presence of specific centrifugation fractions (*i.e.* lutoid and/or serum) on the structure and properties of ADS rubber material will be presented. For example, ADS rubber samples made from lutoid- and serum-deprived latex were those that showed the lower initial plasticity (P_0) and Delta P (ASHT). In addition, differences between genotypes in terms of biochemical compositions, rubber structure and properties will be underlined. For example, the storage hardening behavior of RRIM600 clone (significant increase of P_0 and of gel) was found to be very different from that of PB235 clone (low or no hardening).

This multidisciplinary project provides a significant amount of data that will allow the localization in latex and ease the ranking by order of importance of the biochemical drivers of natural rubber quality.

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