Lipid Composition of Natural Rubber Sheet and Relationship with its Structure and Properties

Sirlukk Liengprayoon 1, 2, Frédéric Bonfils 3, Jérôme Sainte-Beuve 3, Klananor Sirioth 4, Eric Dubreucq 3, Laurent Vayasse 3
1 - Montpellier SupAgro, UMR IATE, Montpellier, 2 - Kasetsart University, Faculty of Agro-Industry, Bangkok, Thailand,
3 - CIRAD, UMR IATE, Montpellier, France, 4 - CIRAD, UMR IATE, Bangkok, Thailand

1. Present situation of natural rubber

Lipid Composition of Natural Rubber Sheet and Relationship with its Structure and Properties

Sirlukk Liengprayoon 1, 2, Frédéric Bonfils 3, Jérôme Sainte-Beuve 3, Klananor Sirioth 4, Eric Dubreucq 3, Laurent Vayasse 3
1 - Montpellier SupAgro, UMR IATE, Montpellier, 2 - Kasetsart University, Faculty of Agro-Industry, Bangkok, Thailand,
3 - CIRAD, UMR IATE, Montpellier, France, 4 - CIRAD, UMR IATE, Bangkok, Thailand

1. Present situation of natural rubber

1.1 World elastomer market

Presently, around 93% of the world production comes from Asia as shown in the figure, the major producers being Thailand (23.5%), Indonesia (27.3%), Malaysia (13.3%) and India (8.8%).

For Thailand, the exported NR products are block rubber (37% of exported products and mainly STR20), rubber sheets (33%, mainly Rubber Latex 10), and latex (6%, mainly R 13).

In year 2007, total production of natural rubber over the world stood at about 9.73 million tons all over the world (IRSG, 2008). Thanks to certain unqualitied properties, natural rubber (NR) keeps its share in world elastomer markets with around 40% for more than 15 years.

1.2 Natural rubber structure and properties

Natural rubber structure is more complicated than the one of its synthetic counterpart (Bonfils and Vayasse, 2003). Apart from its 100% cis-configuration polyisoprene, natural rubber contains 3.5% of non-isoprene component, a part that could not be mimicked by chemical synthesis. This non-rubber fraction has been suspected to be responsible for both superior properties and inconsistent quality of natural rubber.

2. Research question

Lipids have been described to play roles on some rubber properties in both raw and Vulcanized states. Unfortunately, obtained results are hardly comparable due to the difference of rubber sources, method of extraction and analytical techniques. Only one comprehensive work dealing with the eventual relationships between lipid composition and the lack of consistency of natural rubber properties has been published (Haasma, 1984).

Our research question was : 
"18 LIPID COMPOSITION RELATED TO THE LACK OF CONSISTENCY OF NATURAL RUBBER PROPERTIES?"

4. Methodology

The sampling were carried out in the plantation of Vishaakit Thai Rubber Co., LTD in Chantaburi province, Thailand. Four popular rubber clones were chosen: RRIM600, GT1, BPM24 and PB235. Unsmoked sheet (USS) was proved to be similar as ribbed smoked sheet (RSS) in terms of properties (Rothdahslwal et al. 2008) was used as dry rubber model.

Lipids from fresh latex and dry rubber were extracted after methilisation optimization (Liengprayoon et al. 2008). The analyses performed for each sample are presented in the scheme below.

5. Lipid composition of natural rubber

Lipids from fresh latex from four H. brasiliensis clones were characterized and found to be clonal dependent (2.5 – 3.7% w/w dry rubber). PB235 clone was the highest lipid containing clone followed by BPM24, RRIM600 and GT1. The amount of lipids in USS was found to be lower (2.0 – 3.3%) than in latex but the ranking remained the same. Comparison of lipid classes between fresh latex and USS revealed that the quantity of polar lipids in USS decreased by around 50% for glycolipids and 80% for phospholipids from their initial quantity in latex. This change could be due to enzyme-catalyzed hydrolisis as lipoase activity was observed in fresh latex. However, the clonal specificity of lipid profile observed in fresh latex remained unchanged in the corresponding sheet rubber.

From various chromatographic analyses, precise structural information could be obtained. Furan fatty acid (FFA) clearly distinguished PB235 from the other clones as this typical fatty acid represented more than 70% of its total fatty acid content, while linoleic acid (C18:2) was the main fatty acid in the other clones. Among the detected compounds in unsaponifiable fraction, β-sitosterol was the major sterol in every clone. Moreover, the presence of Δ 9-avrenstanol which was previously claimed to be fuscosilate was proved in this study. The structural analysis of fresh latex polar lipids using HPLC/MS/MS showed that both FFA and Δ 9-avrenstanol were more present in natural lipids and glycolipids than in phospholipids for every clone even in PB235.

In parallel with lipid analysis, USS samples were characterized for their structures and properties in order to identify possible correlations.

6. Relationship between lipid composition, structures and properties of NR

The variability of the collected data from 15 samplings (April 2004 – December 2006) i.e. lipid composition, natural rubber structure (molar mass distribution and gel content) and properties (PRI, PBR, breakdown and vulcanization behavior) was represented using principle component analysis (PCA) as shown in figure below.

From further pair correlation determined by analysis of variance with an observed significance probability less than 0.05 (P ≤ 0.05), lipids was found to correlate with various natural rubber structures and properties. Some examples are illustrated below.

Negative correlation between P 0 and total lipids, neutral lipids and fatty acids (α) especially esterfied form of furan fatty acid which indicated a plasticizing effect of lipids. This effect resulted in the drop of consumed energy during mastication assessed by Breakdown Index method (b).

7. Conclusions and perspectives

This study permitted a characterization of lipid composition, structures and properties of fully identified natural rubber samples from various Hvea clones, collected in a database. This allowed through statistical analyses, to provide an overview of the relationships between lipid composition and natural rubber properties. It can be seen that lipids display both advantage and disadvantage effects on natural rubber properties. Some involvements with structures of natural rubber have also been mentioned. Moreover, USS rubber displayed a high but narrow range. With the knowledge from this work, further studies are in progress using a similar approach with various rubber types whose cover a wider range of values.

References

1. ISSO report, vol. 7, No. 11-12 May-June 2008
2. The ministry of commerce report 2008 "The Rubber International
7. Rothdahslwal et al., 2008, Material et. al, 2007, Recherche Agronomique pour le Développement
8. Thai ministry of commerce report 2003
10. Visakhit Thai Rubber Co., LTD in Chantaburi province, Thailand

This poster is the part of the PR.O. thesis entitled: "Characterization of lipid composition of sheet rubber from Hvea brasiliensis and relations with its structure and properties", Liengprayoon S., 2008

IPRSS Natural Rubber Conference, 13-15 October 2008, Selangor, Malaysia