

## Biolubricants for the textile and tannery industries as an alternative to conventional mineral oils: An application experience in the Tuscany province

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### Abstract

The use of chemical compounds of vegetable origin in industrial production shows several environmentally beneficial effects (renewability, biodegradability, low toxicity, no impact on CO<sub>2</sub> level) over synthetic products presently being widely used.

In this paper, some pre-industrial studies on the potential of substituting in two Tuscan industrial districts some mineral lubricants (mainly alkylbenzene) widely used in textile (spinning phase of wool) and tannery (both in dry and damp phase) processing with formulations based on High Oleic Sunflower Oil (HOSO) will be discussed. This research was carried out by private companies that depend on seed production (farmers and their main associations, Seed Company), oil extraction, refining, and formulation. The new, low environmental impact formulations were tested at an industrial level to verify their application potential from technical, environmental, and economical viewpoints.

The results confirmed that HOSO could substitute mineral oils in textile and tannery applications without any technical problem and without any facility modifications. In some cases such as crust leather production, the HOSO-based lubricant (BIOVIT) improved the softness of the finished product. The environmental impact evaluation carried out by the Eurostat framework of environmental pressure indicators confirmed how a higher sustainability could be obtained by the utilisation of new oils characterised by a higher biodegradability. Finally, the economic analysis showed a higher production cost and price of vegetable oils, but, at the same time, indicated the possibility of reducing the required amount due to a lower utilisation rate. Anyway, the price difference between the mineral and vegetable-based oils has to be limited to arrive at a commercial application. Based on these results, HOSO could represent

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an efficient alternative to mineral oils and so new commercial lubricant called BIOVIT based on HOSO began to be commercialised both for textile and tannery industries.

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## 1. Introduction

Europe uses around 5.3 Gkg year<sup>-1</sup> of lubricant and Italy is the fourth largest user among European countries after Germany, France and UK, with an annual consumption of around 700 Mkg (Europalub, 1999). More than 95% of lubricants used in Europe are derived from synthetic materials, mainly of fossil origin. Around 50% of this wide European market is covered by lubricants for four stroke engines, while more than 1.7 Gkg year<sup>-1</sup> are used as auxiliaries in several industrial productions. This sector comprises hydraulic fluids (750 Gkg year<sup>-1</sup>), oils for steel casting and hardening (450 Gkg year<sup>-1</sup>), while another 400 Gkg year<sup>-1</sup> is used in different industrial productions (viz. textile, tannery, paper production, extractive). Due to the wide and different types of applications, it is often very difficult for the sanitary and environmental authorities to analyse their harmfulness to the environment and control their effective distribution on territory (Cunningham et al., 2003). Moreover if we consider that several of these uses release the oils in the environment after utilisation, there is a strong need for depuration plants to limit their impact on water and/or air quality. In addition, we have to remember that only a fraction, ranging from 50 to 60% (Europalub, 1999) of the mineral oils used in Europe are recovered from official structures and correctly refined after their use.

An industrial lubricant is on average based on mineral derived oils at a rise of 60–99%, depending on the application that requires the presence of specific additives to improve and stabilise oil technical performances (Theodori et al., 2004; Gunstone, 2004). The type of additives used distinguishes each commercial lubricant formulation, while, generally, the qualitative performance of mineral-based oils are very similar for the different formulations. This work was carried out as a Project of Prai Programme “Technological Innovation in Tuscany” named BIOVIT (Vegetable biolubricants for Tuscan industries) financed from Tuscany Region, European Union and Italian Ministry of Economy, with the aim of evaluating, at an industrial level, the potential of substituting some mineral lubricants widely used in textile (spinning phase of wool) and tannery (both in dry and damp phase) processing by formulations based on High Oleic Sunflower Oil (HOSO). The industrial approach

in experimentation of the new formulations obliged in some phases to apply a limited methodology that can be seen as a scientific limit of the work. In the same time, the application of the methods normally applied at industrial level in the evaluation of every new lubricant to verify directly their performances permits a final test on the technical and economical perspectives of HOSO-based lubricant. From an environmental point of view, it is important to emphasize that the new formulations for textile and tannery application satisfy the Directive 2003/53/EC (<http://europa.eu.int/eur-lex/en/index.html>) resulting Nonylphenols and Nonylphenols Ethoxylate free.

### 1.1. Industrial chain organisation

At the beginning of the project, the Agronomy Department of the University of Pisa and the Research Institute for Industrial Crops of Bologna organised, activated and coordinated the entire industrial chain for biolubricant production: all the roles from agriculture to agro-industry to formulation to the final user were covered by Italian private Companies as requested from the European Set aside Reglement. This activity was so articulated:

- *Agricultural production of HOSO.* High oleic sunflower varieties of a Private Tuscan seed Company (Cerealtoscana), selected through traditional genetic improvement and lacking in GMO's, have been produced in the Pisa area in collaboration with the three main Italian agricultural associations (Coldiretti, CIA and Confagricultura), using low environmental impact cultivation techniques.
- *First transformation.* After harvesting, sunflower seeds were transported at Itacol, a Tuscan Company specialized in the oil extraction for alimentary uses. The extracted crude oils were rectified (neutralised, degummed, decoloured, deodorised) with the aim of becoming more suitable for industrial applications.
- *Preparation of the optimum formulation based on HOSO.* The final formulation for textile applications has been prepared in the laboratories of Houghton Italy, while the formulation for tannery application was prepared at Chimont.

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