PROCESS FOR THE PRODUCTON OF SOPHOROLIPID BIOSURFACTANT

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610

MPOB INFORMATION SERIES • ISSN 1511-7871 • JUNE 2012 MPOB TT No. 523

Biosurfactants are natural surfactants derived from microbial origin containing mostly sugar and fatty acid moieties. They have higher biodegradability, lower toxicity and excellent biological activities than their synthetic counterparts. In addition, biosurfactants have better properties with respect to higher foaming capacity and activity at extreme temperatures, pH levels and salinity than the synthetic surfactants which are mostly derived from petroleum. Palm-based sophorolipids (SL) are a group of biosurfactants produced by non-pathogenic yeasts, such as *Candida bombicola, Yarrowia lipolytica, C. apicola* and *C. bogoriensis* (Nunez *et al.*, 2003). SL have also shown to inhibit the growth of *Propionibacterium acne* and *Streptococcus epidemides* (*Figure 1*). The anti-bacterial property enabled SL to be used in personal care products such as deodorants.

SL are produced as complex mixtures containing both the free acid and lactone forms (*Figure 2*). The acidic SL are composed of a free fatty acid tail, while the lactonic SL are formed by an internal esterification between the carboxylic end of the fatty acid and the 4" of the sophorose head. Generally, lactonic SL have better surface tension lowering property and anti-microbial activity, whereas the acidic SL display a better

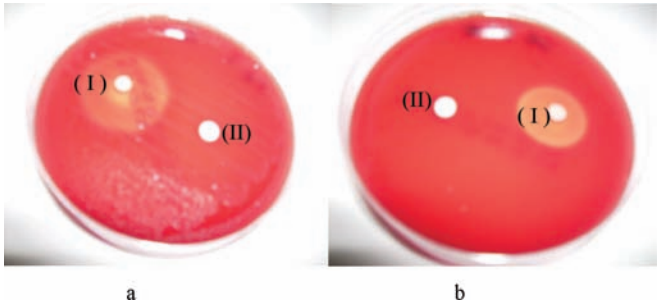

Figure 1. Inhibition of S. epidemides *(a) and P.* acnes *(b) cultures by palm-based liquid deodorant. (I) Sample disc with liquid deodorant showing inhibition zone. (II) Sample disc without liquid deodorant showing no inhibition zone.*

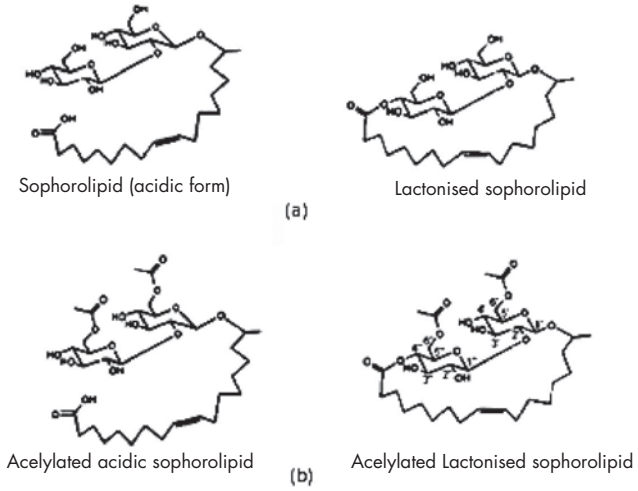

Figure 2. Chemical structures of sophorolipids: (a) acidic and lactonised forms, (b) acetylated acidic and acetylated lactonised forms.

foam production and solubility. However, our experimental results showed that both lactonic and acidic SL lower the interfacial tension between n-hexadecane and water from 40 mN m^{-1} to 5 mN m^{-1} and display stability toward pH (6-9), temperature changes (20°C-90°C) and high salt concentrations. Nevertheless, di- and mono-acetylated lactonic SL display better anti-bacterial activity than the non-acetylated lactonic and acidic forms. The results also showed that the critical micelle concentration (CMC) was 97 mg $litre^{-1}$ SL. This indicated that SL at a very low concentration can reduce surface tension of water.

TECHNOLOGY FOR THE BIO-PRODUCTION OF PALM-BASED SOPHOROLIPIDS BIOSURFACTANT

High yield of SL (*Table 1*) was obtained from the extracellular fluid of *C. bombicola* cultures. The production of SL is enhanced when two types of carbon sources, hydrophilic (glycidic) and hydrophobic (lipidic), are provided. In most cases, glucose is used as the hydrophilic carbon source, while oils, fatty acids, and their corresponding esters or alkanes are used as the hydrophobic substrates. Typically, the medium for production

ISSN 1511-7871
9 771511 787001

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TABLE 1. YIELDS OF YEAST CELLS AND SOPHOROLIPIDS (SL) AND OIL UTILISED DURING SL BIOPROCESS

Medium Composition	Max yeast Cell (g litre^{-1})	Max SL (g litre^{-1})	Oil utilised (g litre^{-1})	$Y_{x/s}$ g g^{-1} substrate	$Y_{p/s}$ g g^{-1} substrate
10% CPO + 10% glucose	19.54	112.4	81.8	0.10	0.57
10% RBD PO + 10% glucose	18.24	165.5	97.0	0.08	0.84

Figure 3. Pilot plant bioreactor.

Figure 4. Harvesting sophorolipids.

of SL contains glucose, an additional hydrophobic carbon source, a source of nitrogen such as low concentration of yeast extract, and favourably, but not essentially, addition of a nitrogen source such as urea or NH^{4+}, citrate, buffering compounds, and a small amount of minerals such as Mg^{2+}, Fe^{3+}, Ca^{2+}, Zn^{2+} and Na^{+}.

ADVANTAGES OF PALM-BASED SOPHOROLIPID BIOSURFACTANT PRODUCTION TECHNOLOGY

Biosurfactants production processes and microbial synthesis are now emerging as clean, non-toxic and environmentally acceptable 'green chemistry' production procedures based on renewable resources.

In particular, the benefits of the technology are:

- mild temperature bioreactor utilisation;
- easy control of processing parameters; and
- high productivity and recovery.

POTENTIAL APPLICATION OF PALM-BASED SOPHOROLIPIDS

The interest in microbial surface active compounds (biosurfactants) has increased especially in the production of detergents, pharmaceuticals, cosmetics and food products. Moreover, they exhibit anti-microbial and anti-viral activities which have great potentials as alternatives to synthetic drugs.

ECONOMIC ANALYSIS

Payback period = 3.5 years.
Return on investment (ROI) = 25%.

CONCLUSION

MPOB has developed a highly efficient green biotechnological process for the bio-production of palm-based SL. Through bioprocess, MPOB is currently producing more than 160 g palm-based SL per litre.

REFERENCE

NUNEZ, A; FOGLIA, T A and ASHBY, R (2003). Enzymatic synthesis of a galactopyranose sophorolipid fatty acid-ester. *Biotechnol. Lett, 25*: 1291-1297.

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