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Liquid-Liquid extraction method for the recovery of gluconic acid from aqueous medium and experimental determination of corresponding distribution coefficients

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PURPOSE OF THE ABSTRACT

The valorization of inedible and waste biomass, mainly towards fuels and chemicals, has received increasing attention over the last couple of decades. In this framework, gluconic acid, a carboxylic acid formed by glucose oxidation, is considered one of the most important platform chemicals derived from biomass, as itself and its derivatives can be utilized in numerous applications in the dairy, beverage and textile industries, as well as in health products and cosmetics. Currently, gluconic acid is produced biotechnologically via fermentation, followed by downstream purification protocols that increase its price and restrict its large-scale production. The recovery of gluconic acid from fermentation broth involves the use of inorganic bases, i.e. to precipitate the corresponding calcium salt, as well as inorganic acids, in order to liberate gluconic acid [1]. Therefore, undesirable salts are formed while the use of inorganic acids and bases is also unfavorable. The most widely applied method for the recovery of chemicals from reaction solutions on industrial level, remains liquid-liquid extraction (LLE) with conventional organic solvents, due to low requirements in terms of equipment and easy implementation [2]. The selection of the proper solvent for LLE of gluconic acid is based on the accurate determination of the corresponding distribution coefficients, which is also the scope of this work. Such data have only scarcely been reported in the literature [3].

In this study, the distribution coefficients of gluconic acid between water and six commonly used industrial solvents (ethyl acetate, MIBK, Me-THF, di-isopropyl ether, dichloromethane and 2-butanol) were determined, at 4 levels of temperature (25-55 oC). The concentration of the acid in the aqueous solution before and after contact with the solvent was determined by Ion Chromatography. The distribution coefficient was calculated according to the equation PA i,j= CA i/CA j , where A is the substance distributing between solvents i (initial solvent) and j (extracting solvent). Subsequently, for the best performing organic solvent the presence of tertiary and quaternary amines as complexing agents for gluconic acid as well as the salting out effect, were also examined.

According to experimental results, it was confirmed that gluconic acid is a very hydrophilic compound which is not easily extracted from water. Among the solvents tested, 2-butanol proved to be the most efficient extracting agent, as almost 50 % extraction of gluconic acid from water was achieved at 45 oC (Figure 1). The possibility of enhancing gluconic acid distribution in 2 BuOH by the addition of inorganic salts, was unsuccessful under the conditions employed, contrary to trioctylamine (TOA), the presence of which improved substantially the extraction efficiency.

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FIGURES

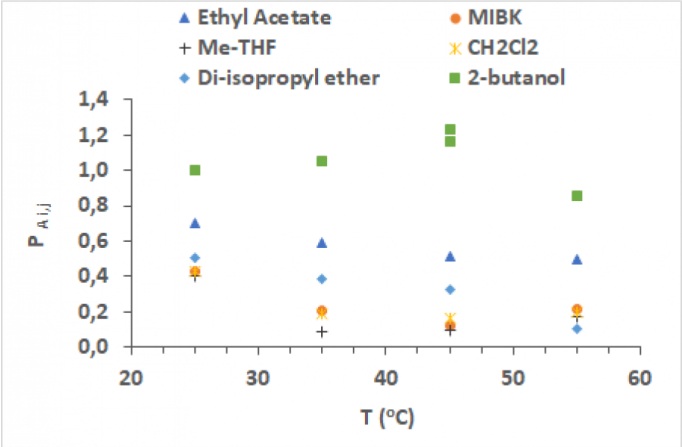

FIGURE 1

Figure 1

Experimentally determined distribution coefficients of gluconic acid between water and the selected solvents

FIGURE 2

KEYWORDS

biomass | gluconic acid | distribution coefficient | liquid-liquid extraction

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