1.0 INTRODUCTION

2,3-Butanediol ($CH_3CHOHCHOHCH_3$) has been known as a bacterial fermentation product since the early part of this century. This is an important chemical feedstock for producing 1,3-butadiene, which is used in manufacturing synthetic rubber. During the World War II, research on the production of 2,3-butanediol by biochemical means was intensified in Canada and USA in anticipation of a shortage of 1,3-butadine. This work was largely discontinued in the face of competition from synthetic 1,3-butadine obtained from petrochemical sources. Following the oil-shocks of the 1970's, interest was rekindled in the production of chemical feedstock and fuels like ethanol, butanol and butanediol from renewable natural resources by fermentation techniques. A chronological development of this process is available in literature (Pirt and Callow, 1958). More recent developments on the fermentation techniques have been reported by Jansen et al. (1984), Sablayrolles and Goma (1984), Ramachandran and Goma (1988), Quershi and Cheryan (1989), Ramachandran et al. (1990), Garg and Jain (1995), Serebrennikov (1995), Nilegaonkar et al. (1996), Ui et al. (1997) and Nakashimada (1998).

Commercial application of 2,3-butanediol is not limited to the manufacture of butadiene or antifreeze. According to Flickinger (1980) a calorific value of 27,198 kJ/kg, diol compares with methanol (22,081 kJ/kg) and ethanol (29,055 kJ/kg) for use as a liquid fuel. Condensation of diol to methyl ethyl ketone (MEK) coupled with subsequent hydrogenation yields octane isomers that can be used to produce high-quality aviation fuels. MEK can also be used as a solvent for resins and lacquers. Esterification of butanediol forms precursors of polyurethane foams. Diacetyl, formed by catalytic dehydrogenation of the diol, is a highly valued food additive. Butanediol has also been shown to have potential application in the manufacture of printing inks, perfumes, fumigants, moistening and softening agents, explosives and plasticizers, and as a carrier for pharmaceuticals (Magee and Kosaric, 1987). 2,3 Butanediol can be used not only to produce a wide range of basic chemicals but also directly as an extraction agent and solvent. Fig. 1.1 shows the most important uses of 2,3-butanediol.

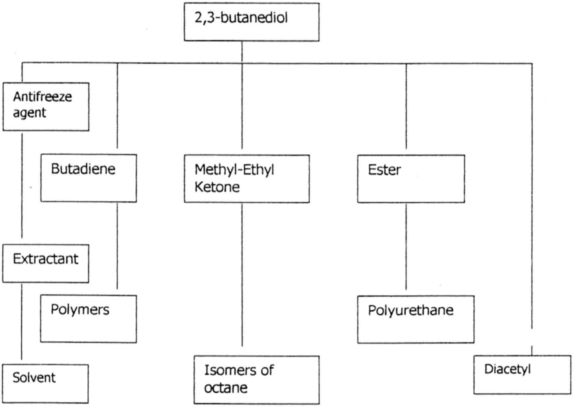

Fig. 1.1 – Applications of 2,3-butanediol (Source: Afschar et al., 1993)

2,3-butanediol is biodegradable which implies it can be used as an environment friendly solvent or cross-linking agent in the production of dyes and polymers. An important advantage of butanediol over ethanol and butanol is that it is much less toxic to the microorganism. Thus it allows a higher product concentration in the fermentation broth. Two bacterial species, *Bacillus polymyxa* and *Klebsiella oxytoca* have demonstrated potential for butanediol fermentation on a commercial scale. *Klebsiella oxytoca* owing to its broad substrate and cultural adaptability, is the most thoroughly investigated organism (Garg and Jain, 1995).

Industrial-scale production of fuels or chemical feedstocks via bioconversion technology requires the availability of substrates that are both abundant and inexpensive. 2,3-Butanediol has been produced from a variety of natural substrates like agricultural residues, sugar beet pulp, wood hydrolysates, food industry waste and waste sulphite liquor from a paper mill (Yu and Saddler, 1982). However, blackstrap molasses, which is abundantly available in sugar cane growing countries, has not been commercially exploited for production of 2,3-butanediol. The term 'blackstrap molasses' is applied to the by-product of sugar production from which no significant additional amounts of sugar can be recovered economically. In this work, blackstrap molasses has been used as the carbon source for producing 2,3-butanediol in a 5L fermenter. There is only one brief report available on fermentation of blackstrap molasses by *Klebsiella oxytoca* (Afschar et al., 1993).

Molasses is abundantly available in Malaysia and there is no available report on its use as a carbon source for 2,3-butanediol production. It is believed that application of molasses in fermentation of butanediol would be commercially more attractive than simple alcohol fermentation.

The objectives of the present work are as follows.

1. To evaluate the suitability of local blackstrap molasses in fermentation of 2,3-butanediol by *Klebsiella oxytoca*.
2. To explore the nature of relationship between butanediol production, sugar utilisation and the dissolved oxygen content in the fermentation broth.
3. To estimate appropriate conditions for fed batch production of 2,3-butanediol from blackstrap molasses.