THE PRODUCTION OF LACTIC ACID FROM WHEY BY CONTINUOUS CULTURE AS A POSSIBLE MEANS OF WASTE DISPOSAL

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ABSTRACT

THE PRODUCTION OF LACTIC ACID FROM WHEY BY CONTINUOUS CULTURE AS A POSSIBLE MEANS OF WASTE DISPOSAL.

A study was made of the fermentation of lactose in lactic casein whey to lactic acid using a strain of Lactobacillus bulgaricus. Both batch and continuous culture were used.

A culture vessel capable of being operated under controlled conditions was designed and built for this study. Temperature, pH, gas atmosphere, degree of agitation and medium flow rate could be altered and controlled.

A meter was developed for the continuous measurement of lactic acid production. The meter used a capacitance probe to measure the volume of alkali added to the culture to maintain a constant pH.

The kinetics of lactic acid production in a batch culture of whey were characterized by :

$$\frac{dP}{dt} = \left(\alpha \frac{dN}{dt} + \beta N\right) \quad \frac{P_m - P}{K_p + P_m - P}$$

The kinetics of bacterial cell growth were consistent with the normally accepted Monod equation but no direct verification of this was made.

A notable feature of the production of lactic acid in a batch culture was the considerable amount of lactic acid formed by non-dividing bacterial cells. More than 50 percent of the acid produced during a batch culture was synthesised while the cell population was in a stationary growth phase.

The maximum cell number was not limited by the concentration of lactose. Supplementation with tryptophan, casamino acids and a number of vitamins increased the cell population and the rate of acid production and decreased the batch time. Sodium caseinate was a good source of essential and stimulatory nutrients.

The optimum heat treatment of the whey involved heating to 69°C.

In unsupplemented whey the removal of suspended material by centrifuging and filtration prevented the formation of acid. To maintain maximum acid formation rates the impeller Reynolds number had to be greater than 10,000.

The presence of oxygen prevented the growth of the bacterial cell population, but once the maximum cell population had been reached oxygen did not effect the acid synthesis.

In a single stage continuous culture reactor the concentration of lactic acid was given by :

$$P = N\left(\alpha + \frac{\beta}{D}\right)\frac{P_m - P}{K_p + P_m - P}$$

The constants were determined from batch culture data.

A single stage continuous culture is not suitable for the conversion of all the lactose in the whey to lactic acid. If lactic acid production by continuous culture is to be considered as a means of waste disposal it will be necessary to use feed back of cells to a single - stage reactor or multi-stage stirred tanks.

In continuous culture studies it was shown that the optimum temperature for the fermentation of lactic casein whey was 46°C. A pH in the rage 5.4 - 6.0 was best. Outside this range, productivity and yield were decreased.

It can be concluded that though continuous production of lactic acid from whey is feasible, multi-stage continuous reaction systems and/or cell feedback are necessary to reduce the lactose concentration to an acceptable level. The whey should be supplemented with a source of amino acids.

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TABLE OF CONTENTS

FIGURES

TABLES