Yeast Carboxylase and Cell Permeability

Heikki Suomalainen and Erkki Oura

Research Laboratories of the State Alcohol Monopoly, Helsinki, Finland

The effect of cell permeability on the metabolic functions of micro-organisms has been repeatedly discussed in the literature, but very little direct evidence has been presented [1-3]. In this work the question has been studied by comparing the decarboxylating activity of yeast carboxylase preparations and of intact yeast cells.

Yeast carboxylase decarboxylates not only pyruvic acid but also other straight-chain α-keto acids, at least up to acids with 8 carbon atoms. Our results with dried brewer's yeast as a crude carboxylase preparation show that, in accordance with earlier observations [4,5], the decarboxylating power of the enzyme decreases with increase of the carbon chain length (Table 1).

It has been generally supposed that the enzyme carboxylase is located in the interior of the yeast cell. Thus the cell wall may form a barrier tending to prevent the substrate from coming in contact with the enzyme. The longer the carbon chain the faster the normal fatty acids penetrate into a yeast cell [6,7].

Table 1. Decarboxylation of different α-keto acids by dried brewer's yeast at pH 5.8. α-Keto acids were used at a concentration (0.04 M) at which the enzyme was saturated with the substrate.

Substrate	CO_2, μl/3 min/10 mg dry yeast
Pyruvic acid	192
α-Ketobutyric acid	143
α-Ketovaleric acid	122
α-Ketocaproic acid	58
α-Ketooenanthic acid	33
α-Ketocaprylic acid	28

The same tendency in decarboxylating power was found both in dried baker's yeast and in brewer's or baker's yeast disintegrated by freeze-thawing.

Table 2. Decarboxylation of different α-keto acids by intact brewer's yeast, in two substrate concentrations.

Substrate	CO_2, μl/3 min/80 mg fresh yeast Concentration of the keto acid	
	0.0015 M	0.0075M
Pyruvic acid	2	11
α-Ketobutyric acid	7	31
α-Ketovaleric acid	8	38
α-Ketocaproic acid	11	51
α-Ketooenanthic acid	22	—
α-Ketocaprylic acid	27	—

Analogous results were obtained with intact baker's yeast.

Consequently it is possible that in intact yeast the permeability of the cell wall determines the velocity of the decarboxylation of α-keto acids. Because only undissociated acid molecules can penetrate, the experiments with intact yeast were performed at a lower pH, at which, however, the longer-chain keto acids can be used in low concentrations only. Examples of the results are given in Table 2.

From these results it would appear that the velocity of decarboxylation of α-keto acids by intact yeast bears an inverse relation to the velocity of decarboxylation of dried yeast preparations or of disintegrated yeast cells. The explanation that this difference is due to the limiting effect of the cell permeability has been confirmed by potentiometric measurements of the penetration velocities of the α-keto acids.

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