

NOTE

## Microbial Production of D-Valine from Racemic $\alpha$ -Aminoisovaleronitrile

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Stereoselectivity is one of the most salient characteristics of enzymes. Thus, enzymes and microbial cells as enzyme bags have been widely used as effective biocatalysts for the industrial production of a variety of optically active compounds such as L- and D-amino acids. Various optically active amino acids now are produced microbially and enzymatically.<sup>1-5)</sup>

Aminonitrile compounds are hydrolyzed chemically to their corresponding racemic amino acids.

Fukuda et al. studied microbial hydrolysis of DL-aminonitriles, and found that racemic amino acids were produced from racemic aminonitriles by incubation with the cell suspensions of a strain of *Corynebacterium* sp. HR.<sup>6)</sup> Asano et al. reported that the nitrilase activity of *Arthrobacter* sp. is effected by combination of nitrile hydratase and amidase,<sup>7)</sup> but a single enzyme, nitrilase, also catalyzes hydrolysis of nitrile compounds to the corresponding carboxylic acids.<sup>8)</sup> Recently, Arnand et al. isolated a D-amidase-less mutant of *Brevibacterium* sp. which produces L-amino acids and D-amino amides from DL-aminonitriles.<sup>9)</sup>

We describe here the stereospecific production of D-valine from DL- $\alpha$ -aminoisovaleronitrile by means of mycelia of *Fusarium oxysporum* IFO 5942. The enzyme(s) system participating to the production of D-valine is also discussed.

DL- $\alpha$ -aminoisovaleronitrile, DL-, D- and L-valineamide were kindly supplied from Research center, Daicel Chemical Industries, Ltd., Hyogo, Japan. The other chemicals were analytical grade reagents. *Fusarium oxysporum* was grown aerobically in the medium (pH 6.0) containing 1% polypeptone, 0.5% meat extract, 0.5% yeast extract, and 0.5% NaCl at 30°C for 18 hr. The mycelia were collected by centrifugation and washed with 0.1 M potassium phosphate buffer (pH 7.2).

Mycelia of the *Fusarium* (50 mg, wet weight) were incubated with the standard reaction mixture (1 ml) containing 100  $\mu$ mol of DL- $\alpha$ -aminoisovaleronitrile and 100  $\mu$ mol of potassium phosphate buffer (pH 7.2). D-Valine formed was determined by enantioselective high per-

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formance liquid chromatography with the authentic D-valine (retention time, 20.0 min) on Daicel Chiralpak WH column (4.6×250 mm) (mobile phase, 0.25 mM copper sulfate; flow rate, 1.0 ml per min; at 50°C). The remaining DL- $\alpha$ -aminoisovaleronitrile and DL-valineamide were determined spectrophotometrically after extraction from the silica gel 60 F254 plates (Merck) with a solvent, *n*-butanol-acetic acid-H<sub>2</sub>O (12:3:5, v/v/v) according to the procedure of Watanabe et al.<sup>10)</sup>

As the incubation proceeded, the concentration of DL- $\alpha$ -aminoisovaleronitrile decreased and that of D-valine increase as shown in Fig. 1. After incubation for 10 hr, 30  $\mu$ mol of D-valine was produced, and 58  $\mu$ mol of DL- $\alpha$ -aminoisovaleronitrile was remained. None of L-valine and DL-valineamide were formed during the reaction. When the reaction mixture was incubated larger, and with more than 150 mg (wet weight) of the mycelia, L-valine was produced gradually to accumulate about 3.6  $\mu$ mol, and 35.6  $\mu$ mol of the enantiomer was formed.

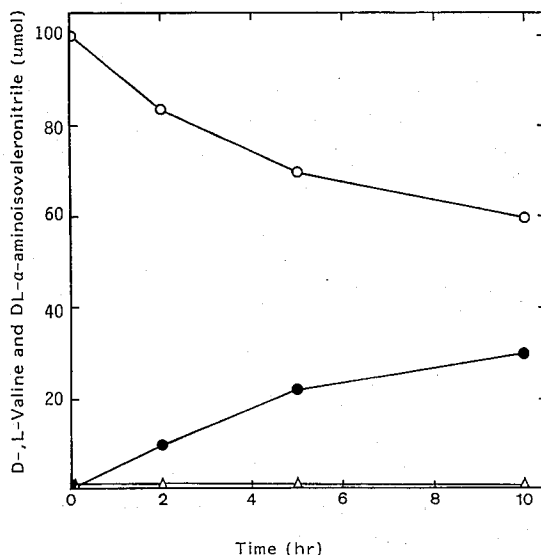


Fig. 1. Formation of D-Valine from DL- $\alpha$ -Aminoisovaleronitrile. The reaction mixture (1 ml) contained 50 mg (wet weight) of the mycelia, 100  $\mu$ mol of DL- $\alpha$ -aminoisovaleronitrile, and 100  $\mu$ mol of potassium phosphate buffer (pH 7.2). Incubation was carried out at 30°C. (●), D-valine; (▲), L-valine; (○), DL- $\alpha$ -aminoisovaleronitrile.

When 100  $\mu$ mol of DL-valineamide was incubated for 10 hr with the mycelia in the standard reaction mixture, nearly 86% of initial amount of DL-valineamide was converted to DL-valine (D-valine, 38.0  $\mu$ mol; L-valine, 48.0  $\mu$ mol). Both of D- and L-isomers of valineamide probably were hydrolyzed by the amidase as reported previously.<sup>7)</sup>

After incubation with 50 mg of the mycelia for 10 hr, the remaining DL- $\alpha$ -aminoisovaleronitrile was separated by preparative thin layer chromatography and hydrolyzed with 6N HCl as described previously.<sup>10)</sup> The hydrolysate containing valine was analyzed by the enantioselective high performance liquid chromatography. L- $\alpha$ -aminoisovaleronitrile remained

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Table I. Analysis of isomers of remaining DL- $\alpha$ -aminoisovaleronitrile after D-valine production by *Fusarium oxysporum* IFO 5942

| Incubation time<br>(hr) | Percentage of isomers of remaining<br>DL- $\alpha$ -aminoisovaleronitrile (%) |    |
|-------------------------|-------------------------------------------------------------------------------|----|
|                         | D                                                                             | L  |
| 0                       | 48                                                                            | 52 |
| 10                      | 24                                                                            | 76 |

The reaction conditions were identical to that of in Fig. 1. Remaining DL- $\alpha$ -aminoisovaleronitrile separated by thin layer chromatography was analyzed by enantioselective high performance liquid chromatography after the 6N HCl hydrolysis as described in the text. Percentage of isomers of remaining DL- $\alpha$ -aminoisovaleronitrile is expressed as valine converted by the 6N HCl hydrolysis.

predominantly (Table I). This suggests that D- $\alpha$ -aminoisovaleronitrile is probably hydrolyzed by a D-stereospecific aminonitrilase to form D-valine, although the L-isomer of substrate also is hydrolyzed more slowly enzymatically or non-enzymatically.

D-Valine was produced with the mycelia grown in the medium (pH 7.2) containing 1% propionitrile, 0.5% glycerol, 0.2% K<sub>2</sub>HPO<sub>4</sub>, 0.2% KH<sub>2</sub>PO<sub>4</sub>, 0.1% NaCl, and 0.02% yeast extract at 30°C for 72 hr,<sup>6)</sup> as well as with the mycelia grown in the medium containing polypeptone, meat extract, and yeast extract as described above. Therefore, the D-aminonitrilase is probably formed constitutively.

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## REFERENCES

- (1) K. Kitahara, S. Fukui and M. Misawa, *Nippon Nôgeikagaku kaishi*, **34**, 44 (1960).
- (2) H. Yamada, S. Takahashi, Y. Kii and H. Kumagai, *J. Ferment. Technol.*, **56**, 484 (1978).
- (3) N. Esaki, K. Soda, H. Kumagai and H. Yamada, *Biotech. Bioengi.*, **22**, 127 (1980).
- (4) C. Wandry, R. Wichman and A. S. Jandel, "Enzyme Engineering", Vol. 6, ed. by I. Chibata, S. Fukui and L. B. Jr. Wingard, Plenum Press, New York, 1982, p. 61.
- (5) K. Soda, H. Tanaka and N. Esaki, "Biotechnology", Vol. 3, 1986, p. 479.
- (6) M. Fukui, T. Harada and Y. Izumi, *J. Ferment. Technol.*, **49**, 1011 (1971).
- (7) Y. Asano, Y. Tani and H. Yamada, *Agric. Biol. Chem.*, **44**, 2251 (1980).
- (8) H. Yamada, Y. Asano, T. Hino and Y. Tani, *J. Ferment. Technol.*, **57**, 8 (1980).
- (9) A. Arnayd, P. Galzy and J. Jallageas, *Bull. Soc. Chem. France*, **87**, 1 (1980).
- (10) Y. Watanabe, K. Watanabe, F. Koide, T. Saito and K. Simura, *Agric. Biol. Chem.*, **34**, 620 (1960).