Fructosyl-amino Acid Oxidase (FAOX-TE)

from recombinant *E. coli*

Fructosyl-L-amino acid : oxygen oxidoreductase, EC 1.5.3

SPECIFICATION

Appearance	yellow lyophilizate
Activity	≧0.5 U/mg lyophilizate
Stabilizer	trehalose
Storage	at −20°C

PROPERTIES

Molecular weight	*ca*. 88 kDa (gel filtration)	
Structure	2 subunits of 44 kDa (SDS-PAGE)	
Isoelectric point	4.2	
Michaelis constant	5.0×10^{-4} M (fructosyl-glycine)	
pH Optimum	7.5–8.5	(Fig. 1)
pH Stability	6.0–10.0	(Fig. 2)
Optimum temperature	40–50°C	(Fig. 3)
Thermal stability	below 45°C	(Fig. 4)
Stability (liquid form)	stable at 20°C for at least two weeks	(Fig. 5)
Stability (powder form)	stable at 37°C for at least one month	(Fig. 6)
Inhibitors	Hg^{2+}, Pb^{2+}	
Specificity	fructosyl-glycine (100), fructosyl-L-valine (132) N^{ε}-fructosyl-L-lysine (0)	

ASSAY PROCEDURE

Principle

$$\text{Fructosyl-L-amino acid} + H_2O + O_2 \xrightarrow{\text{fructosyl-amino acid oxidase}} \text{L-Amino acid} + \text{Glucosone} + H_2O_2$$

$$2\ H_2O_2 + \text{4-Aminoantipyrine} + \text{TOOS} \xrightarrow{\text{peroxidase}} \text{Quinoneimine dye} + 4\ H_2O$$

The appearance of quinoneimine dye is measured spectrophotometrically at 555 nm.

Definition of unit

One unit (U) is defined as the amount of enzyme which produces 1 μmol of hydrogen peroxide per min at 37°C and pH 8.0 under the conditions described below.

Reagents

A. Potassium phosphate buffer, 0.1 M; pH 8.0: mix 0.1 M KH_2PO_4 solution and 0.1 M K_2HPO_4 solution to make a pH 8.0 solution.
B. TOOS solution, 15 mM: 0.50 g of TOOS (*N*-ethyl-*N*-(2-hydroxy-3-sulfopropyl)-*m*-toluidine)/100 ml of distilled water.
C. Peroxidase (POD)–4-aminoantipyrine (4-AA) solution: dissolve 5 mg of POD (200 guaiacol U/mg) in 800 ml of potassium phosphate buffer (Reagent A), then add 100 mg of 4-AA and dilute with potassium phosphate buffer (Reagent A) to 1000 ml.
D. Fructosyl-glycine solution, 150 mM: 356 mg of fructosyl-glycine/10 ml of distilled water.
E. Enzyme dilution buffer: 20 mM Tris-HCl buffer, pH 8.0.

Sample: dissolve the lyophilized enzyme to a volume activity of 0.02–0.20 U/ml in ice-cold enzyme dilution buffer (Reagent E) immediately before measurement.

Procedure

1. Pipette the following reagents into a cuvette (light path: 1 cm).

0.1 ml	TOOS solution	(Reagent B)
2.7 ml	POD–4-AA solution	(Reagent C)
0.1 ml	sample	

2. Equilibrate at 37°C for about 5 min.
3. Add 0.1 ml of fructosyl-glycine solution (Reagent D) and mix.
4. Record the increase of absorbance at 555 nm in a spectrophotometer thermostated at 37°C, and calculate the ΔA per min using the linear portion of the curve (ΔA_S).
   The blank solution is prepared by adding distilled water instead of fructosyl-glycine solution (Reagent D) (ΔA_0).

Calculation

Activity can be calculated by using the following formula:

$$\text{Volume activity (U/ml)} = \frac{(\Delta A_S - \Delta A_0) \times 3.0\,(\text{ml}) \times df}{39.2 \times 1/2 \times 0.1\,(\text{ml})} = \Delta A \times 1.53 \times df$$

Weight activity (U/mg) = (U/ml) × 1/*C*

39.2 : Millimolar extinction coefficient of quinoneimine dye under the assay conditions ($cm^2/\mu mol$)
1/2 : Factor based on the fact that 1 mol of hydrogen peroxide produces 1/2 mol of quinoneimine dye
df : Dilution factor
C : Content of fructosyl-amino acid oxidase preparation in sample (mg/ml)

APPLICATIONS

The enzyme is useful for the determination of fructosyl-L-amino acid.

$$\text{Fructosyl-L-amino acid} + H_2O + O_2 \xrightarrow{\text{fructosyl-amino acid oxidase}} \text{L-Amino acid} + \text{Glucosone} + H_2O_2$$

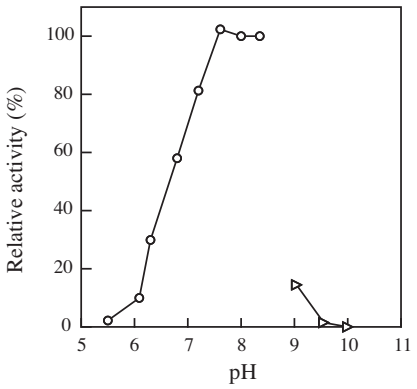
$$2\,H_2O_2 + \text{4-Aminoantipyrine} + \text{TOOS} \xrightarrow{\text{peroxidase}} \text{Quinoneimine dye} + 4\,H_2O$$

REFERENCES

Horiuchi, T. *et al*., *Agric. Biol. Chem*., **53**, 103–110 (1989).
Sakaue, R. *et al.*, *Biosci. Biotechnol. Biochem.*, **66**, 1256–1261 (2002).
Hirokawa, K. and Kajiyama, N., *Biosci. Biotechnol. Biochem.*, **66**, 2323–2329 (2002).
Sakaue, R. and Kajiyama, N., *Appl. Environ. Microbiol.*, **69**, 139–145 (2003).
Sakaue, R. *et al.*, *Acta Cryst.*, **F61**, 196–198 (2005).

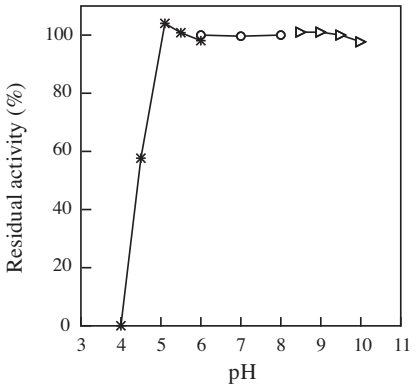
EXPERIMENTAL DATA

Fig. 1 pH Optimum



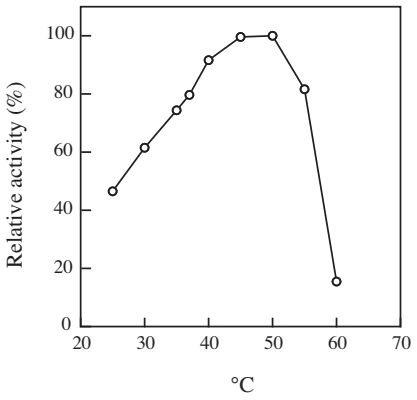
○: 0.1 M phosphate buffer
▷: 0.1 M $NaHCO_3$-Na_2CO_3 buffer

Fig. 2 pH Stability



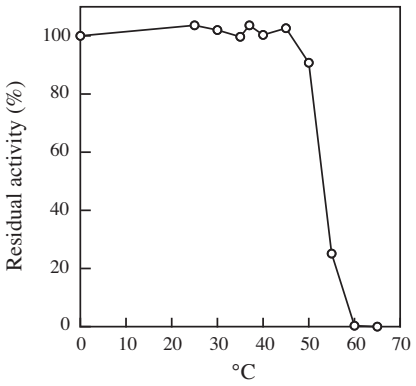
Treatment: 40°C, 10 min
✳: 0.1 M McIlvaine buffer
○: 0.1 M phosphate buffer
▷: 0.1 M $NaHCO_3$-Na_2CO_3 buffer

Fig. 3 Optimum temperature



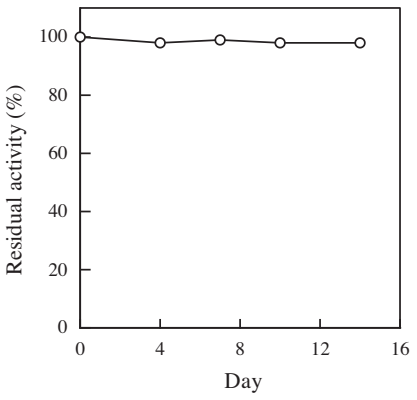
Buffer: 0.1 M phosphate buffer, pH 8.0

Fig. 4 Thermal stability



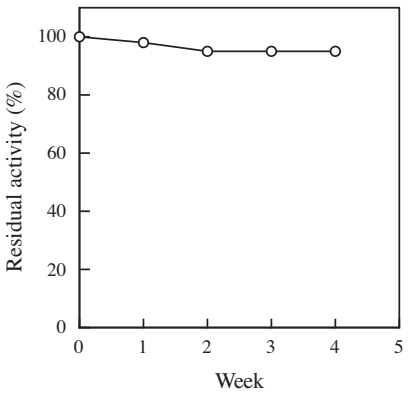
Treatment: 0.1 M phosphate buffer, pH 8.0, 10 min

Fig. 5 Stability (liquid form) at 20°C



[Kept in 0.1 M phosphate buffer, pH 8.0, containing 15% trehalose]

Fig. 6 Stability (powder form) at 37°C



(Kept under dry conditions)