Yeast Topoisomerase II Relaxation Assay

Introduction

Yeast topo II is a type II topoisomerase that is able to relax supercoiled DNA. In this assay, the substrate is supercoiled pBR322 which is relaxed by the enzyme. The two forms of the plasmid can be separated by agarose gel electrophoresis. It can be used to determine the activity of compounds as inhibitors of topo II.

Materials

Yeast Topo II assay buffer : 10 mM Tris.HCl (pH7.9), 100 mM KCl, 5 mM $MgCl_2$, 2% (v/v) glycerol (supplied at 10X). Store at -20°C or below.

Dilution Buffer : 50 mM Tris.HCl (pH 7.5), 200 mM NaCl, 5 mM DTT, 1 mM EDTA, 50% (v/v) glycerol (supplied as 1X). Store at -20°C or below.

ATP: 30 mM ATP (supplied as 30X). Store at -20°C or below.

Enzyme : Yeast Topo II (supplied at a minimum 5 U/µL). (NOTE 1) Store at -80°C.

Plasmid : Supercoiled pBR322 (supplied at 1 µg/µL). Store at -20°C or below. Not supplied in enzyme only kits.

GSTEB: 40% (w/v) Glycerol, 100 mM Tris-HCl pH8, 10 mM EDTA, 0.5 mg/mL Bromophenol Blue. (Supplied at 10X)

Method

(Note: This is an example method and the volume of water can be increased or decreased to allow for the addition of inhibitors although the final volume will be 30 µL).

On ice, set up a MIX of (per assay): Assay Buffer (3 µL of 10X buffer per assay) (NOTE 2), ATP (1 µL per assay), supercoiled pBR322 (0.5 µL per assay) and water (22.5 µL).

26.7 µL of MIX are required per assay.

Set up the appropriate number of 1.5 mL tubes and aliquot 26.7 µL of MIX into each tube.

If the compounds are dissolved in DMSO then add 3 µL of DMSO to tubes 1 and 2 (NOTE 3).

Add 0.3 µL of the test compounds to the other tubes as appropriate.

Mix briefly (gentle vortexing or pipetting).

Add 0.3 µL of dilution buffer (NOTE 4) to tube 1.

Dilute the enzyme in dilution buffer then add 3 µL of this to the remaining tubes (see NOTE 1).

Mix by gentle vortexing and incubate 30 minutes at 30°C.

Stop reaction by adding 30 µL of 2X GSTEB and 30 µL of chloroform/isoamyl alcohol (v:v, 24:1) (NOTE 5).

Vortex briefly ~5 secs and centrifuge for 2 minutes.

Load 20 µL of aqueous (upper blue) phase onto a 1% (w/v) agarose gel.

Run at 85V for approximately 2 hours (or 15 V overnight) (see NOTE 6 to 8).

Stain with ethidium bromide (1 µg/mL in water) (15 mins), destain (5-10 mins) in water (NOTE 6) and visualise with a transilluminator or gel documentation system.

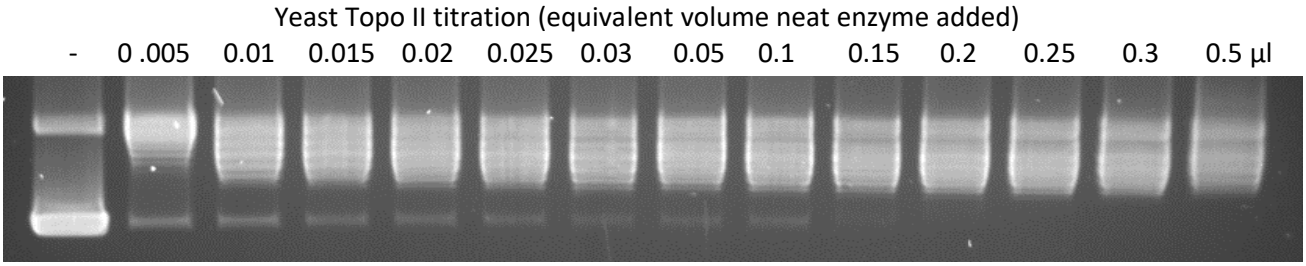
Example Results

1. Determination of enzyme activity.

The gel below shows the results for a gel-based relaxation experiment to determine the amount of enzyme to use in a subsequent inhibition assay. This is performed with supercoiled pBR322 in the presence of 2 % (v/v) DMSO, set up as follows: a MIX was prepared of 42 µL of (10X) Assay Buffer, 14 µL of ATP, 7 µL sc pBR322, 8.4 µL DMSO, 306.6 µL of water. 27 µL of this MIX was added to each tube.

Serial dilutions of the enzyme were made in dilution buffer. Then 3.0 µL added to the reactions.

Reaction	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Dilution	DB	1/600	1/300	1/200	1/150	1/120	1/100	1/60	1/30	1/20	1/15	1/12	1/10	1/6

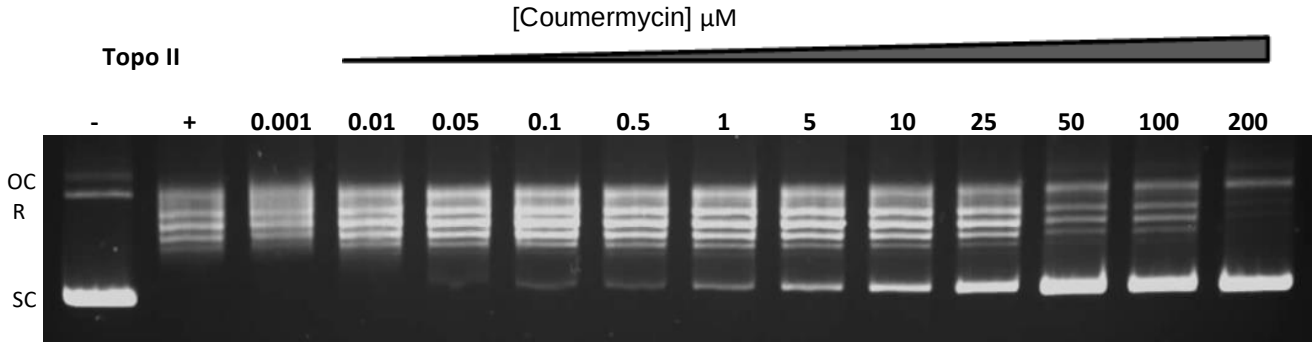


In this case approximately 0.2 µL of the neat enzyme is required to give full relaxation. It is not recommended to store the diluted enzyme as it can lose activity.

2. Determination of the inhibitory activity of a compound

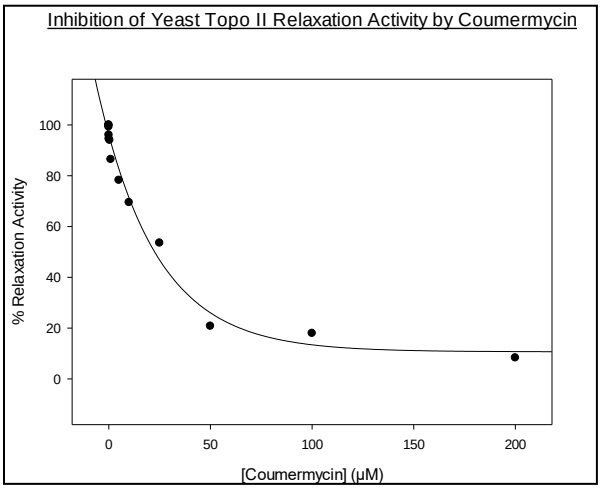
The gel below shows the results for a relaxation inhibition experiment with increasing amounts of the inhibitor coumermycin (dissolved in 10 % (v/v) DMSO). The assay was set up as follows: a MIX was made consisting of 42 µL of (10X) Assay Buffer, 14 µL µL of ATP, 7 µL of sc pBR322, 273 µL of water. 24 µL of the MIX was added to each tube then 3 µL of 10 % DMSO or coumermycin and finally the dilution buffer/enzyme (using a dilution determined as in example 1 above).

Sample	1	2	3	4	5	6	7	8	9	10	11	12	13	14
MIX (µL)	24	24	24	24	24	24	24	24	24	24	24	24	24	24
Vol Cpd (µL)	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Initial [Cpd] µM	DMSO	DMSO	0.01	0.1	0.5	1.0	5.0	10	50	100	250	500	1000	2000
Final [Cpd] µM	-	0	0.001	0.01	0.05	0.1	0.5	1	5	10	25	50	100	200
Dil. Buffer (µL)	3													
Enzyme (µL)		3	3	3	3	3	3	3	3	3	3	3	3	3



OC= nicked, open circular R=relaxed topoisomers SC= supercoiled topoisomers

The intensity of the supercoiled band in each track was determined by scanning the gel image and the amount calculated as a percentage of that in the enzyme only track. These values were then plotted against the coumermycin concentration.
The IC_{50} was calculated as 15.7 μM.



Notes

1) Enzyme is supplied at a minimum number of 5 U/μL (where 1U is the amount of topo II required to just relax 0.5 μg of relaxed pBR322), but it can be significantly more. Thus if you require a known amount of relaxation (e.g. 90% relaxed or just fully relaxed) then it is recommended to run an enzyme dilution series first, where the enzyme is titrated into the assay. The quoted activity (e.g. 5 U/μL) is in the absence of solvents so an enzyme titration must be done in the actual assay conditions before assaying inhibitors.

2) The final concentration of assay buffer should be 1X.

3) DMSO has an inhibitory effect on the enzyme, thus no more than 5% (v/v) DMSO (final concentration) should be used (to check the effect of DMSO on the reaction, tubes +/- DMSO can be included). Also see NOTE 1 above. More enzyme will need to be added in the presence of DMSO to allow for its inhibitory effect. For example, if the enzyme has only 50% activity in the presence of DMSO then twice as much (i.e. 2U) will need to be added to get full relaxation. In this case more inhibitor will probably need to be added to get 50% inhibition. Other solvents (e.g. ethanol) may also have an inhibitory effect on the enzyme.

4) The dilution buffer contains a high concentration of glycerol therefore the total dilution buffer added should not exceed 10% of the final volume.

5) Compounds can be removed from the reactions by extracting with water-saturated butanol before this step (the GSTEB/ chloroform step) if necessary. The upper (butanol) phase is then removed and discarded and the GSTEB/chloroform added as normal. Usually however, the chloroform extraction is sufficient to remove the compounds as well as the topo II.

6) The agarose gels shown in the results are run in Tris-acetate-EDTA buffer (40 mM Tris-acetate, 1 mM EDTA) but TPE (36 mM Tris, 30 mM sodium phosphate, 1 mM EDTA pH 7.8) or TBE (89 mM Tris, 89 mM borate, 2 mM EDTA pH 7.6) buffers can also be used. Gels should be run at about 4 V/cm. Gels are usually run until the bromophenol blue dye has run at least 6-7 cm. This will resolve the relaxed and supercoiled bands. Longer runs will give greater separation if necessary.

7) Gel tanks, gel formers and combs should be free of intercalators such as ethidium bromide and chloroquine which will affect the mobility of the various forms of the plasmid (relaxed, supercoiled etc.). If the apparatus has been used with intercalators then they should be thoroughly cleaned before use. This can be done by soaking for several hours or preferable overnight in a detergent solution (e.g. washing up liquid) and then thoroughly rinsing with water before rinsing with distilled water.

8) Once the reactions have been stopped with the GSTEB and mixed, it is possible to store them overnight at 4^{o}C although it is preferable to load them on a gel as soon as possible.