# Radiosensitivity of *Saccharomyces cerevisiae* W303-1A and BY4741 Strains

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## 1. Introduction

*Saccharomyces cerevisiae*, a simple eukaryotic cell, has been widely used as a model for all eukaryotes including humans for the study of fundamental cellular processes such as DNA replication, DNA recombination, cell cycle, cell division and metabolism. Numerous laboratory strains are used in yeast research. Most of the mutants have been derived from the two widely used laboratory strains W303-1A and BY4741. While BY4741 is a derivative of S288C, used in the systematic sequencing of the *S. cerevisiae* genome, strains with a W303 background serve in many physiological and biochemical studies [1]. It was found in a recent study that W303-1A contains a mutant allele of *YBP1*, *ybp1-1*, encoding four amino acid substitutions, that results in increased peroxide sensitivity [2]. Mutation of *ybp1-1* is not a complete loss of function allele as it is more resistant to peroxides than the knock-out mutant. Ybp1 is required for oxidation of specific cysteine residues of the transcription factor Yap1p resulting in the nuclear localization of Yap1p in response to stress. Ionizing radiation (IR) can produce highly reactive hydroxyl radicals through the decomposition of cellular water, such as superoxide anion radical, hydrogen peroxide, hydroxyl radical [3]. These reactive oxygen species (ROS) can cause wide-ranging cellular damage, including DNA double-strand breaks (DSBs), lipid peroxidation, and protein modification [4]. Also, ROS produced by IR cause oxidative stress. Detoxification enzymes are activated for ROS scavenging against oxidative stress [5]. Also, antioxidants are used for detoxification of ROS and reduction of oxidative damage. NAC, one of the antioxidants, is a precursor for glutathione (GSH) [6]. The aim of the present study was to compare the differences in radiosensitivity-associated cell viability between the two strains. Also, effect of NAC against IR on cell protection was investigated.

## 2. Methods and Results

*Saccharomyces cerevisiae* W303-1A and BY4741 strains were used in this study (Table1). Cell viability was measured by means of CFU (colony forming unit). Yeast was cultured in the YPDA liquid medium at 30°C for 48 hours. Yeast cells were diluted in the YPDA media to an $A_{600} = 10^{-4}$. NAC of 10 mM was treated for 2 hours in prior. Yeast cells were exposure to gamma-radiation from a $^{60}$Co gamma irradiator (7.4 PBq of capacity; AECL, Canada at the Korea Atomic Energy Research Institute) at room temperature. Yeast cells received radiation doses of 10, 30, 50, 100, 200, 300, and 400 Gy. After irradiation, 100 uL of yeast cells were spread on the YPDA solid plates. Plates were incubated at 30°C for 48 hr.

Table 1 Yeast strains used in this study

| Strain | Genotype | Reference |
|---|---|---|
| W303-1A | MATa, *leu2-3/112 trp1-1 can1-100 ura3-1 ade2-1 his3-11/15, ybp1-1* | Wallis et al. 1989 |
| BY4741 | MATa, his3Δ1 leu2Δ0 met15Δ0 ura3Δ0 | EUROSCARF |

### *2.1 Cell viability against ionizing radiation*

To investigate the difference of IR-mediated relative cell death between W303-1A and BY4741, yeast cells were exposed to total doses of 10, 30, 50, 100, 200, 300, and 400 Gy gamma rays. Fig. 1 graph shows considerable differences in radiosensitivity. Relative survival rate of W303-1A strain was lower than that of BY4741 strain on irradiated conditions. After irradiation with 30 Gy, the relative cell survival rate of W303-1A strain and BY4741 strain was 35.8% and 58.3%, respectively. Also, the relative survival rate of W303-1A and BY4741 cells was 15.7% and 32.7% after irradiation with 100 Gy. Therefore, BY4741 strain was more resistant to IR than W303-1A strain.

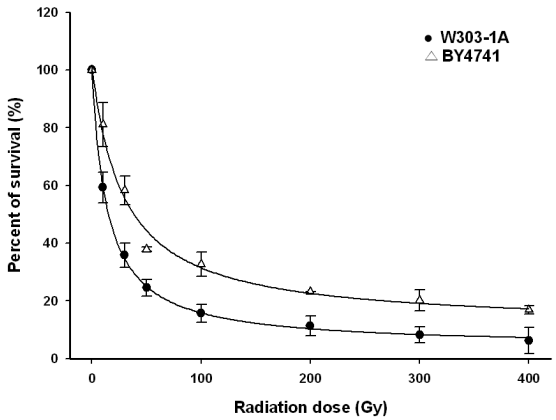


Fig. 1. Comparison of relative cell viability of W303-1A and BY4741 cells after irradiation with gamma rays.

*2.2 Effect of NAC*

To determine the cell protection of NAC against IR in both strains, yeast cells were pretreated 10 mM of NAC. Sensitivity to NAC has been previously described [7]. As growth of the yeast cells was inhibited on concentrations of over 35 mM of NAC, 10 mM of NAC was used in this study. The survival rate of W303-1A and BY4741 cells was not different from non-NAC treated cell survival rates (Fig. 2). Therefore, 10 mM of NAC did not protect the yeast cells irradiated with gamma-rays.

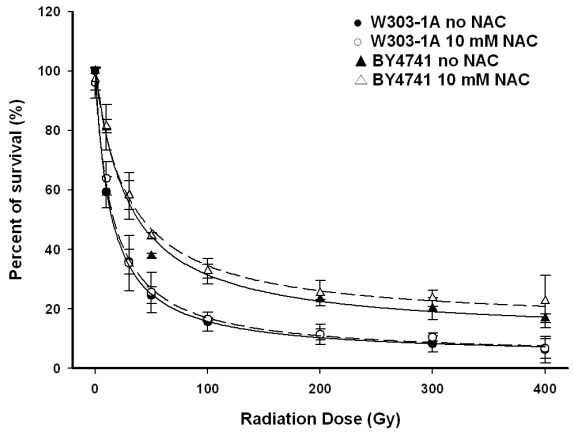


Fig. 2. Comparison of relative cell viability of W303-1A and BY4741 cells treated with 10 mM of NAC and gamma rays.

## 3. Conclusions

The present study shows that the two widely used *S.cerevisiae* strains, W303-1A and BY4741, differ in cell viability after irradiation, which causes oxidative stress. BY4741 strain is more resistant to IR than W303-1A. This result was involved in an *ybp1-1* mutation of W303-1A strain. NAC in this experiment, one of an antioxidant, did not protect IR-induced cell death. Therefore, NAC is a lower concentration cannot be a radio-cell protector against IR-induced cell death. In conclusion, disruption of *YBP1* gene leads to sensitivity to IR in *S.cerevisiae*.

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## REFERENCES

[1] S. Petrezselyova, J. Zahradka, and H. Sychrova, *Saccharomyces cerevisiae* BY4741 and W303-1A laboratory strains differ in salt tolerance, Fungal Biology, Vol. 114, p.144, 2010.

[2] E. A. Veal, S. J. Ross, P. Malakasi, E. Peacock, and B. A. Morgan, The Journal of Biological Chemistry, Vol.278, p.30896, 2003.

[3] Y. Liu, H. Zhang, L. Zhang, Q. Zhou, X. Wang, J. Long, T. Dong, and W. Zhao, European Journal of Pharmacology, Vol. 575, p.142, 2007.

[4] E. J. Collinson, G. L. Wheeler, E. O. Garrido, A. M. Avery, S. V. Avery, and C. M. Grant, The yeast glutaredoxins are active as glutathione peroxidases, The Journal of Biological Chemistry, Vol. 277, p. 16712, 2002.

[5] M. A. Esnault, F. Legue, and C. Chenal, Ionizing radiation: Advances in plant response, Environmental and Experimental Botany, Vol.68, p.231, 2010.

[6] R. Reliene, J. M. Pollard, Z. Sobal, B. Trouiller, R. A. Gatti, and R. H. Schiestl, N-acetyl cysteine protects against ionizing radiation-induced DNA damage but not against cell killing in yeast mammals, Mutation Research, Vol.665, p.37, 2009.

[7] J. Park, M. Nili, and J. K. Kim, Effect of *N*-acetyl-L-cysteine on yeast cells irradiated with gamma rays, 2010 Korean Society of Environmental Biology, Yongin, Korea, p. 21, Dec. 20-21, 2010.