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T. P. Afanasieva

S. Yu. Filippovich

M. S. Kritsky

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## **An increase of NAD<sup>+</sup> kinase activity in Neurospora cells during adaptation to environmental stress**

### **Abstract**

An increase of NAD<sup>+</sup> kinase activity in Neurospora cells during adaptation to environmental stress

Afanasieva, T.P., S. Yu. Filippovich and M.S. Kritsky

An increase of NAD<sup>+</sup> kinase activity in *Neurospora* cells during adaptation to environmental stress.

et al., 1970 J. Biol. Chem 245 2784-2788; Perlman and Feldman, 1982 Mbl. Cell Biol. 2: 1167-1173). The present paper demonstrates that NAD<sup>+</sup> kinase (ATP:NAD<sup>+</sup>2,-phosphotransferase, EC 2.7.1.23), the enzyme catalyzing the formation of NADP<sup>+</sup>, and thus controlling the NADP<sup>+</sup>(H)/NAD<sup>+</sup>(H) ratio and playing a key role in coordination of the catabolic processes and biosynthetic reactions, may be a part of the adaptational mechanisms.

The experiments were performed with three day-old surface cultures of *N. crassa* *nada* (100) a (FGSC #2696) (NAD<sup>+</sup>/P<sup>+</sup>-glycohydrolase free mutant), which were grown on the cellophane film covering Vogel's agar medium (Vogel, 1964 Amer. Natur. 98: 435-446). To subject the cells to stress, the cellophane films with hyphae were transferred to a nutrient free agar and treated for three hours with some agents which could affect different metabolic processes (the control samples were incubated for the same period of time). Among these agents were osmotic shock after transfer of the cells under hypotonic conditions, inhibition of protein synthesis by cycloheximide (1 ng per Petri dish), impairment of the cell membrane structure by 50% ethanol or 0.1% Triton X-100, temperature, treatment - culture transferring from 28° (cultivation temperature) to 4° or 37°. NAD<sup>+</sup> synthesis catalyzed by NAD<sup>+</sup> kinase was studied in a reaction mixture (1 ml total volume) containing 2 μM NAD<sup>+</sup>, 3 μM ATP, 3 μM MgCl<sub>2</sub>, dissolved in 0.05 M tris-HCl buffer, pH 8.3, and started by the addition of 0.05-0.1 ml enzyme preparation containing 150-300 μg protein. The quantity of NADP<sup>+</sup> was measured by the recycling assay, where NADP<sup>+</sup> dependent glucose-6-phosphate dehydrogenase reaction was conjugated with decoloration of theodox dye 2,6-dichlorophenolindophenol (Slater et al., 1964 Arch. Internat. Physiol. Biochem 72: 427-447; Afanasieva et al., 1982 Arch. Microbiol. 133: 307-311).

The results summarized in Table I show that, except for temperature, shifts in the metabolism of *Neurospora* cells bring about a rise of NAD<sup>+</sup>

Some observations indicate the presence of a regulatory mechanism in *Neurospora crassa* cells providing for an adaptation of the cells to an environmental stress. The influence of a thermal shock or incomplete inhibition of protein synthesis by cycloheximide induces formation of new polypeptides, as well as the synthesis of activation of some enzymes (Horowitz

all agents that could cause sharp kinase activity. Furthermore, visible light which may lead to photodynamic damage of the cells, causes a two-fold increase of NAD<sup>+</sup> kinase activity in maturing conidia. The enzyme activity also rises during hydration of conidia. It is of interest that cycloheximide at a concentration completely blocking the protein synthesis increases the activity of NAD<sup>+</sup> kinase. This may be evidence of activation of the enzyme molecules, rather than of their synthesis *de novo*. The absence of response, i.e. enzyme activation, in the case of the temperature treatment may be related to a slower and more gradual manner of its action, as compared with the other stress-inducing factors.

TABLE I

The specific activity of NAD<sup>+</sup> kinase from *N. crassa* cells subjected to the action of stress-inducing agents (nmol NADP<sup>+</sup>.hr<sup>-1</sup>.ng protein<sup>-1</sup>)

Treatment	Specific activity	
	nmol NADP <sup>+</sup> .hr <sup>-1</sup> .ng protein <sup>-1</sup>	Per cent
Control A (cells transferred to a nutrient free agar)	20.1+ - 1.0	100
Hypotonic shock	56.5+ - 9.5	281
Cycloheximide	68.1+ - 10.5	339
50% ethanol	53.0+ - 12.5	264
0.1% Triton x 100	43.7+ - 5.2	217
Control B (no transfer to a nutrient free agar)	25.7+ - 3.9	100
Temperature shift from 28° to 37°	26.2+ - 5.0	102
Temperature shift from 28° to 4°	27.8+ - 1.1	108

The effect of unfavorable environmental agents on microbial cells is known to disturb the balance between the rates of nutrient consumption and biosynthetic processes (Posmogova, 1974 Advances in Microbiol. [in Russian] 9: 84-85). The fact that NAD<sup>+</sup> kinase activity in the *Neurospora* cells increases in response to the nonspecific action of very diverse stimuli, suggests that the enzyme plays some role in the re-establishment of the disturbed balance between anabolism and cata-

bolism during adaptation. Our observations are paralleled by the experiments which demonstrated the involvement of NAD<sup>+</sup> kinase in the adaptation of plant and animal organisms to the action of toxic compounds (Agosin et al., 1967 Can. J. Biochem 45: 619-626; Harada et al., 1980 J. Fac. Hokkaido University 59: 380-391).

A. N. Bach Institute of Biochemistry, USSR Academy of Sciences, Moscow 117071, USSR.