Investigation of the biological effects of ambient air particulate matter (PM) has involved a number of different approaches, including the studies of particle induced genotoxicity. The latter was shown to be related to chemical compounds bound onto the particles or to particles themselves. Some studies suggest that genotoxic effect of the particulate matter is due to polycyclic aromatic hydrocarbons (PAHs) and their derivatives present in the organic fraction of PM while other studies indicate that some metals, forming PM can catalyze reactions resulting in oxidative stress and DNA damage. This study used the acellular model consisting of calf-thymus DNA ±S9 (rat liver microsomal fraction) to assess the genotoxic potential of complex mixtures of organic air pollutants adsorbed onto particles of various aerodynamic diameter in the air by means of DNA adduct analysis. We compared genotoxicity of the organic extracts (EOM) from aerosols of different aerodynamic diameter (0.17-10 micro-meter) collected by high volume cascade impactors in 4 localities of the Czech Republic differing by the extent of the environmental pollution. For this purpose we analyzed DNA adduct forming activity of extractable organic matter (EOM) from the particles in acellular assay of calf thymus DNA coupled with (32)P-postlabelling. The concentrations of c-PAHs in EOMs in the individual fractions indicate that fine fraction of 0.5 – 1 micro-meter bounds highest quantity of c-PAHs in all localities, which is related to the highest relative mass of this fraction in all samples. Taking into account the relative mass of the specific fraction, condensational fraction of 0.17 – 0.5 micro-meter is the most effective carrier of c-PAHs. Similarly, the DNA adduct levels are highest for the fraction of 0.5 – 1 micro-meter (8 adducts/10(8) nucleotides/m(3)) in case that the adduct levels are normalized per m3 of the air while the fraction of 0.17 – 0.5 micro-meter revealed highest DNA adduct levels in case that PM quantities are taken into the consideration. Highly significant correlation was found between the concentrations of c-PAHs and DNA adduct levels induced in native DNA by EOMs from all the localities and various size fractions ( R(2) = 0.98; p<0.001). Main findings of the study indicate that most of the observed genotoxicity is connected with fine particles (<1 micro-meter). Interestingly, significant DNA adduct levels (upto 1.5 adducts/10(8) nucleotides/m(3)) were detected in DNA samples without metabolic activation (-S9) suggesting the role of directly acting genotoxicants other than c-PAHs. The hypothesis that B[a]P and c-PAHs contents in EOMs are the most important factors for their genotoxic potential was confirmed. Our approach based on the DNA adduct measurement in native DNA with and without metabolic activation might be used in future as standardized methodology to measure genotoxic potential of various complex mixtures containing genotoxic components. Supported by the Czech Ministry of the Environment (grant #SP/1a3/149/08).