CARCINOGENESIS IN OUR FOOD AND CANCER PREVENTION

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ABSTRACT

Worldwide, locally prevailing nutritional traditions account for the occurrence of specific types of cancer. In the Orient, the custom of eating salted, pickled or smoked food parallels the risk of stomach cancer and hypertension-stroke. The underlying mechanisms and relevant carcinogens are partially known. In the Western world, the usual high-fat, low-fiber food is related to risk of cancer of the colon, pancreas, breast, prostate, ovary, and endometrium. The fat component translates to specific promoting mechanisms and fibers reduce risk of colon cancer through dilution of promoters. The associated genotoxic carcinogens may be the heterocyclic amines formed during cooking of meat. Methods have been developed to inhibit their formation. In all situations, a higher intake of vegetables and fruits has led to a lower risk for diverse types of cancer, through varied mechanisms. Based on current knowledge, more wholesome dietary traditions for chronic disease prevention in most countries can be developed.

INTRODUCTION

Much progress has been made in uncovering the causes and modifying factors associated with important types of cancer in man. Whereas the media and the public are under false impression that cancer stems from exposure to environmental and agricultural chemicals, pesticides, insecticides, or food additives, factual information indicates that the major cancer types in any part of the world stem from the locally prevailing lifestyles. In the United States, tobacco use and particularly smoking accounts for about 30% of all cancer deaths. Because of effective health promotion by research groups, by voluntary associations, like the American Cancer Society and the Federal Government, through the Office of the Surgeon General and the National Institutes of Health (NIH), American males have progressively reduced the smoking habit (McGinnis, 1988-1989; Breslow, 1990). Therefore, since about 1984, lung cancer mortality in males has begun to decline. Unfortunately, women tend to smoke more, and lung cancer currently has greater mortality in women than the much feared breast cancer. More effective action in this country, and particularly anywhere else in the world where greater proportions of the adult population are still smoking, is needed to reduce the effect of this known human carcinogen. Smoking also sharply increases the rate of fatal heart attacks in the Western world.
Nutritional traditions account for a large fraction of other types of cancer (American Health Foundation, 1987). While more documentation and research is needed to fully underwrite the view that specific nutrients and methods of cooking relate to certain cancer types, the base of knowledge is adequate to begin making recommendations for alterations in nutritional habits as a means of health promotion and cancer prevention. This is the subject of this report. Prior to the development of this theme, we will review the major new acquisitions in the area of the mechanisms of cancer causation to provide a rational basis for the field of nutritional carcinogenesis.

MECHANISMS OF CARCINOGENESIS

Neoplastic Conversion

Historically, at least two distinct phases of carcinogenesis, namely an early stage and a late stage, or initiating agents and promoting agents were recognized (Berenblum, 1985). In the last 20 to 30 years, it has become apparent that cancer is the result of mutational events. Current major advances in molecular biology actually permit investigation at the molecular level of the precise nature of changes in the genome induced by carcinogens. The carcinogens leading to such mutational events are genotoxic (Williams and Weisburger, 1991). Such carcinogens have been found to be associated with cancers of environmental or occupational origin, or cancers related to lifestyle, because of use of tobacco products or exposure to tobacco smoke, or their presence in foods as a result of cooking, salting or pickling. Genotoxic carcinogens react with DNA, usually after host-mediated biochemical activation. They are thus converted to reactive electrophilic metabolite that react with nucleophilic centers in DNA, RNA, and proteins. There are new procedures involving sensitive immunological methods or biochemical approaches like 32P-postlabeling to determine to what extent such reactions have occurred (Williams, 1989). These markers also permit assessment of prior exposure of individuals to genotoxic chemicals (Bridges et al., 1982). Anticarcinogenesis involves efforts to trap reactive electrophiles with suitable nucleophiles (Wattenberg in Joossens et al., 1985; Hartman and Shankel, 1990).

In a quiescent cell population, the abnormal DNA can be repaired. However, during cell duplication, the carcinogen-modified DNA template forms the basis for the production of an altered DNA. The cells bearing such a changed DNA in its gene structure are considered typical of early neoplastic cells. Clearly, any endogenous event or exogenous chemical that increases the rate of DNA synthesis and mitosis may potentiate the effect of a carcinogen, or vice versa, attenuate it, if the rate is decreased (Newmark et al., 1990).

Overall, these series of events are called neoplastic conversion (Williams and Weisburger, 1991). This set of reactions at the level of DNA and the gene is effected by genotoxic chemicals, by specific tumor viruses, or directly or indirectly by radiation. In addition to altering DNA through translocation and gene amplification, such actions can also affect tumor suppressor genes, and thus provide a template typical of neoplasia for DNA synthesis (Weinberg, 1989; Kumar et al., 1990).

GROWTH AND DEVELOPMENT

The subsequent steps, namely the growth and development of early neoplastic cells, are subject to a totally distinct set of endogenous and exogenous growth controlling elements that operate through distinct