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# The Response of Colon Carcinoma in Mice to Cesium, Zinc and Vitamin A

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TUFTE, M J , F W. TUFTE AND A. K BREWER. *The response of colon carcinoma in mice to cesium, zinc and vitamin A* PHARMACOL BIOCHEM BEHAV **21**: Suppl 1, 25–26, 1984 —Predetermined amounts of cesium chloride or carbonate, zinc gluconate and vitamin A were used together to alter growth of colon carcinoma ($C_{38}$) implants in $BDF_1$ mice Data show that the use of these compounds in a treatment protocol is responsible for repression of tumor growth

Cancer Cesium Colon carcinoma Diet Nutrition pH Therapy and cancer Vitamin A Zinc

STUDIES conducted on the isotope effects, mass spectroscopy, and phosphorescence and fluorescence decay patterns of cell membranes have shown that normal cell membranes in the presence of carcinogenic-type molecules will assume a lower energy level and will be unable to function normally The depressed membrane gradient will permit ions such as cesium, rubidium and potassium to pass into the cell in addition to water and glucose. Such a membrane will not permit ions below potassium in the Electromotive Series or sufficient oxygen to enter The result will be anaerobic metabolism and a lowering of intracellular pH and subsequent promotion of an intracellular environment that has the potential for initiation of malignant changes in the cell [1, 2, 3, 9, 10, 11, 14].

The present study reports the effect of cesium salts and substances which may enhance uptake mechanism of alkali metal ions in cancer cells in mice bearing colon carcinoma.

## METHOD

$BDF_1$ female mice received subcutaneous implants of Colon-38 (-8) (862R) tumor. Tumor retrieval and preparation, implant procedure and handling of mice have been previously described elsewhere [13]. Two days after implant and then daily for 18 days, subcutaneous injections of cesium chloride or cesium carbonate, zinc gluconate, and vitamin A were given to each of 10–20 mice in 5 experimental groups. Twenty mice in a control group did not receive any drug injections. Animals in each of four experimental groups, received subcutaneous injections of 0.1 ml quantities of 1.1 mg cesium carbonate, 100 or 1000 I U. vitamin A, and 0.01 mg or 0.1 mg zinc gluconate One additional experimental group received 1.1 mg cesium chloride, 1000 I.U vitamin A; and 0.1 mg zinc gluconate. The selection, concentration, and combination of compounds as well as the injection schedule and procedure have been described earlier [13], and were based on data from preliminary experiments performed in our laboratory using the same host-tumor system (unpublished observations).

After 18 days of treatment, the size of the tumor in each mouse from all groups was measured with calipers. An equation, $LXW^2/_2$, where L=length and W=width of tumor provided a value to tumor size. The median value for tumor size obtained from each experimental group (T) was then divided by the median value obtained from the control group (C). The experimental protocol was considered significantly effective if the value for T/C was equivalent to 42% or less

## RESULTS

The values for T/C ranged from 3.32% to 74.01% Animals from the experimental group which yielded the value of 3 32% showed, therefore, the greatest amount of tumor suppression. This group received 1.1 mg cesium carbonate, 1000 I.U. vitamin A and 0.1 mg zinc gluconate. No other experimental group yielded a T/C value of 42% or less although data from two other groups were within several percentage points of that figure.

Animals from the experimental group which yielded the T/C value of 74.01% had, therefore, the least amount of tumor suppression. These animals received 1.1 mg cesium chloride, 1000 I.U vitamin A and 0.1 mg zinc gluconate.

## DISCUSSION

Tumor cells have been shown to have a rapid uptake of cesium and rubidium [4,5]. Theoretically, this could result in a sufficient increase in the pH of the malignant cell to terminate its life. The chemical properties of zinc and vitamin A

would be expected to enhance the entry of cesium, rubidium, and potassium [4, 5, 7, 8] into tumor tissues. The results presented indicate that it is possible to achieve highly significant repression of tumor growth by using 1.1 mg cesium carbonate, 1000 I.U vitamin A, and 0 1 mg zinc gluconate This is consistent with results reported showing cesium or rubidium salts to be significantly effective in the shrinkage of tumor masses in animals [6,12]. Except for hyperactivity observed in some of the experimental mice no changes in appearance or activity were noted. On the contrary, mice in the control group lost hair, weight, and activity.

The experimental group showing the best response lived longer than other groups after the treatment sessions were ended In addition, members of this group which did not develop tumors while under treatment did develop tumors within 1 week after the treatment was ended

Approximately 2 weeks after cessation of treatment, an experiment was performed on the high response group whereby treatment was resumed Although no regression of tumor was observed, the median size of the tumors for this group remained considerably less than those for any other group. It is believed that the immune response and treatment protocol are implicated in these data Thus, there appears to be a correlation between data obtained in our laboratory on the suppression of colon carcinoma in mice and the mechanism for the therapeutic effects of high intracellular pH as postulated by Brewer [4,5]

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