EFFECTS OF DRY BEANS ON THE DEVELOPMENT OF EXPERIMENTALLY INDUCED BREAST CANCER

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The social and economic burden caused by chronic diseases such as obesity, diabetes, heart disease, and cancer is enormous. To reduce the impact of these diseases, we must find ways to reduce their prevalence. Epidemiological studies have found links between the incidence of cancer and consumption of dry edible bean \textit{(Phaseolus vulgaris} L.) in the human diet. Correa (1981) examined data from 41 countries and found a significant inverse relationship between bean consumption and morbidity due to breast, prostate, and colon cancer. Preclinical studies have also shown that bean consumption can reduce colon cancer (Hughes et al. 1997; Hangen and Bennink, 2003). Hughes et al. (1997) found that feeding pinto beans to laboratory animals reduced the incidence of colon cancer and the number of tumors compared to a diet without bean. Hangen and Bennink (2003) also reported that feeding black or navy beans to laboratory animals reduced both the incidence and number of colon tumors per animal by 50%.

At the outset of our work on "Defining the Health Benefits of Dry Beans", we decided to focus our initial investigations on ten market classes of dry beans representative of both Centers of Domestication (COD) and market classes that account for the majority of global dry bean production. The objectives of this research were to: \(i\) determine if dry beans in the diet have cancer inhibitory activity in a preclinical model for breast cancer, and \(ii\) determine if differences exist among dry bean market classes for anticancer activity.

METHODS

Beans evaluated in this study were represented by the commercial market classes small red, great northern (race Durango, Middle American COD), navy, black (race Mesoamerican, Middle American COD), dark red kidney, and white kidney (race Nueva Granada, Andean COD). All beans were obtained from Archer Daniels Midland Company, Decatur, IL, a bean seed processor that purchases commercially grown beans throughout the USA. Beans were shipped to Bush Brothers & Company, Knoxville, TN for canning using their standard commercial process, then sent to Van Drunen Farms where they were freeze dried and milled. The resulting powders were used to formulate diets with 60% bean meal in the diet of female Sprague Dawley rats. The control diet was an AIN-93 purified diet with no bean powder (Reeves et al., 1993). To induce mammary cancer female rats were given an intra-peritoneal injection of 1-methyl-1-nitrosourea (MNU) at 50 mg kg\(^{-1}\) body weight at 22 d of age according to published procedures (Thompson et al., 1995). The feeding trial was terminated 46 d post carcinogen administration and at necropsy, euthanized rats were skinned and mammary gland chains were examined at 5X magnification according to Thompson et al. (2000). All pathologies identified by visual inspection were excised and processed for histological classification to verify that they were malignant vs benign according to procedures described by Thompson et al. (2000). Cancer incidence (proportion of cancer bearing rats) and cancer multiplicity (average no of cancer tumors per rat) were based on histologically confirmed adenocarcinomas. All animal research was conducted under a permit and approved by the Colorado
State University Animal Care and Use Committee. The animal feeding trials were repeated using beans produced in the 2004 and 2005 crop year. Thirty animals per treatment per trial were used.

RESULTS AND DISCUSSION

Animal growth rate was unaffected by dry bean in the diet for both the 2004 and 2005 crop. We found that all dry bean market classes evaluated had an ability to inhibit experimentally-induced breast cancer. Beans in the diet of laboratory animals reduced the incidence of cancer from an average of 95% in the control group to 68% in animals fed beans ($P \leq 0.001$). Multiplicity of tumors was also reduced from an average of 3.24 tumors per animal in the control group to 1.45 ($P \leq 0.001$) in animals that were fed the bean diet. The main effects and interactions between crop year, dry bean market class, and the presence or absence of seed coat color were also evaluated. There were no main effects or interactions associated with crop year ($P = 0.95$) or seed coat color ($P = 0.49$) for cancer incidence or multiplicity; however, both variables differed among dry bean market class ($P = 0.024$). To determine if the genetic heritage of different market classes was associated with differences in carcinogenic response we conducted contrast comparison between beans representative of the Middle American and Andean COD. Cancer preventive activity was associated with the geographic origin of the bean market class based on COD. Dry beans of Middle American heritage ($n=4$) had cancer multiplicity that was 40% higher than beans of Andean heritage ($n=2$). These results were reproducible based on tests conducted on beans from two consecutive harvest years. The differences for cancer inhibitory activity of dry beans based on COD will be used to gains insights about the mechanisms that account for this protective activity.

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REFERENCES


