ABSTRACT 1

“Raspberry Breeding & Production Systems”

Harry Swartz, Associate Professor, University of Maryland

Five Aces Breeding L.L.C. (www.fiveacesbreeding.com) is the result of the privatization of the University of Maryland/VPI/Rutgers and University of Wisconsin-River Falls bramble-breeding program. We have seedling fields on three continents and from Florida to Ohio (and perhaps soon in Canada). In the third year of its existence, Five Aces has planted 22,000 strawberry seedlings and 21,000 bramble seedlings at its cooperating growers and clients. Our germplasm base includes multiple *Rubus* and *Fragaria* species and over the years, we have developed selections with several interesting traits. Our greatest successes have been primocane bearing raspberry types, which we feel are the future of bramble production in the East. Our earliest primocane cultivar will fruit on primocanes in May, when grown in an unheated greenhouse, i.e. tunnel. This is earlier than our outdoor floricane (springbearing) types. Our most promising strawberry germplasm includes wild species jointly and exclusively developed with the University of Guelph. We are currently growing "common gardens" to test the biochemical properties of the fruit of our widest germplasm to direct our breedng efforts at producing cultivars with the greater nutriceutical value.

ABSTRACT 2

"Blackberry Breeding Progress – New Releases of Potential Value of Ohio Growers"

John R. Clark, Professor –Department of Horticulture
University of Arkansas, Fayetteville, AR 72701

The University of Arkansas conducts one of the larger blackberry breeding programs in the world, and has released 10 cultivars; seven thorny and three thornless. The thornless cultivars Apache, Arapaho, and Navaho have exceptional fruit-handling characteristics and are excellent for the expanding shipping market for fresh blackberries. However, the Arkansas cultivars are limited in Ohio and other states in the Midwest by winter cold hardiness. Among the Arkansas thornless, Navaho appears to be the hardiest for potential trial. Hopefully new cultivars will be more adapted to the region, and an additional thornless release is planned for spring of 2003. A new type of blackberry is also nearing release, one that fruits on current-season canes (primocanes). All current blackberry cultivars fruit on second-year canes (floricanes), and these require overwintering the canes through the harsh winters of the Midwest. The primocane-fruiting cultivars are envisioned to fruit in the late summer until frost, much like fall-fruiting red raspberries. Testing in Indiana has indicated that this new type of blackberry holds promise in the Midwest. With the release of the first primocane-fruiting blackberry, it is hoped that Ohio growers will be able to reliably produce blackberries. Preliminary plans are for the release of two cultivars in the spring of 2003, with a very limited supply of plants available the first year, and a larger supply in 2004. These first cultivars will be thorny, and will not have the excellent handling capability of the current floricane-fruiting thornless options. However, these new releases should be worthy of small commercial trial and home production. It is also hoped that research will be started in 2003 at The Ohio State University on these new blackberries to determine the optimum cultural system to be used in their production.

ABSTRACT 3

"Antioxidants Phytochemicals in Berries: Are they absorbed and what are the health implications?"

Ronald L. Prior, USDA – ARS Arkansas Children's Nutrition Center

Antioxidant Phytochemicals in Berries: Are they Absorbed and what are the health implications? Ronald L. Prior, USDA/ARS Arkansas Children's Nutrition Center, 1120 Marshall Street, Little Rock, AR 72202

Numerous studies have demonstrated *in vitro* effects of flavonoid components from fruits and vegetables on various measures of oxidative cellular damage. Flavonoids are recognized as being good antioxidants in most *in vitro* assay systems. However, the questions that have not been answered satisfactorily deal with the absorption/metabolism of antioxidant components in fruits and vegetables and whether they are absorbed in sufficient quantities and in a form in which effects on *in vivo* measures of oxidative cellular damage could be observed. Berries are particularly high in anthocyanins, which in vitro are good antioxidants. Absorption of anthocyanins appears to be much less (perhaps as much as 10-fold lower) than the flavonol, quercetin. Relatively high dietary levels of anthocyanins appear to be necessary in order to observe antioxidant effects *in vivo*. Metabolism of cyanidin-3-glucoside and quercetin by methylation or conjugation with glucuronide or sulfate will decrease the antioxidant activity. However, quercetin metabolites seem to maintain at least part of their antioxidant activity *in vivo*. Catechins appear to be metabolized during the absorption process to glucuronide conjugates in the small intestine and may be further sulfated or methylated in the liver or kidney. Polymeric proanthoycanidins may be degraded to lower oligomers or be metabolized in the colon to hydroxylated phenolic acids. In spite of the apparent extensive metabolism, catechins are absorbed and exhibit *in vivo* antioxidant effects. Proanthocyanidins may have a more consistent *in vivo* antioxidant effect. In the hydrolysis of the dimer to the monomer, some of the epicatechin may be prevented from being conjugated and more of the free form is in circulation. Although catechins appear to have antioxidant effects *in vivo*, considerable more work is needed relative to absorption and metabolism in order to understand if flavanols impact cellular systems *in vivo*.

ABSTRACT 4

"Variation in Antioxidant Levels in Blackberries"

John R. Clark, Professor – University of Arkansas, Department of Horticulture

John R. Clark and Luke Howard University of Arkansas, Fayetteville, AR 72701

Antioxidant content [as measured by oxidation radical absorbance capacity (ORAC assay)], along with total anthocyanins, total phenolics, and quercetin were measured on frozen, fully-mature fruit of 13 and 15 blackberry (*Rubus* subgenus *Rubus* Watson) genotypes in 1999 and 2000, respectively. Additionally in 1999, ellagic acid was measured. Eight genotypes were common among sample years. The highest ORAC value was for 'Kiowa' (67.9 μmol Trolox equivalents/g of whole fruit) in 2000. Next highest was 'Navaho' which had a two-year average of 48.8. The lowest content was for selection APF-12, 17.3. Total anthocyanins ranged from a high of 3630.9 mg/kg (malvadin-3-glucoside equivalents) for 'Kiowa' in 2000 to 720.6 for APF-12 for the same year. Total soluble phenolics were highest for APF-12, 10,580.8 mg/kg (chlorogenic acid equivalents) in 2000 to 4217.6 for 'Choctaw' in 1999. Quercetin levels ranged from 94.3 mg/kg fresh weight for Arapaho in 2000 to 10.2 for 'Shawnee' in 2000. Ellagic acid ranged from a high of 383.8 mg/kg fresh weight for 'Chickasaw' to 121.0 for 'Kiowa'. Research continues to further characterize genotypic and year-to-year variation for these health-promoting compounds.

ABSTRACT 5

" Anti-Mutagenic and Potential Anti-Carcinogenic Potential of Blackberries: Unexpected Results from Comparison of Eight Varieties"

Lyndon L. Larcom, Professor – Clemson University, Microbiology and Molecular Medicine

Lyndon L. Larcom[1,2], Patricia Tate[1,2], Amal Kuzmar[1] and Samuel W. Smith[3]

[1]Department of Biological Sciences and [2]Department of Physics and Astronomy, Clemson University, Clemson, SC 29634; [3]Greenville Memorial Hospital, Greenville, SC.

Extracts from berries inhibit cancer development in some animal models. In vitro, berry extracts have been found to possess properties associated with anti-cancer substances. These include high antioxidant content, toxicity toward cultured cancer cells and anti-mutagenic activity. Various types of berries have been analyzed and compared for these activities. However, different varieties of the same type of berry can vary in composition. Composition can also be affected by culture conditions and degree of ripeness. To determine whether anti-cancer potential might differ significantly among different types of the same berry, we obtained eight different varieties of blackberry cultured under the same conditions at the same location. These were compared for their abilities to affect carcinogen-induced mutagenesis. The mutagenesis assay was chosen because cancer develops from somatic mutations which accumulate in a cell in the genes controlling cell division, cell-cell interactions, cell-substrate interactions and immunoresponsiveness. The development of metastatic cancer could be impeded by blocking accumulation of the mutations required for this evolutionary process. The eight blackberry varieties were compared for their effects on mutagenesis induced by methyl methanesulfonate (MMS), 2-amino anthracene (2AA) or ultraviolet radiation (UV). The varieties had similar effects on MMS mutagenesis and on 2AA mutagenesis, but differed greatly in their effects on UV mutagenesis. The UV results imply that some varieties could be much more effective than others as anti-cancer foods.

ABSTRACT 6

"The Healthy Attributes of Red Raspberries"

David Ropa, Consultant to the Washington Red Raspberry Commission

The red raspberry (*Rubus idaeus*) is indigenous to Asia Minor and North America. Today, the leading producing regions for red raspberries in the U.S. are Washington, Oregon and California. However, Washington accounts for nearly 60% of the U.S. production of red raspberries, at nearly 70,000,000 pounds per year.

The world market for red raspberries has grown tremendously in recent years, primarily because of the numerous healthful compounds that are present in red raspberries. The following is a brief overview of the compounds found in red raspberries and the nutraceutical functions to which they contribute.

Ellagic Acid
Ellagic acid is a phenolic compound that has become a known as a potent anti-carcinogenic/anti-mutagenic compound. It also has anti-bacterial and anti-viral properties. Ellagic acid itself is not thought to be naturally present in plants. It is the ellagitannins that are present in red raspberries which are converted naturally to ellagic acid. The concentration of ellagic acid is highest in the Meeker variety of red raspberries, at 8.40 µg/g dry weight.

Ellagic acid acts as a scavenger to "bind" cancer-causing chemicals, making them inactive. It inhibits the ability of other chemicals to cause mutations in bacteria. In addition, ellagic acid from red raspberries prevents binding of carcinogens to DNA, and reduces the incidence of cancer in cultured human cells exposed to carcinogens.

Antioxidants
The Oxygen Radical Absorbance Capacity (ORAC) measure the antioxidant activity of foods. Antioxidants inhibit oxidation which is known to have a damaging effect on tissues. Health research indicates that people who consume a diet rich in fruits and vegetables with a high ORAC values may slow the aging process. Red raspberries contain 171 (µmoleTE/g) on a dry weight basis.

Anthocyanins
Anthocyanins, which act as pigments to give berries their deep color, are a major component of the phenolic/flavonoid class. Recent research shows that anthocyanins act as antioxidants, providing many potential health benefits. Researchers are currently linking anthocyanin activity to improving vision, controlling diabetes, improving circulation, preventing cancer, and retarding the effects of aging, particularly loss of memory and motor skills. The anthocyanins in red raspberries, present at a level of 20-65 mg/100g, help reduce the risk of heart disease.

Recently published research investigated the activity of the anthocyanins found in red raspberries. Researchers analyzed the ability of the fruit to inhibit cyclooxygenase and act as antioxidants to destroy free radicals. Researchers discovered that the antioxidant activity of anthocyanins from red raspberries was superior to vitamin E at a test concentration of 125 µg/ml. The COX inhibitory activities of anthocyanins from red raspberries were comparable to those of ibuprofen and naproxen at 10 µM concentrations.

Salicylic Acid
Salicylic acid is found in red raspberries and is suspected of having the same protective effect against heart disease as aspirin. Aspirin is a closely related compound known to pharmacists as salicylic acid acetate. The therapeutic successes of small daily doses of aspirin to inhibit atherosclerosis suggest the possibility that salicylic acid consumed in foods may provide a similar benefit. A 100-gram serving (about 3/4 cup) of red raspberries contains around 5 milligrams of salicylic acid.

Quercetin
Quercetin is a flavonol that works as an anti-carcinogen and an antioxidant. Quercetin has also been shown to reduce the release of histamine and may be effective against allergies. The quercetin content of red raspberries is 12mg/100g of juice.

Catechins
Catechins are flavonols that support the antioxidant defense system. Catechins found in red raspberries may contribute to cancer prevention. The catechins content found in red raspberries is 0.83 milligrams per 100 g.

ABSTRACT 7

"Chemoprevention of Esophageal Tumorigenesis by Dietary Administration of Lyophilized Black Raspberries"

Laura A. Kresty – The Ohio State University, James Cancer Hospital & Solove Research Institute

Laura A. Kresty, Mark A. Morse, Charlotte Morgan, Peter S. Carlton, Jerry Lu, Ashok Gupta, Michelle Blackwood and Gary D. Stoner

Division of Environmental Health Sciences, School of Public Health, Comprehensive Cancer Center, The Ohio State University, Columbus, Ohio 43210 [L. A. K., M. A. M., C. M., P. S. C., A. G., M. B., G. D. S.], and Department of Environmental and Molecular Carcinogenesis, University of Texas M. D. Anderson Cancer Center, Science Park-Research Division, Smithville, Texas 78957 [J. L.]

Fruit and vegetable consumption has consistently been associated with decreased risk of a number of aerodigestive tract cancers, including esophageal cancer. We have taken a "food-based" chemopreventive approach to evaluate the inhibitory potential of lyophilized black raspberries (LBRs) against *N*-nitrosomethylbenzylamine (NMBA)-induced esophageal tumorigenesis in the F344 rat, during initiation and postinitiation phases of carcinogenesis. Anti-initiation studies included a 30-week tumorigenicity bioassay, quantification of DNA adducts, and NMBA metabolism study. Feeding 5 and 10% LBRs, for 2 weeks prior to NMBA treatment (0.25 mg/kg, weekly for 15 weeks) and throughout a 30-week bioassay, significantly reduced tumor multiplicity (39 and 49%, respectively). In a short-term bioassay, 5 and 10% LBRs inhibited formation of the promutagenic adduct O^6-methylguanine (O^6-meGua) by 73 and 80%, respectively, after a single dose of NMBA at 0.25 mg/kg. Feeding 5% LBRs also significantly inhibited adduct formation (64%) after NMBA administration at 0.50 mg/kg. The postinitiation inhibitory potential of berries was evaluated in a second bioassay with sacrifices at 15, 25, and 35 weeks. Administration of LBRs began after NMBA treatment (0.25 mg/kg, three times per week for 5 weeks). LBRs inhibited tumor progression as evidenced by significant reductions in the formation of preneoplastic esophageal lesions, decreased tumor incidence and multiplicity, and reduced cellular proliferation. At 25 weeks, both 5 and 10% LBRs significantly reduced tumor incidence (54 and 46%, respectively), tumor multiplicity (62 and 43%, respectively), proliferation rates, and preneoplastic lesion development. Yet, at 35 weeks, only 5% LBRs significantly reduced tumor incidence and multiplicity, proliferation indices and preneoplastic lesion formation. In conclusion, dietary administration of LBRs inhibited events associated with both the initiation and promotion/progression stages of carcinogenesis, which is promising considering the limited number of chemopreventives with this potential.

ABSTRACT 8

"Effects of Lyophilized Black Raspberries on Azoxymethane-Induced Colon Cancer and 8-Hydroxy-2'-Deoxyguanosine Levels in the Fischer F344 Rat"

G. Keith Harris, National Research Council Associate – National Institute for Occupational Safety and Health, Pathology & Physiology Research Branch

This study examined the effects of lyophilized black raspberries (BRB) on azoxymethane (AOM)-induced aberrant crypt foci (ACF), colon tumors, and urinary 8-hydroxy-2'-deoxyguanosine (8-OHdG) levels in male F344 rats. AOM was injected (15 mg/kg body weight) i.p. once per week for 2 weeks. Twenty-four hours after the final injection, AOM-treated rats began consuming diets containing 0, 2.5, 5, or 10% (w/w) BRB. Vehicle controls received 5% BRB or diet only. Rats were sacrificed after 9 and 33 weeks of BRB feeding for ACF enumeration and tumor analysis. ACF multiplicity decreased 36, 24, and 21% ($P < 0.01$ for all groups) in the 2.5, 5 and 10% BRB groups, respectively, relative to the AOM only group. Total tumor multiplicity declined 42, 45, and 71% ($P < 0.05$ for all groups). Although not significant, a decrease in tumor burden (28, 42, and 75%) was observed in all BRB groups. Adenocarcinoma multiplicity decreased 28, 35 and 80% ($P < 0.01$) in the same treatment groups. Urinary 8-OHdG levels were reduced by 73, 81, and 83% ($P < 0.01$ for all groups). These results indicate that BRB inhibit several measures of AOM-induced colon carcinogenesis and modulate an important marker of oxidative stress in the F344 rat.

ABSTRACT 9

"Inhibition of Experimental Oral Cancer by Dietary Consumption of Black Raspberries"

Bruce C. Casto, Senior Research Scientist – The Ohio State University, James Cancer Hospital and Solove Research Institute

Oral cavity cancers represent 2.5% of the cancers that occur in the United States and are ranked sixth worldwide. Since current therapeutic protocols are relatively ineffective, alternative strategies for prevention need to be developed and tested in appropriate animal models. In the study reported here, the hamster cheek pouch (HCP) was used to evaluate the ability of black raspberries to inhibit oral cavity tumors. Male Syrian Golden hamsters, 3-4 weeks of age, were fed 5% and 10% lyophilized black raspberries (LBR) in the diet for two weeks prior to treatment with 0.2% DMBA (7,12-dimethylbenz(a)anthracene) in dimethylsulfoxide and for 10 weeks thereafter. HCPs were painted with DMBA 3H/week for eight weeks. Animals were sacrificed 12 weeks from the beginning of DMBA treatment and the number and volume of tumors (mm^3) determined. There was a significant difference ($p=0.02$) in the number of tumors between the 5% LBR and control groups (27 tumors/14 animals and 48 tumors/15 animals, respectively) and an intermediate number of tumors in the 10% berry-treated animals (39 tumors/15 animals). These experiments support previous studies from our laboratories showing the chemopreventive activity of black raspberries and show for the first time that dietary black raspberries will inhibit tumor formation in the oral cavity.

ABSTRACT 10

"Inhibition of Colon Cancer Cell Growth by Berry Extracts"

Bernadene Magnuson, Assistant Professor – Dept. of Nutrition and Food Science, University of Maryland, College Park, MD, USA 20742

Evidence of the protective effect of berries and berry extracts on the development of epithelial cancers is growing. The objective of this presentation is to discuss data from our laboratory and others investigating the effect of berry extracts on colon cancer development. We have investigated the effects of anthocyanin-rich extracts from bilberry (*Vaccinium myrtillus L*.), chokeberry (*Aronia meloncarpa E*.) and grape (*Vitis labrusca*) on colon cancer and normal colon cell lines. All extracts inhibited the proliferation of the human colon cancer cell line, HT-29, within 24h of treatment at a concentrations of 50µg monomeric anthocyanin/ml growth media. Maximum inhibition was consistently observed with the chokeberry extract as compared to grape and bilberry extracts. Notably, colon cancer cells were more susceptible to growth inhibition by anthocyanin-rich extracts at concentrations of 10 to 50 µg/ml than normal human colon cells. Cell cycle analyses indicated that progression through the cell cycle is altered in extract-treated cells as compared to untreated controls. Chokeberry extracts also inhibited levels of expression of cyclooxygenase 2, but not cyclooxygenase 1 levels in the colon cells. Recently, we have investigated the effect of various extracts from black raspberries (*Rubus ursinus*), and also observe inhibition of HT29 colon cancer cell growth with certain extracts. These findings and the results from other studies support the hypothesis that berry extracts contain compounds which inhibit colon cancer cell growth.

% Inhibition			**trt**
24h	**72h**	**6d**	
0	0	0	**DM-0**
42.23	9.031	6.843	**DM-05**
42.72	24.215	2.87	**DM-25**
45.63	33.639	7.947	**DM-50**
0	0	0	**Foo1- 0**
3.07	-0.386	33.483	**Foo1- 05**
16.667	42.6	30.562	**Foo1-25**
40.789	37.58	35.506	**Foo1-50**
0	0	0	**Foo3- 0**
13.0653	47.607	8.913	**Foo3- 05**
4.5226	50.453	18.004	**Foo3-25**
3.518	48.124	24.777	**Foo3-50**
0	0	0	**Foo4-0**
37.433	12.87	29.448	**Foo4-05**
47.594	16.86	40.286	**Foo4-25**
44.92	19.949	37.014	**Foo4-50**
0	0	0	**ET-0**
32.738	-6.7	29.4334	**ET-05**
33.929	5.583	30.189	**ET-25**
35.119	16.005	38.868	**ET-50**

ABSTRACT 11

"Anticarcinogenic Activity of Berries Against Breast & Cervical Cancer Cells"

David E. Wedge, Research Plant Pathologist – USDA / ARS Natural Products Utilization Research Unit in Mississippi

By: David E. Wedge and Lyndon L. Larcom.

Freeze dried fruits of two strawberry cultivars, Sweet Charlie and Carlsbad and two blueberry cultivars, Tifblue and Premier were sequentially extracted with hexane, 50% hexane/ethylacetate, ethyl acetate, ethanol, and 70% acetone/water at ambient temperature. Each extract was tested separately for in vitro anticancer activity on cervical and breast cancer cell lines. Ethanol extracts from all four fruit strongly inhibited CaSki and SiHa cervical cancer cell lines and MCF-7 and T47-D breast cancer cell lines. An unfractionated aqueous extract of raspberry and the ethanol extract of 'Premiere' blueberry significantly inhibited mutagenesis by both direct-acting and metabolically activated carcinogens.

Phytochemicals available from food components may affect tumorigenesis in humans by altering cellular responses to genetic damage or mitogenic stimulants. It has not been clearly demonstrated that such effects occur *in vitro* for ellagic acid. However, ellagic acid is only one of many ellagitannins available from certain fruits and the bioactivity of these phytochemicals is still speculative. These data are consistent with the literature that phytochemicals are effective inhibitors of tumor initiation in humans. Additional research exploring the nutraceutical activity of small fruits should provide important information to help clarify anticancer and other health benefits of some phytochemicals attributed to fruits and berries.

ABSTRACT 12

"Chemoprevention Effects of Phytochemicals in Berries Using A Human Oral Cell Model"

Steve D'Ambrosio, Director – The Ohio State University, Division of Radiobiology

Chemoprevention Effects of Phytochemicals in Berries Using a Human Oral Cellular Model.
Steven M. D'Ambrosio*, Chun H. Han, Ruth Gibson-D'Ambrosio and Haiming Ding, Division of Radiobiology, Department of Radiology, The Ohio State University, Columbus, OH 43221

The cancer preventing effects of fruits and vegetables in humans has been indicated by numerous epidemiological studies. Animal and cell culture models have identified classes of phytochemicals as protecting against or delaying the onset of certain types of cancers. Recent studies in animal models indicate that black raspberries (*Rubus occidentalis*) are a rich source of chemopreventive phytochemicals. Since berries are consumed widely throughout the world, these could be used as a rich source of chemopreventive phytochemicals for human consumption. However, before large scale clinical studies are initiated or diet changes recommended, more detailed cellular and molecular information must be obtained to decipher mechanisms by which phytochemicals in berries elicit their chemopreventive effects in humans. Using a panel of normal, premalignant and malignant oral epithelial cell lines, we determined the cellular (growth inhibiting and cytotoxic) effects of five berry extracts and phytochemicals found in black raspberries. The 3x methanol F001 berry extract representing >95% of the total berry components did not affect the growth or induce cytotoxicity in the oral cell lines. Partitioning and chromatography of the F001 extract yielded three fractions which exhibited varying degrees of growth inhibition in the oral cell lines. The water soluble F003 fraction exhibited no growth inhibiting effects to any the cell lines. The F001 berry fraction portioned into chloroform (F003) was selectively growth inhibitory to the premalignant oral cell line. Following silica gel column chromatography of the F001 extract, the fractions eluting with dichloromethane (DM) and methanol/ethanol (Me/Et) were selectively growth inhibitory to the premalignant and malignant cell lines. The extracts or fractions did not appear to be cytotoxic to the cell lines, suggesting that phytochemicals in the DM, ethanol and methanol extracts are primarily growth inhibitors to the premalignant and malignant cell lines. Coinciding with the selective growth inhibiting effects of DM and Et, the number of premalignant and malignant cells increased in the G_2/M phase of the cell cycle. Ellagic acid a major component of berries was tested and found to be a potent, but non-selective, inhibitor of oral human cell growth. Experiments are continuing to identify: i) the phytochemical(s) in the berry extracts responsible for selective premalignant and malignant cell growth; ii) molecular mechanisms; and iii) targets responsible for berry phytochemicals induced growth inhibition. Using these approaches, we are gaining new insights into the cellular and molecular mechanisms by which phytochemicals in berries and other fruits act as chemopreventive agents in human oral cancer. Information obtained from this project should help guide future preclinical and clinical studies with effective berry extracts, or individual and combination phytochemicals identified from berries for chemoprevention.

ABSTRACT 13

"Effect of Berry Extracts on BPDE – Induced Signal Transduction Pathways"

Chuanshu Huang, Assistant Professor – New York School of Medicine

Chuanshu Huang, Yi Huang, Jingxia Li, Wenwei Hu, Robeena Aziz[#], *Moon-shong Tang, Nanjun Sun+, John Cassady+ and Gary D. Stoner*[#]

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Epidemiological studies indicate that fruit and vegetable consumption reduces the incidence of cancer at multiple organ sites. Experimentally, it have been demonstrated the ability of freeze-dried black raspberries to inhibit the development of chemically-induced cancer in the rodent esophagus and colon, and of organic extracts of black raspberries to inhibit benzo(a)pyrene [B(a)P]-induced cell transformation *in vitro*. However, the molecular mechanisms involved in the inhibition of carcinogenesis by black raspberries remain unclear. We investigated the effects of black raspberry extracts on transactivation of activated protein-1 (AP-1) and nuclear factor-κB (NFκB) induced by benzo(a)pyrene diol-epoxide (BPDE), the ultimate carcinogen of B(a)P, in mouse epidermal JB6 Cl 41 (Cl 41) cells. Black raspberries were extracted with methanol, and the methanol extract was partitioned and chromatographed into several fractions designated RU-F003, RU-F004, RU-DM and RU-ME. Pretreatment of Cl 41 cells with either RU-F003, RU-DM or RU-ME resulted in an inhibition of BPDE-induced AP-1 and NFκB activities. The RU-ME fraction was the most potent inhibitor among the fractions tested. In contrast, fraction RU-F004 did not inhibit BPDE-induced AP-1 or NFκB activities in Cl 41 cells. The inhibitory effects of RU-ME on BPDE-induced activation of AP-1 and NFκB appear to be mediated via inhibition of mitogen activated protein kinase (MAPK) activation and inhibitory subunit kappa-B (IκBα) phosphorylation, respectively. Pretreatment of cells with berry fractions did not result in an inhibition of BPDE binding to DNA, thus, this was not a mechanism of reduced AP-1 and NFκB activities. None of the fractions was found to affect p53-dependent transcription activity. In view of the important roles of AP-1 and NFκB in tumor promotion/progression, these results suggest that the ability of black raspberries to inhibit tumor development may be mediated by impairing signal transduction pathways leading to activation of AP-1 and NFκB. The RU-ME fraction appears to be the major fraction responsible for the inhibitory activity of black raspberries.

ABSTRACT 14

"Health Effects of Cranberries"

Marge Leahy, Senior Manager of Health and Nutrition Research – Ocean Spray

The Latest on Cranberry Health Benefits

Marge Leahy, Ph.D.
Ocean Spray Cranberries, Inc.

Folklore has attributed the American cranberry with maintaining health in a number of ways. Now, growing bodies of research support cranberry's role in providing two different paths to health - through microbial anti-adhesion and broader benefits that may be related to its antioxidant and other activities. Bacterial anti-adhesion benefits appear to differentiate the cranberry from most other fruits. New clinical and mechanistic research adds to the base of support for cranberry's role in maintaining urinary tract health. Also, new findings track the effect of cranberry on certain antibiotic-resistant strains of *E. coli*. Although it was once believed that cranberry acted by acidifying the urine, research best supports a mechanism of anti-adhesion against certain urinary pathogens. Preliminary research suggests that cranberry's microbial anti-adhesion effect shows promise in other sites of the body, including the oral cavity and stomach. Cranberries are rich in a variety of phytochemical antioxidants. New research suggests cranberry's potential for broader benefits that may be related to its antioxidant components, including various vascular and neurological benefits. Preliminary research suggests that like other fruits, cranberries contain anti-carcinogenic components.

ABSTRACT 15

"Berry Marketing - Turning Research Into Sales"

Jan-Marie Schroeder, Marketing Director – Oregon Raspberry & Blackberry Commission

Marketing Caneberries: From Research to Sales

The Nutraceutical, Pharmaceutical and Cosmeceutical Industries

The Nutraceutical Industry is one of the largest growing sectors of the food industry today. Global sales of nutraceuticals were estimated at $71 billion with predictions of rapid growth to $500 billion by 2010. Driven by consumer demand for more control over their own health and well being, this industry will become increasingly important to manufacturers worldwide. The rapid rise of this industry and its effect on the pharmaceutical industry will be discussed. Consumers eager to maintain a youthful appearance have also created the emerging cosmeceutical industry that is growing at a rate of 20 – 25 percent annually. The growth of these markets from a small segment of the natural products sector to the mainstream giants of today will be discussed.

Labeling Issues

While growth in the natural products industry booms, government regulators struggle to keep up with this fast growing trend. The role of the USDA and the importance of FDA claim and how they will be a key factor in the future growth of the emerging nutraceutical and cosmeceutical markets will be discussed.

Target Audience

Who are the consumers that are driving the growth of these markets and how can the industry best reach them with new products that are being created based on current scientific research and experimentation. Market research conducted by the ORBC has helped to pinpoint this target audience for nutraceutical products based on caneberries. A review of this research will be discussed.

Media Relations

Working with the media to effectively communicate to consumers the information that has been gained by painstaking scientific research. What are the best strategies for creating materials that will transfer research from the laboratory to the printed page?

The Future

How can we work together to on a national level to assure adequate funding for future research and gain a media platform from which to launch information that is critical to health and human wellness?

ABSTRACT 16

"Berry Production and Marketing in Ohio"

Sandy Kuhn, Berry Coordinator – The Ohio State University, South Centers

In 1997, a Berry Task Force was formed to explore the opportunities of expanding the berry industry in Ohio. The Task Force consisted of Ohio berry producers, government agency representatives, OSU faculty and staff, produce buyers, and others. Their goal was to develop a Berry Strategic Plan for Ohio. That goal was accomplished in March 1999.

In 1999, two years of funding was granted to carry out the goals of the Berry Strategic Plan through an annual amount of $300,000 of earmarked funds in the Ohio legislative budget. The overall budget responsibilities for the berry money was given to the Ohio Agricultural Research and Development Center with the thought that they would administer the money according to the goals of the strategic plan. The initial money was utilized to hire a berry coordinator to champion these efforts as well as to fund numerous production and medical research trials. In 2001, the funding was renewed for another 2 years with a 6% recession from the original amount. Again, this funding is being utilized to fund production, marketing, product promotion and medical research efforts.

Activities and accomplishments in Ohio's Berry Industry in the past 5 years include:

- Formation of a Berry Task Force and completion of the Ohio Berry Strategic Plan
- Funding of a Berry Program through Ohio legislative line item in 1999 and re-funding in 2001. The Berry Coordinator position created a permanent position on the OARDC budget.
- Formation and incorporation of the American Berry Cooperative. In 1998, the co-op consisted of 8 members representing 40 plus acres in Ohio and in 2002, the co-op have 14 members representing 100 plus acres in Ohio with a possible new member in Michigan.
- Overall growth of raspberry acres from 245 acres listed in the 1997 Ohio Census of Agriculture report to 360 acres reported in a survey conducted by Ohio State University South Centers and National Agricultural Statistics Service in 2001.
- Development of a frozen black raspberry market through working with farm markets throughout Ohio and surrounding states. Selling over 4,000 pounds of frozen black raspberries during each summer sale at prices comparable to fresh-market prices. The limiting factor for expansion of this sale is the availability of black raspberries in Ohio.
- Growth in attendance at berry schools range from 22-45 in 1998 and 1999 to numbers in excess of 125 in 2001. Over 3,000 participants at extension educational berry workshops in 2001.
- Development of numerous brochures and marketing tools for use by Ohio growers and grocery retailers.
- Development and distribution of Berry Starter Packets to Extension agents, potential growers, current growers, etc… Distributed over 200 in 2001 and over 400 in 2002.
- Have over 2 acres of berry research combined at both the Piketon and Hillsboro locations of OSU South Centers with 12 different trials or demonstration plots.
- Conducted black raspberry colon cancer studies on rats and found that 5-10 percent berries in rat's diet reduced the rate of tumors by 70-80 percent.
- "Chemoprevention of Esophageal Tumorigenesis by Dietary Administration of Lypholized Black Raspberries" animal trial showed tumor reductions up to 60 percent.
- National and international publicity on OSU cancer studies headed by Gary D. Stoner, Ph.D.