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Anthocyanins *Anthocyanins in Fruits, Vegetables, and Grains* Anthocyanins in Health and Disease **Evaluation of Carotenoids and Anthocyanins in High Pigment, Processing, Heirloom and Anthocyanin Fruit Tomatoes** Bioactive Heterocycles VII Bioactive Heterocycles VI **Anthocyanins** Impact of Food Processing on Anthocyanins **Anthocyanins from Natural Sources** *Anthocyanins as Food Colors* **Anthocyanins in the Genetics of Maize** *Anthocyanins in Subtropical Fruits* **Anthocyanins in Berries and Their Potential Use in Human Health Anthocyanins in Leaves** *Anthocyanins and Human Health: Biomolecular and therapeutic aspects Anthocyanins* Kinetic Parameter Estimation for Degradation of Anthocyanins in Grape Pomace *Anthocyanins in Barbera Grapes Anthocyanin Content and Diversity in Crucifer Vegetables Acylated Anthocyanins in Red Onions* Anthocyanins in Red Onions *Bioactive Heterocycles V* **Analysis of Procyanidins and Anthocyanins in Food Products Using Chromatographic and Spectroscopic Techniques Biosynthesis of Anthocyanins in Radishes** *Antioxidant and Anti-ageing Properties of Polyphenols Resveratrol, Aspalathin and Anthocyanins in Caenorhabditis Elegans* Phenolics, Anthocyanins and Antioxidant Activity in Red Raspberry Muffins *The Effect of Blanching on the Stability of Anthocyanins in Frozen Tart Cherries Anthocyanins in Fruits, Vegetables, and Grains* Polyphenols in Human Health and Disease *Forordning hvorledis med dend Forstreckning som Bunden skeer til sin Aufflings Fortsettelse skal forholdis* **The Detection and Determination of Anthocyanins in Pig Blood Compartments** Phenylalanine Ammonia-lyase, Phenylalanine Ammonia-lyase Inactivating System and Anthocyanin in Apple Identification and Quantification of Anthocyanins in Sorghum and Sweetpotato Leaves *Characterization of Anthocyanins in Fruit Juices and Natural Colorants Assessing the Physiological Basis for Instability of Anthocyanin Production in Grape Cell Culture* **Anthocyanin and Anthocyanin Formation in Seedlings of Fagopyrum Esculentum Moench Handbook of Anthocyanins** Thermal and Enzymatic Degradation of Raspberry Anthocyanins Anthocyanin Pigments in Trousseau Grapes *Anthocyanins and Copigments from fruits, vegetables and flowers*

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Anthocyanin pigments are responsible for the red, purple, and blue colours of many fruits, vegetables, cereal grains, and flowers, increasing the interest due to their strong antioxidant capacity and their possible use to the benefit of human health. Abundant evidence is available about the preventive and therapeutic roles of anthocyanin in different kinds of chronic diseases. According to the structural differences and anthocyanin content of berries such as blackberry, blueberry, chokeberry, and others, there are different healthy properties in the treatments of circulatory disorders, cancer cell lines, and diabetes as well as antiviral and antimicrobial activities. On the other hand, molecular aspects play an important role in anthocyanin biosynthesis, making it possible to determine how biotic and abiotic factors impact its biosynthesis complex. Thus, the aim of this chapter was to describe the use of anthocyanins from berries for human health and their potential use as a pharmacological bioresource in the prevention of chronic diseases. In addition, an update of the molecular mechanisms involved in anthocyanin biosynthesis will be discussed. This text is a comprehensive reference covering the chemistry, physiology, chemotaxonomy, biotechnology and food technology aspects of the anthocyanins. Topics discussed include types of anthocyanins, structural transformations, colour stabilization and intensification factors, biosynthesis and intensification factors, biosynthesis, analysis and functions of anthocyanins. An in-depth review of the literature discussing anthocyanins of fruits, cereals, legumes, roots, tubers, bulbs, cole crops, oilseeds, herbs, spices, and minor crops is included as well With contributions by numerous experts The elucidation of the structure of the red pigments of the black raspberries. Monger variety, was achieved. The components of the pigment of the berries were (a) cyanidin-3-glucoside, (b) cyanidin-3, 5-diglucoside, (c) cyanidin-3-diglucoside and (d) cyanidin-3-rhamnoglucosido- 5-glucoside. The elucidation was carried out after isolation, purification, concentration and chromatographic separation of the components. Further analysis by paper chromatographic techniques and spectrophotometric methods were carried out on the pigments and their products after specific chemical degradations. The degradation of the major anthocyanin component, cyanidin- 3-diglucoside, was further studied in buffered model systems of various pH

values at 50 ° C. As the pH of the medium decreased the anthocyanin stability increased. The same was true for total crude pigment and the anthocyanin in the juice. Nitrogen atmosphere enhanced the stability of cyanidin-3- diglucoside as compared to an oxygen atmosphere. This held for the crude pigment and juice as well. Cyanidin in buffered model systems at 50 ° C was much more unstable than cyanidin-3-diglucoside under the same conditions. Nitrogen atmosphere resulted in improvement of the pigment retention over that in atmospheric conditions. The thermal degradation of cyanidin-3-diglucoside in model systems followed first order kinetics. The rate constants of the reaction at various pH levels under air and nitrogen were determined. The effect of the presence of various sugars and their degradation products on the destruction of cyanidin-3-diglucoside was studied in buffered model systems of pH 3.25 at 50 ° C. All of these additives increased the rate of pigment destruction. No differences were revealed among the sugars glucose, fructose, xylose and sucrose, which were used. All reactions followed first order kinetics and the rate constants were determined. When these reactions were carried out in the presence of nitrogen instead of air, a marked decrease in the rate of the pigment destruction was detected. Ascorbic acid in model buffered systems of pH 3.25 at 50 ° C markedly accelerated the destruction of cyanidin-3-diglucoside. Metal ions and atmospheric oxygen acted synergistically with ascorbic acid in the destruction of this anthocyanin. When the action of either of these synergists was blocked, the stability of the pigment was increased. EDTA was found to improve the retention of cyanidin-3-diglucoside by means of its ability to chelate the metal ions present, thus indirectly inhibiting the effect of ascorbic acid. When nitrogen was used instead of air, an improvement of the stability of anthocyanin in this system resulted. The degradation of cyanidin-3-diglucoside and the disappearance of ascorbic acid followed the same pattern. The same observations were also true for the anthocyanins of the juice. Cyanidin-3-diglucoside in buffer at pH 6.5 was acted upon by tyrosinase. This activity was low but nevertheless demonstrable. When catechol was added to this system, a rapid decolorization of anthocyanin was produced. This effect was further investigated and a scheme of the enzymatic reaction was proposed. Protocatechuic acid and tyrosine were able to couple with cyanidin-3-diglucoside and enhance the destructive action of tyrosinase on anthocyanins. The rate of the decolorization of the anthocyanin was lower in these systems than in the coupling with catechol. This Brief presents comprehensive coverage of anthocyanins. The text covers the scientific literature and clinical significance of this Flavonoid sub-group, with a special focus on their therapeutic aspects. In focusing on secondary metabolites in plants, this work aims to cover the resulting therapeutic potential for humans by referencing the numerous herbal-derived substances which have been evaluated and the rapidly growing data on the interactions of anthocyanins with the microbiome. Anthocyanins and Human Health: Biomolecular and therapeutic aspects covers all angles of biomolecular, in vitro and in vivo anthocyanins from their general chemical structure to their use as a coloring agent. The intake, metabolism and secretion of anthocyanins in the human body are covered in-depth, as are the biosynthetic

pathways through which these compounds are synthesized in the natural system. Factors affecting stability and extraction are listed, and health related uses and biological activities are covered in great detail. Present and future trends in anthocyanins research are also presented. Anthocyanins are the most abundant water-soluble flavonoid pigments that are biosynthesized via the phenylpropanoid pathway in plants. Consumption of anthocyanin-rich vegetables and fruits has been linked with multiple health benefits in chronic disease prevention. This dissertation consisted of three studies as follows focused on the profiles and contents of anthocyanins in various sorghum accessions and sweetpotato leaves. Study 1: Sorghum is a rich source of various phytochemicals, but the contents of anthocyanins in various sorghum accessions are not clear. This study was to identify and quantify the anthocyanins by HPLC-DAD in selected 25 sorghum accessions with various phenotypic pericarp pigments. The predominant anthocyanins found in sorghums were 3-deoxyanthocyanidins including the unique leuteolinidin and apigeninidin analogs. The high levels of total anthocyanins were found in the red pericarp PI297139 and the brown pericarp PI221723, followed by the brown pericarp PI35038 and the yellow pericarp PI229838. There were moderate to low levels of anthocyanins observed in all the other accessions except for the white pericarp that generally contained least to undetectable amount. Although anthocyanins appeared to be associated with the pericarp color in the sorghum accessions with the highest contents in each pericarp pigment category, a distinguishable diversity of anthocyanin contents was presented among and between the phenotypic pericarp colors, suggesting other colorful phytochemicals such as carotenoids might be contributed. Establishing a database of anthocyanin profile and diversity in sorghum accessions with various pericarp pigments may lead to the development of novel functional sorghum products with active anthocyanin-enriched health benefits. Study 2: As phytochemical-enriched edible greens, sweetpotato (Ipomoea batatas L.) leaves have become popular. However, the profile and content of phytochemicals in sweetpotato leaves are mostly unknown. We previously bred a purple-fleshed sweetpotato P40 that demonstrated cancer prevention due to high levels of anthocyanins in the tuberous roots. The objectives of this study were to identify and quantify anthocyanins in P40 leaves when compared with the white-fleshed Bonita and orange-fleshed Beauregard. The mature leaves of P40 at 6-week vine stage were collected and extracted for anthocyanin analysis by HPLC-MS/MS. Fourteen anthocyanins, including a novel anthocyanin (peonidin 3-caffeoyl-p-coumaryl sophoroside-5-glucoside), were identified and quantitated. The contents of anthocyanins in P40 leaves (38 ± 2.9 mg/kg DW) were much lower than that in the tubers (13,100 ± 70 mg/kg DW). Furthermore, anthocyanin contents in P40 leaves were even lesser than those of the white-fleshed Bonita (448 ± 50.4 mg/kg DW) and orange-fleshed Beauregard (240 ± 60.9 mg/kg DW). Total phenolic contents as measured by Folin-Ciocalteu were 36.8 ± 4.8 mg GAE/g DW in the leaves of P40, but 46.7 ± 2.1 mg GAE/g DW in Bonita and 41.2 ± 5.0 mg GAE/g DW in Beauregard. No anthocyanin was detectable in the stems of these three sweetpotato varieties. Taken together, this study

reports for the first time the profile and content of anthocyanins in the leaves of three sweetpotato varieties with a new anthocyanin identified. The unexpected lower levels of anthocyanins in the purple-fleshed sweetpotato leaves when compared with the tuberous roots advanced our existing database and also validated a diverse phenotype of anthocyanin biosynthesis between sweetpotato leaves and tubers. Study 3: As phytochemical-enriched edible greens, sweetpotato (Ipomoea batatas L.) leaves have potential health benefits. However, how anthocyanin content in sweetpotato leaves responds to harvest stages and growth conditions remains mostly unknown. In this study, we investigated the effect of harvest timing on the accumulation of anthocyanin in the leaves of several sweetpotato varieties: white-skinned and white-fleshed Bonita, red-skinned and orange-fleshed Beauregard, red-skinned and white-fleshed Murasaki, and purple-skinned and purple-fleshed P40. Anthocyanin content increased continuously in Bonita from 1st slip stage to vine stage, but P40 did not have the same response. Beauregard had most anthocyanin (592.5 ± 86.4 mg /kg DW) and total phenolic content (52.2 ± 3 mg GAE/g DW) of mature leaves at vine stage. The P40 variety had low anthocyanin and total phenolic content in the leaves although P40 tubers have the highest among these varieties. In the high tunnel studies, no significant differences in anthocyanin content were found in Beauregard leaves grown in the high tunnels versus the open field. Our study showed for the first time that anthocyanin levels were significantly affected by the growth stages. Our overall results indicate that growth stage and/or environmental factors among sweetpotato varieties affected anthocyanin content, which is highly variable and genotype-dependent. In conclusion, the three studies conducted in this dissertation provided a fundamental understanding of anthocyanin profiles and contents in various sorghum accessions with various phenotypic pericarp pigments and sweetpotato leaves in various growth stages and conditions. These results can be useful not only for the breeders but also consumers in the selection of sorghum accessions and sweetpotato varieties for anthocyanin-contained health benefits. The long-term goal is to increase the knowledge and understanding of the role of procyanidins and anthocyanins in the diet and the many positive health benefits attributed to these compounds upon consumption by the consumer. The specific goal of this research was to develop better analytical methods for identification and quantification of procyanidins and anthocyanins in foods and to apply those methods to understand their chemistry in various food matrices, while monitoring the viability, stability, and integrity of these compounds to select processing conditions. Since gas exchange rates often change upon scale-up of cultures, this factor may be critical in observed instabilities in these cultures. Heterocyclic chemistry is the biggest branch of chemistry covering two-thirds of the chemical literature and this book covers the hot topics of frontier research summarized by reputed scientists in the field. Public scandals, awareness of food safety of colorants and health promotion are factors that have prompted changes in the legislation of food additives worldwide. Furthermore, the substitution of synthetic with natural food colorants and the importance of finding new sources for natural food colorants have significantly

increased. In the first part of this work, the main aim was to characterize the phenolic composition of anthocyanin-rich plant-derived extracts, especially from blackberry, black chokeberry, sour cherry, black carrots, purple sweet potatoes, roselle and butterfly pea. The chemical composition of anthocyanins-rich extracts was obtained by TLC, UV spectra, HPLC-DAD, HPLC ESI-MSn and NMR analysis. In this way, their fingerprints were established in order to be used for routine analytical purposes as well as authenticity control. In the second part, the preparative isolation of anthocyanins by membrane chromatography and countercurrent chromatography was performed. Separation of anthocyanins by both chromatographic techniques was achieved in all cases and allowed isolation of anthocyanin pigments on a large scale in high purity and quantity. On the other hand, countercurrent chromatography, especially LSRCCC, HSCCC and HPCCC provided separation of polyphenols and isolation of individual compounds on a large scale, particularly anthocyanins, chlorogenic acids, quercetin glycosides and kaempferol glycosides. Anthocyanins are one of the powerful antioxidants that can alleviate several lifestyle diseases such as heart diseases and hypertension. They can reduce cancer by protecting cells against damage. Several subtropical fruits, including berries, plums, black grapes, apricots, and peaches, among others, are a rich source of anthocyanin. Consumption of these fruits will prolong the longevity of consumers; this is ascribed to the curative effects of anthocyanins present in those fruits. Anthocyanins in Subtropical Fruits: Chemical Properties, Processing, and Health Benefits discusses novel techniques adopted for the extraction of anthocyanins from various subtropical fruits. In this book, experts in the field examine solutions for efficiently extracting anthocyanins from subtropical fruits with higher yield. Protocols for the commercial production of anthocyanins from various subtropical fruits with their applications are also discussed in detail. Additional features: ▪ Addresses chemical properties, classification, and stability of anthocyanins during processing and storage ▪ Discusses the benefits of using both thermal and non-thermal processing methods for extraction of anthocyanins from various subtropical fruits ▪ Explains the applications of synthetic and natural anthocyanins in foods and their regulatory aspects Providing comprehensive information on extraction techniques as well as the chemical and health properties of anthocyanins from various subtropical fruits, this book is a valuable resource for academic students, research scholars, and food scientists. 9781032127958_See Table of Contents (PMP) This book summarizes the current knowledge of anthocyanins, provides systematic information for future exploration of anthocyanin applications. It focuses on several aspects regarding the studying progression in the field of anthocyanins. The first section of the book provides a brief introduction to the scope and progress on anthocyanins, which is followed by the second section that describes the natural sources, structure, extraction approaches, bioavailability, and current stabilizing approach of anthocyanins. Then in the third part, the book focuses on the industrial processing of anthocyanins in foods by discussing the impact of food processing on anthocyanin structure and composition as well as classical processing techniques on anthocyanin-containing foods, including high-

pressure, encapsulation, microwave, and combined application of the above techniques. In the last section of the book, the authors explore the currently most popular application of anthocyanins in improving human health, such as the effect of anthocyanin on vision, metabolism, neural system, cardiovascular system, and cancers. The book will facilitate readers ' understanding of the progress of anthocyanin studies. And it will benefit researchers and graduate students in the fields of natural products, functional food, and nutrition, etc. Polyphenols: Mechanisms of Action in Human Health and Disease, Second Edition describes the mechanisms of polyphenol antioxidant activities and their use in disease prevention. Chapters highlight the anti-inflammatory activity of polyphenols on key dendritic cells, how they modulate and suppress inflammation, and how they are inactivated or activated by metabolism in the gut and circulating blood. Polyphenols have proven effective for key health benefits, including bone health, organ health, cardiac and vascular conditions, absorption and metabolism, and cancer and diseases of the immune system. They are a unique group of phytochemicals that are present in all fruits, vegetables and other plant products. This very diverse and multi-functional group of active plant compounds contain powerful antioxidant properties and exhibit remarkable chemical, biological and physiological properties, including cancer prevention and cardio-protective activities. Expands coverage on green tea, cocoa, wine, cumin and herbs Outlines their chemical properties, bioavailability and metabolomics Provides a self-teaching guide to learn the mechanisms of action and health benefits of polyphenols The Brassicaceae family is one of the most diverse groups of economically important crops. Brassicaceae plants are known for the production of health promoting phytochemicals including glucosinolates, carotenoids, and anthocyanins. The red and purple colors of Brassicaceae plants is primarily associated with anthocyanins, which are a diverse group of water-soluble polyphenolic pigments produced across many plant species and organs. Anthocyanins are water-soluble vacuolar pigments that may appear red, purple, or blue depending on pH, which has led to interest in their use by the food industry as natural colors. B. oleracea (cabbage and kale) and R. sativus (radish) were initially assessed for the distribution of anthocyanins within plant tissues through cytological methods. Anthocyanins were found in the epithelial and outer mesophyll cells of B. oleracea stems and leaves. R sativus produced anthocyanins within internal tissues and roots in addition to the outer cells of stems and leaves, indicating the ability to produce high concentrations and total quantities of anthocyanins. The species were also assessed for anthocyanin pigment quality. High quality anthocyanins have high levels of acylation which results in molecular stability and a 'blue-green' color. Radish, cabbage, kale, and Brussels sprouts samples were extracted in buffers ranging from pH 1 through 12. Images of these extracts were used for RGB measurements. Results indicated that B. oleracea morphotypes produced strong 'red' pigmentation at low pH values, 'purple' pigmentation at slightly acidic conditions, 'bluegreen' at neutral conditions and 'yellow' at basic conditions. Radish contained 'orange' and 'brown' color profiles throughout the pH range due to pelargonidin, indicating that this source may be

less desirable for the food industry. When comparing juvenile types of B. oleracea morphotypes (cabbage, kale and Brussels sprouts) and B. rapa and B. juncea mustard types, kale juvenile types produced the highest levels of anthocyanins (3.49 mg/g dry weight Cy-3,5-DiG Equiv.). The mustards produced unique chromatograms and higher levels of diacylation (84.5%) with the lowest concentrations of anthocyanins (1.15 mg/g Cy-3,5-DiG Equiv.) when compared to their B. oleracea counterparts. B. oleracea genotypes were identified as having preferable natural colors with red cabbage mature morphotypes being typically high in anthocyanins. Screening of germplasm from four repositories was initiated comprising a total of 173 red cabbage accessions. These were evaluated using high performance liquid chromatography (HPLC) methods to assess anthocyanin content. The results showed strong phenotypic diversity both in total anthocyanin content and in percent diacylation of anthocyanins. Several accessions were noted for their high levels of anthocyanins and/or levels of diacylation: HRI 002657A (4.29 mg/g Cy-3,5-DiG Equiv. and 74.4% diacylated), BRA 770 (14.24 mg/g Cy-3,5-DiG Equiv. and 68% diacylated), and CGN 07090 (12.07 mg/g Cy-3,5-DiG Equiv. and 49.1% diacylated). These results indicate that genetic diversity is available for selection of high levels of anthocyanins in Brassica vegetables through plant breeding. A subset of accessions were treated with cold temperature to assess the effect of post-harvest cooling on anthocyanin content of mature cabbage types. Cooling significantly increased both total anthocyanin concentrations and the relative percentage of diacylation (an increase from 9.14 mg/g Cy-3,5-DiG Equiv. (32.7% diacylated) to 11.91mg/g Cy-3,5-DiG Equiv. (39.5% diacylated)). These results indicate that postharvest storage and cooling may be a beneficial process for industry purposes prior to extraction of anthocyanins. Plant stresses often reduce biomass yet increase anthocyanin concentration. A study was initiated to evaluate whether biomass directly correlated with anthocyanin concentration. B. juncea cultivar 'Crimson Red' was selected for evaluation due to foliar anthocyanin concentration less dependent upon environment variation when compared to B. oleracea genotypes. HPLC data indicated a negative correlation (-0.44) between biomass and anthocyanin concentration. A negative correlation (18 cell Styrofoam tray density, -0.25; 32 cell, -0.72; and 72 cell, -0.60) was also observed with the biomass and percentage of diacylated anthocyanins. This suggests that growing plants to a desired biomass prior to inducing stress would be the most pragmatic approach to increasing anthocyanin concentration. This research has identified genotypes of interest for anthocyanin production and contributes to understanding the effects of post-harvest environmental stresses on anthocyanin quantity and type within Brassicaceae. Research into radish anthocyanin profiles would contribute further to a better understanding of anthocyanin diversity within Brassicaceae Future research using light-emitting diode (LED) lighting for controlled production of desirable genotypes could enable precise production of anthocyanin concentration and type. Pairing this with bioclimatic chambers and vertical farming would allow for increased environmental control of anthocyanin production capitalizing on controlled production of natural colors from plant tissues. In recent years there has been an

unprecedented expansion of knowledge about anthocyanins pigments. Indeed, the molecular genetic control of anthocyanins biosynthesis is now one of the best understood of all secondary metabolic pathways. There have also been substantial improvements in analytical technology that have led to the discovery of novel anthocyanin compounds. Armed with this knowledge and the tools for genetic engineering, plant breeders are now introducing vibrant new colors into horticultural crops. The food industry has also benefited from the resurgence of interest in anthocyanins. A greater understanding of the chemistry of these pigments has led to improved methods for stabilizing the color of anthocyanins extracts, so that they are more useful as food colorings. Methods for the bulk production of anthocyanins from cell cultures have been optimized for this purpose. Possible benefits to human health from the ingestion of anthocyanin-rich foods have also been a major feature of the recent scientific literature. Anthocyanins are remarkably potent antioxidants, and their ingestion has been postulated to stave off the effects of oxidative stress. These pigments, especially in conjunction with other flavonoids, have been associated with reductions in the incidence and severity of many other non-infectious diseases, including diabetes, cardiovascular disease and certain cancers. An industry is developing around anthocyanins as nutritional supplements. Finally, there has been significant progress in our understanding of the benefits of anthocyanins to plants themselves. Originally considered an extravagance without a purpose, anthocyanins are now implicated in multifarious vital functions. These include the attraction of pollinators and frugivores, aposematic defense from herbivores, and protection from environmental stressors such as strong light, UVB, drought, and free radical attacks. Anthocyanins are evidently highly versatile, and enormously useful to plants. This book covers all aspects of the biosynthesis and function of anthocyanins (and related compounds such as proanthocyanidins) in plants, and their applications in agriculture, food products, and human health. Featured areas include their relevance to: * Plant stress * Flower and fruit color * Human health * Wine quality and health attributes * Food colorants and ingredients * Cell culture production systems * The pastoral sector Anthocyanins are the pigments in leaves and fruits that give them their colour; for example, the red colour of strawberries, or red leaves in autumn. Although these pigments are especially prominent in the autumn foliage of deciduous trees and in the growth flushes of tropical rainforest plants, they are also found in the leaves of many species after exposure to environmental or biotic stresses. Although the control of anthocyanin synthesis in vegetative organs has long been studied, and is a model system in plant molecular genetics, potential functions of these pigments in leaves have been largely ignored. This volume pulls together new information from experts in the fields of genetics, biochemistry, molecular biology, physiological ecology and plant development, providing a platform to discuss putative hypotheses for anthocyanin function in these vegetative organs. In recent years there has been an unprecedented expansion of knowledge about anthocyanins pigments. Indeed, the molecular genetic control of anthocyanins biosynthesis is now one of the best understood of all secondary

metabolic pathways. There have also been substantial improvements in analytical technology that have led to the discovery of novel anthocyanin compounds. Armed with this knowledge and the tools for genetic engineering, plant breeders are now introducing vibrant new colors into horticultural crops. The food industry has also benefited from the resurgence of interest in anthocyanins. A greater understanding of the chemistry of these pigments has led to improved methods for stabilizing the color of anthocyanins extracts, so that they are more useful as food colorings. Methods for the bulk production of anthocyanins from cell cultures have been optimized for this purpose. Possible benefits to human health from the ingestion of anthocyanin-rich foods have also been a major feature of the recent scientific literature. Anthocyanins are remarkably potent antioxidants, and their ingestion has been postulated to stave off the effects of oxidative stress. These pigments, especially in conjunction with other flavonoids, have been associated with reductions in the incidence and severity of many other non-infectious diseases, including diabetes, cardiovascular disease and certain cancers. An industry is developing around anthocyanins as nutritional supplements. Finally, there has been significant progress in our understanding of the benefits of anthocyanins to plants themselves. Originally considered an extravagance without a purpose, anthocyanins are now implicated in multifarious vital functions. These include the attraction of pollinators and frugivores, aposematic defense from herbivores, and protection from environmental stressors such as strong light, UVB, drought, and free radical attacks. Anthocyanins are evidently highly versatile, and enormously useful to plants. This book covers all aspects of the biosynthesis and function of anthocyanins (and related compounds such as proanthocyanidins) in plants, and their applications in agriculture, food products, and human health. Featured areas include their relevance to: * Plant stress * Flower and fruit color * Human health * Wine quality and health attributes * Food colorants and ingredients * Cell culture production systems * The pastoral sector A method for separation and characterization of individual anthocyanins was developed. High Performance Liquid Chromatography (HPLC) with a polymer based reversed-phase column was used to separate the pigments while on-line Photodiode Array Detection (PDA) was employed to record the UV and Visible spectrum of the individual peaks. Spectral information obtained from on-line PDA detection provided information about: 1) the nature of the aglycone, 2) the sugar substitution pattern and 3) the presence or absence of hydroxy aromatic organic acids. The nature of the glycosidation can be determined from the HPLC retention characteristics. The HPLC/PDA methods were employed to characterize the anthocyanin profiles of the pigments in cranberry, roselle, cherry, bilberry, grape, red cabbage, black raspberry, blackberry, elderberry, plum, blackcurrant and strawberry. The anthocyanidin profiles were also determined for the samples for purposes of confirmation of the anthocyanin data. In addition to the anthocyanin and anthocyanidin profiles, the general coloring properties for most of the samples were also determined. Included were Hunter L, a, b values, total anthocyanin pigment concentration, wavelength maxima, percent tannin measurements, tinctoral strength, pH

measurements and titratable acidity. Interest in anthocyanins has increased in the past few years, due to their potential health-promoting properties as dietary antioxidants. Previously they were known as an important class of natural colorant, orange-red to blue-violet, found in fruits such as berries and in vegetables. This book discusses ways of targeting the delivery of these compounds, through manipulation of exploitation mechanisms. It addresses all aspects from extraction of anthocyanins from natural sources, their health benefits and metabolism to specialized controlled release applications. It will serve as a unique reference for those specializing in the fate of anthocyanins in the body (pharmacokinetics) and the research related to controlled release systems. It will provide an insight for pharmaceutical scientists, food engineers, food scientists and those interested in human health and nutrition. This thesis studies the impact of food processing on the stability and antioxidant capacity of anthocyanins in aqueous and real food systems. It investigates the effects of temperature and pH on the stability and antioxidant capacity of anthocyanins in aqueous systems and in real semi-solid and solid food systems including bread and biscuits. The results of this thesis offer food manufacturers valuable guidelines on the production of functional foods containing anthocyanins, helping to reduce anthocyanins loss and achieve a desired amount of anthocyanins in foods with extra health benefits. Anthocyanins are a group of phenolic compounds widely found in nature, occurring in all tissues of higher plants. Currently, there are over 600 identified anthocyanins, and their activity is related to the protection of plants against insect attacks and to the animals attraction for pollination and seed dispersal. Red fruits such as blueberries and cranberries are among the main sources of anthocyanins and can supply large quantities of this compound in a single meal. Several studies have shown the beneficial effects of anthocyanins on health due to its high antioxidant action through neutralising free radicals by the donation of hydrogen atoms. These beneficial effects include, among others, the anti-carcinogenic and anti-inflammatory activities, the protective effect against degenerative and chronic diseases, the risk reduction of cardiovascular diseases, and vision improvement. In addition to discussing the health benefits of anthocyanins, it also discusses different food sources for anthocyanins and the chemical applications. Anthocyanins, polyphenolic compounds abundant in certain foods, are responsible for the orange-red to blue-violet hues evident in many fruits, vegetables, cereal grains, and flowers. Interest in these pigments has intensified due to their potential health-promoting properties as dietary antioxidants, as well as their use as natural dyes in a variet Anthocyanins as Food Colors aims to assemble scattered information on anthocyanins pertinent to food coloration. Both basic and applied aspects of these pigments are discussed. Organized into nine chapters, this book begins with a discussion of the chemical structure of anthocyanins, followed by its copigmentation and biosynthesis. It then discusses the distribution of anthocyanin in food plants, as well as the compounds' stability in food. This work also looks into the analysis of anthocyanins and their presence in grapes and wine. Utilization of anthocyanins as food additives is addressed in the last chapter. This book will provide

additional information in order to maximize the visual appeal of these pigments both in products in which they are naturally present and in products to which they may be added as colorants.

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