

The Impacts of Environment on Plant Products

E. Ceyhan, A. Kahraman, and M. Onder

Abstract—Plant species depend on specific environment conditions to optimum growing. There are various agricultural areas that comprised from plant species which originated in climatically quite different regions. Plants absorb many elements from soil which have biological function and some of them are known as toxic also at low amounts. In case of environmental conditions change, plants will response as changing some of their metabolic activities. So that some of the quality parameters will change. Some of the plants can adopt as well as reasonable values, but some of them will be affected negatively. Although human are not able to or has limits to change ecological situations, they also able to recognize some characteristics of plants and again can develop new plant species and regulate or eliminate some of the harmful effects of environment on plant quality parameters for adaptation to different climatic conditions. If we know the effects of ecological conditions on plants, the definition and improvement of plant quality parameters will be easy. Therefore plants are the basic place of food chain; there are some sorrows about their quality and credibility.

Index Terms—Environment, food quality, human nutrition, inhibitors.

I. INTRODUCTION

Environmental is a concept that encompasses all the factors that affect an organism and this term also among the basic terms of ecology. Any organism is not independent from its own environment. Environment includes all internal-external factors and forces also for plants. External factors cover light, water, temperature, wind, soil etc. elements [1]. One of neglect related to the affects of globally climate change is about their impacts on the food quality [2]. There are different microenvironment and microclimate modeling techniques for plants [3]. But they are still limited and expensive for extensively using.

Features of the environment are determined by the contributions of factors that constitute it. Impact degrees of factors vary as depend on plant species. For example, while cool climate legumes (peas, broad beans, chickpeas and lentils) show the best developments around 18-20 °C, hot-climate legumes (beans, cowpeas) show a better development around 20-24 °C. This shows us the plants are

able to adjust to very different ecologies. In addition, the best plant growth and development takes place when there is an optimal level of environmental factors. Changing in environmental conditions may cause deterioration of plants to grow and develop to a certain extent. Accordingly, it will cause a change in the quality of the plants. Quality parameters seems to be particularly sensitive to environmental stress such as rainfall, light intensity, length of growing season, length of day, temperature as well as agronomic factors such as plant density, weeds, or soil fertility [4, 5, 6, 7, 8].

The quality of crops is also affected by global climatic changes because a large number and complexity of factors such as growth assimilate partitioning and storage, pre- and post- harvest, including nutritional, technological and environmental factors [9].

Today, one of the main restrictive effective between environmental factors is drought. Abscisic acid is a plant hormone which has functions in many plant developmental processes. It also acts a part to protect plants against drought stress by closing stomas [10]. Figure 1 shows drought-induced abscisic acid- dependent plant response.

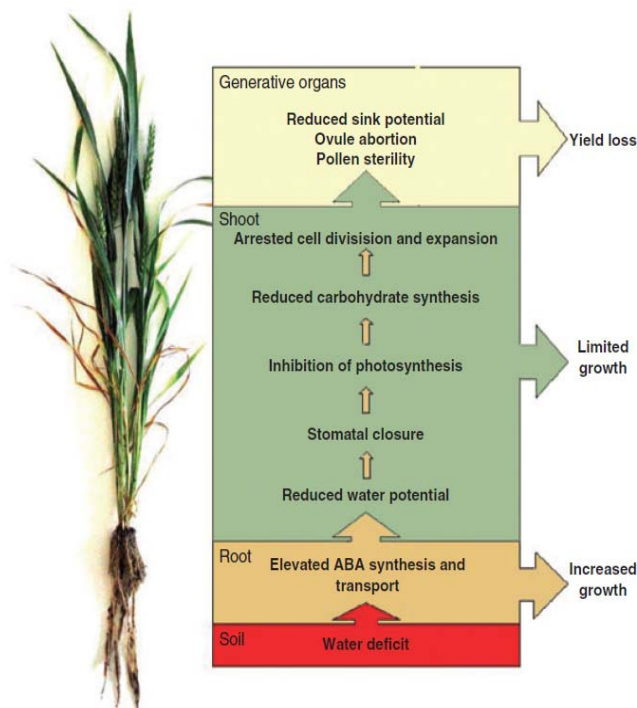


Fig. 1. Drought-induced abscisic acid- dependent plant response

Most of the foods are unknown in the sense of their nutritional value and their effects on human and animal. In this paper, we focus on the effects of environment on quality of plant products.

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II. SOME QUALITY PARAMETERS AND EFFECTS OF ENVIRONMENT

A. Proteins

Plant products are cheap and high quality sources of protein. While cereal grains have around 11 % protein, legumes have 18-30 % protein average. Legumes have higher amounts of amino acids such as thryptophan, lysine and aspartic acid. However, cereals have methionine, cystine, and glutamic acid more than legumes. The negative effects of unbalanced amino acids suppose to eliminate for optimal nutrition [5]. Protein content is one of the most important criteria used in determining the quality of plant products. Protein content is influenced largely by environmental factors [6, 7, 8]. External factors that affecting the amount of protein, are also the factors which affecting the duration of plant maturing periods. Protein decreases in grains after pollination because of the environment conditions which have rainy weather, cool and damp weather. However, if the weather is much rainy during vegetative development and it is hot and dry during generative growth period, the protein content increases. Environmental conditions also have important effects on the amino acids [8]. It is known that environmental factors are effective on the amino acid content of legumes [11].

Figure 2 shows a conceptual model of physiological responses of crops stimulated by five types of abiotic environmental stress, and their prevalent effects on quality parameters [12]

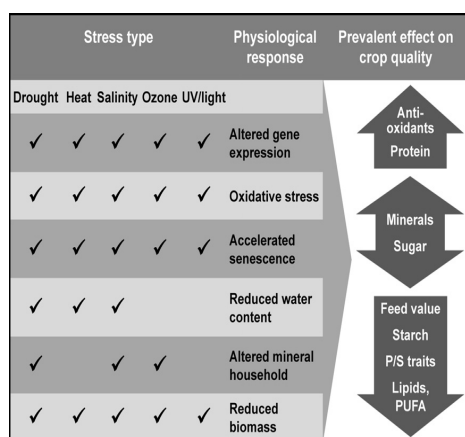


Fig. 2. Effects of abiotic environmental stress on quality parameters of crops

B. Oils

Vegetable oils have high nutritional value due to containing high proportion of polyunsaturated fatty acids and low proportion of saturated fatty acids. Environmental conditions effects growing and development, yield and oil quality of the plants in different ways. High temperature during growing period especially duration of seed development may influence the composition of fatty acids, and results lower quality of the oil. Despite the identification of fatty acids composition is determined by genetically, they are also changed by environmental conditions. More unsaturated fatty acid consists in cold climates and high altitudes [13]. Seed oil content and fatty acids in plants varies depending on environmental conditions by the time of developing stage. While environmental factors especially the

minimum temperature and sunlight (solar radiation) has a significant influence on the concentration of sunflower oleic acid, the effect of maximum temperature has less importance. Linoleic acid content of sunflower is affected negatively by minimum temperature and sunlight [14]. It is possible that climate change would be harm to food production, especially in developing countries where they are located in tropical regions as a base of warmer climates [15]

C. Mineral Substances

Agricultural products are quite rich in terms of minerals especially potassium, phosphorus, calcium and iron. Mineral contents of plants affect a lot due to genotype and nutrition elements in the environment where they are grown. The amount of mineral contents especially iron, phosphorus and zinc are also influenced very much by environment [16, 8]. It has been reported that most of macronutrients and micronutrients amounts were decreased in wheat and barley under high carbon dioxide concentrate and more affected in straw than in grains [17].

It has been reported that intensive water deficit treatment gave rise to importantly increased Ca (28%), Mg (11%), Cu (18%), and Zn (33%) concentrations in maize grains while decreasing in P (17%), and K (17%) in the meanwhile compared with a fully watered treatment. Authors saw as that situation came true by lower soil moisture which leads to decreased availability of those minerals [18].

D. Carbohydrates and Dietary Fibers

Carbohydrates are occurred by sugar, starch and other polysaccharides. The functional properties of carbohydrates based on water absorption, swelling and solubility, gelatinization and viscosity, oil extraction and structural characteristics [19]. Baking and cooking under pressure facilitates the digestion of carbohydrates. The most important part of carbohydrates is dietary fibers which are organic non-digestible parts of foods. The constituent parts of dietary fibers are cellulose, hemicellulose, pectin and lignin. The first three of these are carbohydrate, but lignin is not a carbohydrate. A very large amount of fiber is concentrated in the seed coat. Therefore, peeling the shell reduces the amount of fiber [20]. While pectins, gums and some hemicelluloses in plant products are generally soluble dietary fiber sources, cellulose and some hemicelluloses are insoluble dietary fibers. Soluble and insoluble dietary fibers have shown positive effects on diet and weight loss [21, 22]. Insoluble dietary fiber consumption has an effect to reduce the risk of bowel cancer and heart diseases [22, 23]. Environment has important influences on the content of starch, carbohydrates and fibers [8].

E. Enzyme Inhibitors

Plants externalize individual shapes of ion transporters and enzymes that containing catalytic activities sufficient for the uptake and use of nutrients in the environment. They suppose to keep these ion transporters and catalytic proteins which are expressed at matching locations and timing to make ultimate the amount of nutrient assimilation. Not only increasing the capacities of transporters and enzymes, plants are also able to modifying their root architecture to be more effective accession to the mineral nutrients which are available in the soil [24]. Figure 3 shows an overview to root and regulatory elements.

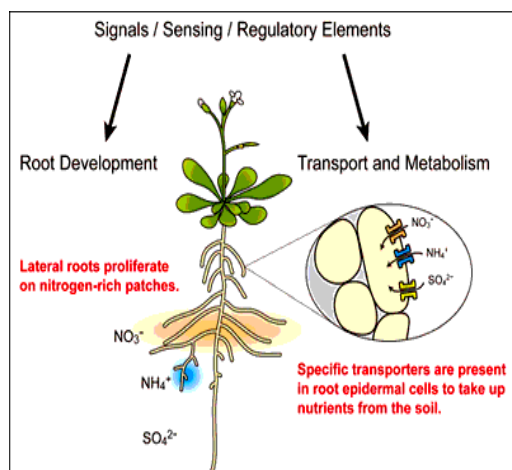


Fig. 3. An overview to root and regulatory elements

The livestock sector continues to develop technologies which are increasing the efficiency of natural resource use. These technologies target feed conversion because feed typically accounts around 60 to 70 percent of production costs. Better feed conversion saves land. Wide arrays of technologies have been improved for feed conversion. They are mainly used in industrial systems in industrial countries, but their use is quickly picking up in developing countries as well. One of the most important one is: improving digestibility by adding an enzyme (called phytase) that catalysis the digestion of phosphates contained in feed and reduces waste loads on the environment [25].

E1. Protease inhibitors (Trypsin and Chymotrypsin)

These are enzymes that break down certain proteins inhibit the functions, so that the protein digestion cannot be completed. These substances are broken down by heat during cooking and roasting. Trypsin is a protease inhibitor that situated naturally in the seed protein. Protease inhibitors are soluble proteins (albumin) that are included by soybean, bean, corn, rice, barley, peanut, potato, cocoa pods, animal tissues and various plant tissues. Environment has effect also with small amounts on especially trypsin content [8].

E2. Amylase inhibitors

Plants contain different amounts of alfa-amylase inhibitors that responsible for slowing digestion and give rise to changing of blood glucose and insulin responses [26]. These effects are beneficial for diabetics therefore present day many research is being done to improve diabetic products which contain alpha-amylase inhibitors. Amylase inhibitors are significantly affected by environmental conditions.

E3. Oligosaccharides

Legumes are known as a manufacturer of digestive gases. Animals and people are not capable of oligosaccharides digestion because of absence α -galactosidase enzyme in mucous of digestive systems. As a result, α -galaktocytes pass into the intestine and digested by intestinal bacteria owing to gas production [27]. Legume seed oligosaccharides commonly contain galactose such as raffinose, stachyose and verbascose which are the flatulent factors in humans and animals [28, 29]. Environment has effect also with small amounts on oligosaccharides [8].

E4. Phenolic compounds

There are large amounts of phenolic compounds in plants.

They protect plants against insect and animal damage. Major phenolic compounds in plants are phenolic acids, flavonoids, isoflavonoids and tocopherols. Phenolic compounds reduce to exploited some of the mineral substances such as zinc.

E5. Tannins

Tannins are quite complex group of plant secondary metabolites. They are dissolvable in polar solution and they are different from other polyphenolic compounds because of their capability to sediment proteins. Tannins are especially concentrated in the seed coat. The amounts of tannins are also important for animals.

High temperatures give rise to smaller and fibrous leaves that indicates changing of nutritional quality like reducing nitrogen and increasing tannins and phenols [30].

E6. Isoflavones

These are similar compounds to phytoestrogen that show both estrogenic and antiestrogenic activities in human exist various quantities in plants such as unrefined cereal grains, edible grain legumes, some fruits and vegetables [31].

E7. Lectins (Hemagglutinins)

They are carbohydrate binding proteins. They spread in multifarious plants and ingested daily perceivable amounts by humans and animals. They are able to survive digestion by the gastrointestinal system of consumers. Lectins provides to clotting of red blood cells. Plants contain a lot of lectin and these substances are broken down by heat [20].

E8. Cyanogenic glycosides

They consist of more than 20 compounds. There are many kinds of glycoside compounds show cytotoxic, antibacterial and other biological activities. These substances are important to their act in plant-herbivore interactions. Plants that varied greatly have toxic potential because of glycosides which are composed of HCN that a result of hydrolysis.

E9. Saponins

Saponins are a vast group of glycosides that distribute in higher plants. They have many wide ranges of biological properties especially as pharmacological. Legumes are major source of saponins that still working on because of cholesterol-lowering effects. Also there are many plants that used in traditional medicine contain saponins.

E10. Phytic acids - Phytates

Phytic acid is a free acid ester which consisted of myo-inositol ring and adherent inorganic phosphate. Chemical name is myo-inositol 1, 2, 3, 4, 5, 6 hexakis dihydrogen phosphate. Phytates are the Ca, Mg, K and Fe salt derivatives of phytic acid. Phytic acid and phytates are stored in plant seeds, feed grains, roots and tubers with widely different levels (0.1-6.0%). Environmental conditions have slightly effect on phytic acid. In addition, phytic acid content of genotypes is affected by environmental conditions in different ways [8]. In diets, the procuration of Fe decreases by inhibition in lack of phytic acids and polyphenols. Determination of precise dispersion Fe, phosphate, phytic acid and tannins therein the sorghum grains is needful to be able to improvement of more effective combinations of food processing methods which oriented to more eligible phytic acide-Fe molar ratios [32].

III. RESULTS AND SUGGESTIONS

Plants often have sufficient to take the daily diet of protein, fat many vitamins (A, B, C, D and E) and minerals. The natural role of plant compounds is mainly for mission to protect plants from pathogens. The various effects of these compounds are entailed to interest for their potential chemotherapeutic impacts. In addition, as well as plants are important in human nutrition, they also important to animal nutrition. Still, phytic acids, phenolics, saponins, protease inhibitors, phytoestrogens and lignans have been related to reduced cancer risks [33]. These results entailed some debates such as the anti-cancer effects of soy isoflavones, especially genistein, in breast cancer prevention [34]. It is also well known that daily nutrient consumption such as from vitamin and mineral has importance to prevent cancer risk [35]. Polyphenols are also known as antioxidants and have importance to prevent of cardiovascular disease and some of cancer forms [36]. Practically, as accepted recently; one of anti-cancer plant is tea. Tea polyphenols are the major ingredients in green tea, and it has been suggested that their anti-carcinogenic effect is a result of their antioxidant activities, modulation of immunity, and activation of detoxification enzymes [37].

Due to superior nutritional value of plants influenced more or less by environmental conditions. From this perspective, the environmental conditions and soils to cultivate plants should be suitable. Plant agronomists, breeders, processors and all other relatives need pay attention to observation, study, evaluation and figuration about food quality to improve the plants which are capable of climate changes. As a result, the potential and new detected effects of plant compounds might be used in new approaches in medicine for humans. Therefore, more research is definitely needed.

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