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A Systematic Link Between the Importance of Biodiversity Conservation and the Benefits of Phytochemical Attributes Present in Food Crops

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ABSTRACT

Biodiversity has been known to contribute positively to the running of different systems on earth. Biodiversity help in the maintenance and sustainability of plants and animals, important for the wellbeing of human beings. Diversified Flora and Fauna play a greater role in supplying the required ingredients in the diet of human beings. Apart from that they also help in their own sustenance and resilience to environmental forces. Plants possess phytochemicals which are secondary metabolites and very important for their health. These chemicals are found in a diversity of indigenous and non-indigenous food crops. Due to their pharmaceutical benefits in human bodies and livestock, secondary metabolites have highly been studied. Studies indicate that there are a lot of benefits that one can accumulate by the consumption of food crops rich in phytochemical attributes. It is therefore the aim of this mini review to report some of these benefits and encourage people to include food crops rich in phytochemicals in their diets. The inclusion of phytochemical food crops in the diet of many would help curb problems such as visual impairments, degenerative diseases such as cancer and largely help to improve food and nutrition security.

Keywords: Biodiversity, Conservation, Phytochemicals, Food and nutrition security

INTRODUCTION

Biodiversity refers to the degree of variations within the natural systems in terms of numbers and frequency of existing organisms [1] and plays a great role in the health existence of the biosphere. It includes the wide variety of plants and animals, the genes they contain and the whole ecosystem in which they live. United Nations Environmental Programme (UNEP) estimates that there are 52 million species globally [2]. These species have been grouped into three basic levels which include: Genetic diversity, Species diversity and Ecosystem diversity. Genetic diversity results in phenotypic variations that lead to the adaptability of the organism in their different areas [2-4]. Species diversity contributes highly to the co-existence of all living things [5]. Ecosystem diversity deals with the variations in ecosystems within a geographical location and its overall impact on human existence and the environment [3,6]. Different geographical locations have different agronomic practices and climatic factors that affects the physicochemical and phytochemical attributes of food crops produced in an area [7]. This therefore contributes greatly to differences in the diets of individuals in specific areas of production [8].

Phytochemical are secondary metabolites that plants produce to counter some environmental stresses in the area where they are growing [9]. Phytochemicals are a wide variety of non-nutritive chemical compounds found in plant foods, which may have health effects. A few examples of well-known phytochemicals are the flavonoids, phenolic acids, isoflavones, curcumin, isothiocyanates, and carotenoids [10-15]. Apart from being stress adapters, studies have revealed that phytochemicals offer much benefits in human beings and livestock. Although research on phytochemicals is still limited, studies have shown that these compounds boast a range of benefits [9,16]. They are associated with sharper

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vision and a reduced risk of heart disease, cancer and neurodegenerative diseases such as Alzheimer and Parkinson's disease [10]. Phytochemical contents differ in different food crops and the differences may also be experienced in different varieties of the same food crops [9,17]. These differences might be due to the differences in the genetic make-up of the food crop but also the differences in the climatic conditions of the provenances where these crops are grown [18,19]. Soil attributes such as fertility, Ph and cation exchange capacity play a role in affecting chemical contents of phytochemicals in food crops [18]. Apart from soil attributes, chemical concentration is also linked to how genes available in a particular crop interacts with the available climatic factors [9]. This brings the issue of crop resilience into play. Crops need to be hardy to survive the present climatic conditions and continue to supply nutrients to humans and livestock. Indigenous crops are defined as hardy due to co-evolution with the pests and diseases and are better adapted to the local climatic factors. However, it is not only the indigenous crops that are rich in phytochemicals of great importance. There also exist non-indigenous food crops that are also rich in phytochemicals, and if they can be harnessed, healthy status of many individuals might improve for better [11,10]. It is therefore the aim of this mini-review to report some of the benefits that can be gained through the inclusion of the phytochemical rich indigenous and non-indigenous food crops in their diets. Utilization of these crops would not only help improve the general healthy status of individuals but would also help in the promotion of biodiversity in the food crops.

MATERIALS AND METHODS

This work is a product of reviewing different published papers. The papers were obtained from different databases such as PubMed, science direct and Google scholar through searching key terms.

FINDINGS AND DISCUSSIONS

Biodiversity contributes heavily to the wellbeing of human beings in many various aspects [20-22]. Humans obtain various products from plants and animals for food and industrial raw materials [22,23]. Natural phytochemicals present in leaves, fruits, barks, stems and roots act as medicine and industrial raw materials [24-28]. Developing countries such as Malawi have benefited from the use of these raw materials as medicine [29,30]. Plant and animal species are used for human consumption and over 2 million people depend on wild species for at least part of their food [31]. This helps to improve nutrition security as most of these species provide high yields because of their pest and disease resistance characteristics. The high yield is attributed to co-evolution that exist among different organisms with the environmental factors in their areas [19,32]. Production location is therefore detrimental in nutritious food availability [8].

Biodiversity is also important for its future use [22]. Conservation of biodiversity enables the future generation to have an option, for it is not known which species would be of great value then [33]. Conservation would, therefore, help maintain traditional strains of plants and animals which would easily adapt and generate resources for people to use later [31,34]. Variations that exist in all individual plants and animals are important in co-existence of all organism on earth [2]. This helps in the continued existence of plants and animals for they consequently survive adverse external conditions experienced in areas they are found through co-evolution [19]. Production location impacts the co-evolution of organisms with the pests and diseases in areas where they are found [35].

Impact of provenance on physicochemical and phytochemical composition of food crops such as *Zea mays* and *Adansonia digitata* have been studied [9,36,37]. Indigenous Maize is one of the food crops having high genetic diversity [8,20,38]. Landraces carry desirable traits such as disease and pest resistance but they are also drought tolerant [19,39]. Decreased production of indigenous crops and loss of other crop varieties have been observed in Malawi and globally [8,38]. These have been attributed to factors such as habitat alteration due to increased land demand [40] overexploitation of biological resources and many others [41]. The trend has been influenced by the increasing availability and adoption of modern food crop varieties in many of the farming communities [42,43].

In Malawi policy has been faulted due to different sectors dealing with issues of biodiversity individually [8]. Such fragmentation has led to poor implementation of biodiversity conservation measures [44]. According to FAO [41] some of the plant species that used to exist in Malawi have been lost. This might be attributed to policies that favor modern crop varieties over the local indigenous varieties. Local indigenous food crops are considered as a source of nutritive diet due to their genetic diversity and resilience in different production locations [8].

Genetic diversity help crops in developing resilience to biotic and abiotic stresses [19]. Biodiversity loss can be minimized by applying restoration measures and by strengthening the policy and practice of sustainable development [45]. Indigenous food crop varieties are believed to be drought tolerant; and pest and disease resistant [42]. These traits result in high yield realization because production in most countries including Malawi is negatively affected by both biotic and abiotic factors present in production location [19].

Phytochemicals are non-nutritive health-promoting substances found in plant foods and are biologically active in living cells of animals when consumed [46,47]. Phytochemicals are secondary metabolites as opposed to primary plant components of carbohydrates, proteins and fats [46]. They are known to enhance human health over and above vitamins and minerals found in pigmented food crops [48]. Fruits, grains, vegetables, legumes, herbs, tea, and some spices are good examples of plants that produce phytochemicals for their own defense against other organisms [47,49,50].

There are tens of thousands of phytochemicals in plants and the largest group of these phytochemicals is that of polyphenols which have more than 8,000 compounds [48]. Increased knowledge in phytochemicals has resulted in growing interest of including pigmented crop varieties in the diet of many human beings globally [51,52]. Differences in phytochemical composition of diets consumed by individuals are due to environmental factors in different production locations [37,53].

Phenolic compounds consist of a wide range of compounds possessing an aromatic benzene ring bearing a functional group called hydroxyl group (OH) which is directly jointed to the phenol. Phenolic compounds also include substituents functional derivatives [54]. Phenol is an aromatic hydrocarbon group made of six carbon atoms (C_6H_5OH) (**Figure 1**).

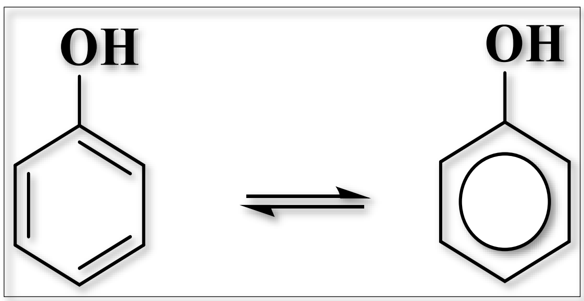

Figure 1. Phenol group of phenolic compounds [55].

Phenolic compounds are classified as simple or polyphenols depending on phenol units that are joined together in a compound [55]. Phenolic compounds are very important because of their antioxidant activity in the body of animal species [56]. Ferulic acid is one good example of phenolic acids that predominates in both pigmented and non-pigmented cereals [11].

Many food traits such as palatability, taste, bitterness, astringency, and color flavor but also toxicity and pharmacological effects are attributed to the presence of phenolic compounds in plants [55,57].

Phenolic compounds are strong antioxidants, they act against radicals and prevent the body from oxidative stresses [56,58]. Radicals are generated from the normal metabolic processes in the body and are highly active and causes degenerative diseases. Phenolic compounds deactivate the radicals and upgrade the production of enzymes and other proteins that deactivate these carcinogenic species [58,59]. Apart from the influence of the variety, differences in composition of crops is attributed to climatic factors that are experienced in an environment [18].

Apart from Phenolic compounds, Carotenoids are notable for their wide distribution, structural diversity and various functions. According to their structure, Carotenoid are classified as xanthophyll (Lutein, Zeaxathin, and β-Cryptoxanthin) and carotenes (β-carotene and α-carotene) [10]. Lutein and zeaxanthin are mainly recognized for their antioxidant activities [60,61]. More than 600 carotenoids from natural sources, excluding cis and trans- isomers have been isolated and characterized [10,62]. Carotenoids have provitamin A activity (Hwang; Zhang) [10,63]. They are also associated with reduction in sight and cancer problems (Lutein and zeaxanthin) as they modulate the metabolism of carcinogens, inhibit cell proliferation, and enhance cell differentiation [38,64]. The action of carotenoids against diseases has been attributed specifically to their ability to quench the singlet oxygen and interact with free radicals due to conjugated double bond system [65]. Secondary metabolites such as carotenoids are produced to help crops adapt to different environmental stresses encountered in their different production locations (Hwang) [10]. Other food crops rich in carotenoids and phenolic compounds help to improve vision and reduce oxygen radicals thereby preventing degenerative diseases in human [10,9,56,67-71]. Among the many other food crops including fruits, the differences in phytochemical and physicochemical composition is a factor of environmental conditions and many other factors that contribute to crop growth such as mineral availability in the soil but also pH [18,19,36,37,72]. The corn type for example in Pigmented landrace maize is flint and help to be easily stored preventing damage from the pests which contribute highly to post-harvest food crop losses [9,73].

Studies have reported that food and nutrition insecurity in today's world are not mainly due to crop failure. Food and nutrition insecurity are as a result of post-harvest losses due to pests that feed on the dent corn of the highly adopted modern white maize crop and fruits [9,73]. Most important to note is that post-harvest handling processes of food crops have great impact on availability of essential nutrients in the human diet [74]. This is because some may be degraded due to high thermal exposure and long period of storage [9,67,73,75].

Biodiversity conservation and use of phytochemicals available in the different conserved food crops would help uplift small-scale business that rely on these crop varieties [76]. Looking at the benefits humans accrue from biodiversity conservation and phytochemicals from different food crops, it is therefore very important to sensitize people on and set deliberate policies of biodiversity conservation in both indigenous and non-indigenous food crops. Living in this moment of climate change, it would be very plausible to embrace the hardy food crop varieties and to conserve biodiversity for improved food and nutrition security [16].

CONCLUSIONS AND RECOMMENDATIONS

Despite the high adoption of modern food crop varieties, small-scale farmers continue to cultivate local indigenous crops. These diversified crops are advantageous in both phytochemical composition and agricultural production aspects such as pest and disease resistance. This review can conclude that diversification is important in enabling phytochemical ingredients in the diet of those that are mindful of their diet which is very beneficial to their health status. It is a recommendation of this review that diversification should be harnessed to maximize the use of indigenous food crops for the benefits that can be realized from them.

DATA AVAILABILITY

All data are included in the manuscript.

CONFLICTS OF INTEREST

Authors declare that there are no conflicts of interest as the research was not conducted for commercial or financial purposes.

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