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Elevated carbon dioxide impacts on bioactive compounds or nutraceuticals properties of medicinal plants

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Abstract
Climate change is a very well-known threat in today's world. The few scientific communities at worldwide stated that the future climate change scenario could influence the chemical composition, quality, and quantity of nutraceuticals derived from medicinal plants or crops. However, it is largely unclear about climate change effects on secondary chemicals or nutraceuticals production in medicinal plants. Elsewhere this perspective has been given renewed attention recently. In India, studies on the possible impact of climate change on growth behavior and quality and quantity of bioactive compounds or nutraceuticals of medicinal plants are severely lacking. Therefore, an effort was made to make a valuable document on possible impacts of climate change on quality bioactive compounds or nutraceuticals of medicinal plants. This effort can be useful to researchers, medical practitioners, the pharmaceutical industry and medicinal plant growers in the upcoming future climate change scenario.

Keywords: Climate change, medicinal plants, bioactive compounds, medical practitioners and nutraceuticals.

Introduction
Climate change is one of the alarming subjects today in the community of scientist and politician of most of the countries and has been recognized as one of the greatest challenges to all the lives on earth. Climate change is causing noticeable effects on the life cycles and distributions of the world's vegetation including medicinal plants, and the population too. It also affects the quality and quantity of bioactive compounds or nutraceuticals used by a human as food supplements or recommended by ayurvedic medicine practitioners to cure human and veterinary disease. The alteration in the chemical composition of nutraceuticals is the result of various metabolic processes of plant systems which are governed by various factors i.e. abiotic and biotic or climatic factors. Medicinal plants are the far more important ancient remedy to cure various ailments than people can imagine. It is well known the importance of medicinal plants to people from many years ago. Its use is given in various ancient systems like Ayurveda, Tibetan medicine, and Chinese medicine. Most of the native countries still practice this system as it is more safe with negligible side effects. Traditional use of herbal medicines refers to the long historical use of these medicines. Their use is well established and widely acknowledged to be safe and effective and may be accepted by national authorities. Today a new concept is derived with a combination of nutrition and pharmaceuticals i.e. nutraceutical. This new concept is giving a new revolution in the health care system. In general, nutraceuticals are products derived from food sources that provide extra health benefits in terms of Vitamins, Minerals etc. more than the food in its natural state. These are dietary supplements that not only give the diet a boost but also help in treatment or diseases prevention. It may be a vegetable i.e. herbal or animal i.e. non-herbal origin. Due to the changing climate scenario with the rise in atmospheric carbon dioxide, there can be seen various changes in medicinal plants secondary metabolites with the addition to their nutritional value and health benefits. This research is gaining new interest in today's world and there are only a few studies conducted on this approach. In this study, our main interest is to give a brief review of medicinal plants where alterations occur in their secondary metabolites due to changing climate scenario which further helps the nutraceutical industries giving them a view to use medicinal plants in which amount to gain nutraceutical benefits with changing the climate of the world.

Materials and Methods

If we give a background check we may found that Stephen De Felice who was founder and chairman of FIM i.e. Foundation for innovation in medicine gives the nutraceutical term. He gives a beautiful definition that nutraceutical is food or parts of food that provide health benefits including the prevention and treatment of diseases. (Brower, 1998). This definition has now broadened to include functional ingredients such as vitamins, minerals, amino acids, fatty acids, and probiotics etc. The Okinawans (people from Japan) have a saying 'Ishoku-Dogen' means, food and medicine from the same source. Their food is rich in anticancer, anti-aging antioxidants. Their traditional diet is based mainly on whole grains, sweet potato, leafy greens, soy products, fish, rice, pork etc. Another example is symi people (known as truly ancients Greeks). Epidemiologists have found that in many parts of the world from ancient times. But people are not aware of this healthy diet in symi people have the best health records and high life expectancy. Their diets consist of garlic, native herbs, extra virgin olive oil with flavored herbs, goat cheese, Greek yogurt, a moderate quantity of wine etc. their meal is mostly raw or lightly cooked thus preserving important vitamins and minerals. Campodimele (a village in Europe). Porcini mushrooms, whole wheat bread, olive oil, fruits, vegetables, meat, beans, almonds etc. Hunza people (valley in the northeast of Pakistan) diet contains apricot cherries, walnuts, mulberries, beans, legumes, organic dairy products and meat whole wheat chapattis etc. (Beare, 1967) [1]. All these people which are given here mostly eat food which is organic, rich in antioxidants, vitamins, minerals, enzymes, and fiber which keep their system alkaline and people from these places have fewer diseases and many of them never had medicine in their entire life. It thus shows that nutraceutical properties are known this today world of modernization which is the main cause of health-related problems (Table 1). In this modern world, people have no time to grow vegetables and scarcity of land for everyone to have a kitchen garden in metro cities is another issue. So nutraceutical products are a great benefit to have their balanced n nutrient-rich diet which will boost their immunity. The list of medicinal plants is shown in Table 1 where the increase in nutraceutical property was found with an increase in atmospheric carbon dioxide concentrations.

Table 1: Uses of various medicinal plants

S. No	Medicinal Plant	Uses (against diseases)
1.	*Digitalis lanata*	Heart disorders, Internal hemorrhage, Inflammatory disorders, Epileptic cases, Acute mania, Ulcers, etc
2.	*Betula pendula*	Renal dysfunction, Kidney stone, Obesity, Arthritis Hypertension, Cholesterol, Cystitis, Nephritis, Diarrhoea and colitis, Liver problem,
3.	*Hymenocallis littoralis*	Tumor**,** Cancer, Viral infections, Bacterial infections etc
4.	*Mentha spicata*	
5.	*Thymus vulgaris*	Bronchitis, Laryngitis, Tonsillitis, Sore mouth, Bad breath, Whooping cough, Arthritis, Gastritis, etc.
6.	*Hypericum perforate*	Neurological disorders and Anticancer potential
7.	*Scutellaria* species	Cancer, Anxiety and stress, Headache, Allergies and asthma, Influenza, pneumonia, and ear infections, Diabetes and atherosclerosis, Heart attack, Hypertension etc
8.	*Zingiber officinale*	Stroke and heart disease, Indigestion nausea, malabsorption, Compromised immunity and respiratory function, Bacterial and Fungal infections, Diabetes etc.
9.	*Labisia pumila*	Hypertension, Vascular fragility, Allergies, Hypercholesterolemia, etc
10	*Artemisia annua*	Malaria, Dysentery, Tuberculosis, Fungal Upset stomach, infections, Common cold, Loss of appetite, Constipation, etc
11	*Elaeis guineensis*	Breast cancer, Cardiovascular disease, Female related problems, Anti-diabetic, Wound healing, etc
12.	*Catharanthus roseus*	Cancer (leukemia), Blood pressure, Mouth ulcer, Malaria, Depression, Nausea, etc

Results and Discussion

Elevated carbon dioxide is a boon to given medicinal plants in increasing their active ingredients, which may be beneficial to pharmaceutical industries in the era of climate change (Table 2). The increase in nutraceutical properties may be due to the rise in the activity of Rubisco enzyme and carbohydrate formation which further develop alterations in secondary metabolites production.

Table 2: Increase in given bioactive compounds under elevated CO_2 comcentrations

S. No	Medicinal Plant	Nutraceutical Properties	Reference
1.	*Digitalis lanata*	Digoxin	Stuhlfauth, and Fock. 1990
2.	*Betula pendula*	Sugar, Proanthocyanidins, Flavonoids, Triterpenoid and Saponins	Lavola and Tiitto.1994
3.	*Hymenocallis littoralis*	Transdihydronarciclasine, Pancratistatin, and Mixture of 7-deoxynarciclasine and 7-deoxy-*trans* dihydronarciclasine	Idso *et al*., 2000
4.	*Mentha spicata*	Piperitenone oxide	Tisserat, B. *et al.,* 2002
5.	*Thymus vulgaris*	Thymol	Tisserat, B. *et al.* 2002
6.	*Hypericum perforate*	Hypericin, Pseudohypericin and Hyperforin	Save, R. *et al*., 2007
7.	*Scutellaria* species	Flavonoids (scutellarein, baicalin, and apigenin)	Stutte and Eraso. 2008
8.	*Zingiber officinale*	Flavanoids (kaempferol, naringenin, fisetin and morin), Phenolic acid (gallic acid, vanillic acid, ferulic acid, tannic acid, cinnamic acid and salicylic acid)	Ghasemzadeh, *et al*., 2010
9.	*Labisia pumila*	Phenolics and Flavanoids	Ibrahim, *et al.,* 2010
10.	*Artemisia annua*	Artemisinin	Supaibulvatana, K. *et al*., 2011
11.	*Eleais guineensis*	Phenolics Flavanoids	Ibrahim and Jaafar, 2012
12.	*Catharanthus roseus*	Sesquiterpene, Sesquiterpene, Phenol, Flavonoid, Carbohydrate, Tannin and Protein	Saravanan and Karthi. 2014

Conclusion

The result concludes that high levels of carbon dioxide up to a certain level is beneficial to given medicinal plants, but everything comes with a threshold. Therefore it is recommended to find out that optimum level up to which these plants can perform better so as to increase the human life span.

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