Nutraceuticals from Fruits and Vegetables at a Glance: A Review

1Mahima, 2Amit Kumar Verma, 3Ruchi Tiwari, 4K. Karthik, 5Sandip Chakraborty, 6Rajib Deb and 7Kuldeep Dhama  
1Department of Animal Nutrition, 2Department of Veterinary Epidemiology and Preventive Medicine, 3Department of Veterinary Microbiology and Immunology, Uttar Pradesh Pandit Deen Dayal Upadhyay Pashu Chikitsa Vigyan Vishvvidyalaya Evum Go-Anusandhan Sansthan (DUVASU), Mathura U.P., India 4Division of Bacteriology and Mycology, 5Division of Pathology, Indian Veterinary Research Institute, Izatnagar, Bareilly (U.P.), India 6Department of Animal Resource Development, Pt. Nehru Complex, Agartala, Tripura, India 7Animal Genetics and Breeding, Project Directorate on Cattle, Indian Council of Agricultural Research, Grass farm Road, Meerut, Uttar Pradesh, India

Abstract: Earth is rich in variety of plant species including the beneficial one having some medicinal properties. The use of herbal medicines for the treatment of various diseases like hepatitis, arthritis, chronic heart diseases, skin disorders, wounds and even cancer have been mentioned in our ‘ayurveda’ and proved scientifically by many researchers of modern times. Now-a-days, fruits and vegetables are gaining popularity in medicine for treating mastitis, foot-and-mouth disease, skin allergies, hypersensitivity reaction, typhany, food poisoning, retention of placenta etc. These medicines are suitable for both the human as well as animals being cost economic and without side effects. Out of 21,000 medicinal plants listed by World Health organization, 2,500 species are found in India making India the largest potential producer of medicinal herbs. The plant or herbs particularly the fruits and vegetables are the cheapest and most common store of nutrients viz., carbohydrates, protein, vitamin, minerals and essential amino acids along with dietary fiber and thus reducing the risk of cardiovascular and metabolic diseases and obesity. Apart from this, fruits and vegetables also supply additional vitamins and minerals to the diet and are important sources of phytochemicals that play important role as antioxidants, phytoestrogens and anti-inflammatory agents and through various protective mechanisms. Fruits and vegetables have the potential to develop nutritional ingredients and supplements, causing a change in the perception of horticultural crops and products and helps in anaerobic digestion. The present review discusses the role of fiber and health benefits of fruits and vegetables for humans and their companion animals.

Key words: Fruits, vegetables, medicine, vaccine, nutraceuticals

INTRODUCTION

In modern days, planet is having various problems like increase in population, unemployment, loss of ethical values (Mahima et al., 2012a, 2011), increase in the incidences of pathogens and diseases like arcobacter (Patial et al., 2011), salmonellosis (Verna et al., 2007), foot-and-mouth disease (Verma et al., 2008, 2012), campylobacteriosis (Kumar et al., 2012a), development of resistance to antibacterial (Verma et al., 2007; Lambey et al., 2009; Kumar et al., 2011; Kumar et al., 2012a, b) and antiviral drugs. These problems have forced the scientists and researchers to think about the natural or alternative medicines and their applications (Hashemi and Davoodi, 2012). Earth is rich in variety of plant species including the beneficial one having some medicinal properties. Some of these have been used since a long time for the immunomodulation to prevent or treat the diseases (Mahima et al., 2012b). Herbal medicines have always been a form of therapy for livestock among resource poor marginal farmers (Tan and Vanitha, 2004; Alamgir and Uddin, 2010; Mizaei-Aghsaghal, 2012). The use of herbal medicines for the treatment of various diseases like hepatitis, arthritis, chronic heart diseases, skin disorders, wounds and even cancer have been mentioned in our ‘ayurveda’ and proved scientifically by many researchers of modern times (Mathew et al., 2010; Umashankar and Shruti, 2011). Now-a-days, herbs are also gaining popularity in veterinary medicine for treating mastitis, foot-and-mouth disease, skin allergies, food
poisoning, tympany, expulsion of placenta, etc. These medicines are suitable for both the human as well as animals being cost economic and without side effects (Rahal and Kumar, 2009). Out of 21,000 plants listed by World Health organization, 2,500 species are found in India declaring the tremendous potential of the country as making India the largest producer of medicinal herbs.

The Plants, or herbs particularly the fruits and vegetables are the cheapest and most common store of nutrients viz., carbohydrates, protein, vitamins, minerals and essential amino acids (Murphy et al., 2012; Binghamer et al., 2012). Apart from that they can also be helpful in treating various diseases (Mahima et al., 2012b). Fruits and vegetables vary in their composition like energy contents, vitamin and mineral contents, fibre contents. Their fiber contents further aid in reducing the risk of cardiovascular disease and obesity (Weingartner et al., 2008). Fruits and vegetables are important source of vitamins, minerals, antioxidants, anti-inflammatory, antimicrobial phytochemicals (Goff and Klee, 2006) and at the same time of those phytochemicals that are having antioxidant properties (Table 1, 2), thereby having a therapeutic effect in patients having coronary heart disease (Hasler, 2005). They share their role either as a cooked delicacy or as a part of the raw salad. The present review discusses the different scientifically validated medicinal role of fruits and vegetables along with their major phytoconstituents important health promotion and protection of human beings and their companion animals (Kalra, 2003; Hui et al., 2010).

In general, fruits and vegetables are the best examples of edible plant harvests, with a potential to develop nutritional ingredients and supplements, causing a change in the perception of horticultural crops and products (Khamuja and Shukla, 2011). Fruits like berries, bananas (Musa spp.), grape (Vitis vinifera), watermelon (Citrullus lanatus), citrus fruits like orange (Citrus sinensis) and lemon (Citrus limon) and vegetables viz., tomato (Solanum lycopersicum), carrot (Daucus carota), beed (Aegle marmelos), pomegranate (Punica granatum), ginger (Zingiber officinale) etc., are having nutraceutical potential. Such lists are ever expanding with emerging research leads across the globe (Tikunov et al., 2010).

Benefits of fruits and vegetables as green salad: Although all vegetables are beneficial, but, interestingly, raw leafy vegetables, having highest levels of vitamins and minerals, offer added benefits by adding roughage and bulk and prevent the drying out of intestinal contents. Raw vegetables are generally used as salad, which help to maintain the gastrointestinal motility and its health (www.ezhealthyt.com). A plate of salad may include a large variety like cabbage, carrot, radish, tomato, onion, turnip, arugula, broccoli, spinach, kale, cabbage, dandelion greens, swiss chard and watercress. The other benefits of green salad include:

- Provide intense flavour, vivid colours and crispy rich texture to the dine menu (Xiao et al., 2012)
- Helpful in weight management through controlling hunger (Ello-Martin et al., 2005)
- Prevent constipation (as discussed above) and enhances gastrointestinal function (Wagensteen et al., 2004)
- Reduce the chances of metabolic diseases viz., diabetes mellitus and hypercholesterolemia (Azadbashti et al., 2012).
- Rich source of vitamins (vitamin B complex) and minerals (Logendra et al., 2002; Dahl et al., 2012)
- Reduces oxidative stress (Esfahani et al., 2011)
- Enhance immunity (Gibson et al., 2012)
- Consumption of green salad reduces the risk of chronic diseases like diabetes, cancer, central nervous system defects, neural tube defects (NTDs) in infants, megaloblastic anaemia and cardiovascular disease (Adams et al., 2006; Vazquez-Prieto and Miattello, 2010; Esfahani et al., 2011; Wolfenden et al., 2012; Imai et al., 2012; Sun et al., 2012; Jin et al., 2012)
- Mitigates the contaminant exposure and/or their adverse health effects (Gagne et al., 2013)

Apart from all the medicinal benefits, the fruits and vegetables like carrot, potato, soyabean, cowpea, can also be used as bioreactor, helping in anaerobic digestion. This permits conversion of organic matter 75% easily biodegradable matters like sugars and hemicellulose, 9% cellulose and 5% lignin to methane, the conversion rate being 70-95% (Bouallagui et al., 2005). Moreover, production of hormones, protein and even edible vaccine against various pathogens of man and animals including anthrax, E. coli, Japanese encephalitis, Helicobacter pylori, Hepatitis, corona virus, parvovirus, papilloma virus, Newcastle disease (Yoshida et al., 2011; Ahmad et al., 2012; Hayden et al., 2012; Huy et al., 2012; Loza-Rubio et al., 2012; Shoji et al., 2012; Wang et al., 2012) are possible. These fruits and vegetables may be the source of various pathogens like norovirus, salmonella, E. coli O157, Vibrio parahaemolyticus, Shigella, Listeria, nematode, trematodes and protozoa (Tunung et al., 2010; Selmid et al., 2011; Mercanoglu Taban and Halkman, 2011; Santachi et al., 2012; Castro-Rosas et al., 2012);
<table>
<thead>
<tr>
<th>Common name</th>
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</thead>
<tbody>
<tr>
<td>Pine apple</td>
<td>Ananas comosus</td>
<td>Bromeliaceae</td>
<td>Bromelin</td>
<td>Stypic, Emmenagogue, Anthermic, Vermicide, Diaphoretic, Aperient</td>
<td>Khan et al. (2011)</td>
</tr>
<tr>
<td>Common plum</td>
<td>Prunus domestica</td>
<td>Rosaceae</td>
<td>Amygdalin, emulsin and a little of malic acid</td>
<td>Coolant, Lacative, Emollient. Antioxidant properties are higher compared to dry fruits. Juice has anti cancer property by inducing apoptotic changes especially in colon cancers in human. Keeps hyperlipidemia in check so useful to prevent atherosclerosis. They are good source of selenium and boron hence preserve bone density</td>
<td>Halkar et al. (2010), Shinagawa et al. (2011), Tanaka et al. (2011)</td>
</tr>
<tr>
<td>Lime, Lemon</td>
<td>Citrus limon</td>
<td>Rutaceae</td>
<td>Geraniol, 1-inalool, Citral and hesperidin</td>
<td>Refrigerant, Pithasamani, Antiscorbutic, Rind of fruit-stomachic, carminative. Rich source of vitamin C thus increases resistance to cold and fever. As an antiseptic and can be used in cuts, bruises and infections. Juice good for asthma, headaches, pneumonia and arthritis. Blood and body purifier and a mild diuretic</td>
<td>Bertuzzi et al. (2013)</td>
</tr>
<tr>
<td>Sour orange, bitter orange</td>
<td>Citrus aurantium</td>
<td>Rutaceae</td>
<td>d-Isalaol and hesperidin</td>
<td>Refrigerant, stomachic, tonic. Blood purifier</td>
<td>Hass et al. (2006), Petito et al. (2012)</td>
</tr>
<tr>
<td>Guava</td>
<td>Psidium guajava</td>
<td>Myrtaceae</td>
<td>Eugenol, essential oil and minerals</td>
<td>Locative. Anti bacterial activity against diarrhoea causing organisms like <em>Staphylococcus, Shigella, Salmonella, Bacillus, E. coli, Clostridium</em> and <em>Pseudomonas</em></td>
<td>Currier et al. (2009), Kanath et al. (2008), Rai et al. (2009)</td>
</tr>
<tr>
<td>Jambul</td>
<td>Eugenia jambolana</td>
<td>Myrtaceae</td>
<td>Jambolone, a pale yellow essential oil, ellagic acid</td>
<td>Stomachic, Diuretic, hepatoprotective, Tonic, Haematogenic and semen promoter</td>
<td>Grover et al. (2009), Sisodia and Bhatnagar (2009)</td>
</tr>
<tr>
<td>Indian gooseberry, Emblica myrobolan</td>
<td>Phyllanthus emblica</td>
<td>Euphorbiaceae</td>
<td>Essential oil, Emblica acid, Phyllanthin</td>
<td>Refrigerant, Diuretic, Lacative, Nutritive tonic. As it is rich in Vitamin C it is used for treatment of scurvy. Possess anti-viral (HIV, AIDS, HERPES VIRUS, CMV) antimutagenic, anti-allergic, anti-bacterial properties</td>
<td>DebMandal and Manda (2011), Dhale and Mogle (2011)</td>
</tr>
<tr>
<td>Papaw or pawpaw tree</td>
<td>Carica papaya</td>
<td>Caricaceae</td>
<td>Papain or papaytoin, papainic acid, carpa and carpace</td>
<td>Locative, digestive, diuretic, anthelmintic, Emmenagogaue, allinotic, Antioxidant, antiviral, anti-inflammatory and antiyptic. Fibrinolytic helps in dissolving the blood clots. Aids digestion Contains high manganese content which is good for preventing osteoporosis and bone fractures</td>
<td>Anibijouw and Udde (2009), Singh and Ali (2011)</td>
</tr>
<tr>
<td>Mangosteen</td>
<td>Garcinia mangostana</td>
<td>Guttiferae</td>
<td>Mangosin, Mangostin</td>
<td>Antioxidant, Febrifuge</td>
<td>Pedrazzini-Chaveri et al. (2008), Obolsky et al. (2009), Waadhez et al. (2007)</td>
</tr>
<tr>
<td>Mango</td>
<td>Mangifera indica</td>
<td>Anacardiaceae</td>
<td>Gallic acid</td>
<td>Locative, diuretic, tonic, anthelmintic. Rich in iron, thus helpful in anaemia. The esters, terpenes and aldehydes present in the mangoes, increase appetite and also improve digestion. High content of vitamin B6, help in maintaining and improving the brain functions. The beta-carotene present helps in enhancing the immune system of the body and makes it strong.</td>
<td>Jurini (2008)</td>
</tr>
<tr>
<td>Pomegranate</td>
<td>Punica granatum</td>
<td>Punicaceae</td>
<td>Protein, Minerals like Ca, Mg, P, Fe, Na, K, Cu, S, Cl and Vitamins like carotene, thiamine, riboflavin, Nicotinic acid, vit C, Pectin. Fruit rind has Urolitic acid</td>
<td>Coolant. Can suppress estrogen thus helpful in preventing breast cancer. Slow the development of Alzheimer's disease. Its juice helpful in diarrhoea, cure stomach ailments dysentery. Anti-inflammatory, prevents morning sickness, nausea, Antioxidant and reduce blood pressure. Prevent bacteria from sticking to the epithelial lining of the stomach. Fiber content maintains the bowels movements and help in preventing hemorrhoids and constipation during pregnancy</td>
<td>Jurini (2008)</td>
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Table 1: continued

<table>
<thead>
<tr>
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</tr>
</thead>
<tbody>
<tr>
<td>Plantain or Banana</td>
<td><em>Musa paradisaca</em></td>
<td>Gramineae</td>
<td>Vitamin A, Tannin and minerals like Ca, Mg, P, S, Fe and Cu</td>
<td>Demulcent, laxative, nutritive, emollient, astringent. Smoothens the stomach.</td>
<td>Islam and Akter (2011)</td>
</tr>
<tr>
<td>Stone apple/bael</td>
<td><em>Aegle marmelos</em></td>
<td>Rutaceae</td>
<td>Mucilage, pectin, sugar, tannin (tannic acid), volatile oil and bitter principle</td>
<td>Astringent, laxative, stomachic</td>
<td>Sharma et al. (2011)</td>
</tr>
</tbody>
</table>

Table 2: Vegetables their scientific name, active principle and health benefits

<table>
<thead>
<tr>
<th>Vegetable</th>
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</thead>
<tbody>
<tr>
<td>Ladies finger</td>
<td><em>Abelmoschus esculentus</em></td>
<td>Malvaceae</td>
<td>Mucilage</td>
<td>Have blood sugar stabilizing property by regulating sugar absorption from intestine. Have anti ulcer property. Have hypoglycaemic effect. Lower cholesterol in blood and prevent cancer as it binds to bile acids</td>
<td>Kablon et al. (2007),  Sathïa et al. (2011)</td>
</tr>
<tr>
<td>Tamarind</td>
<td><em>Tamarindus indica</em></td>
<td>Leguminosae</td>
<td>Cardiac glycosides, tannic acid</td>
<td>Have anti microbial effect, anti-inflammatory properties, hypolipidemic and antioxidant activities</td>
<td>Doughari (2006),  Ibekiri et al. (2006)</td>
</tr>
<tr>
<td>Coconut</td>
<td><em>Cocos nucifera</em></td>
<td>Arecaceae</td>
<td>Phytochemicals, peroxidase, RNA polymerases</td>
<td>Coconut juice has estrogenic effect. Have both anti bacterial and anti viral properties, antioxidant effect, anti thrombolic effect</td>
<td>Espinosa et al. (2002)</td>
</tr>
<tr>
<td>Egg plant</td>
<td><em>Solanum melongena</em></td>
<td>Solanaceae</td>
<td>Rich source of iron, calcium, potassium, phosphorus, vitamin B complex</td>
<td>Antiarrhythmic and hypotensive effect. Lowers blood cholesterol level</td>
<td>Guimarães et al. (2009),  Diab et al. (2011)</td>
</tr>
<tr>
<td>Drum stick</td>
<td><em>Moringa oleifera</em></td>
<td>Moringaceae</td>
<td>Its leaves are particularly rich in potassium, calcium, phosphorous, iron, vitamin A and D</td>
<td>Can be used for diabetes, hypertension, or HIV/AIDS</td>
<td>Daye et al. (2008),  Mbikay (2012)</td>
</tr>
<tr>
<td>Cabbage</td>
<td><em>Brassica oleracea</em></td>
<td>Brassicaceae</td>
<td>Beta carotene</td>
<td>Have anticancer, antioxidant, antiinflammatory, analgesic properties. Improve digestion, circulation and remove constipation</td>
<td>Decher (1994)</td>
</tr>
<tr>
<td>Carrot</td>
<td><em>Daucus carota</em></td>
<td>Apiaceae</td>
<td>Acid oligosaccharides</td>
<td>Potent anti cancer, artery protecting, immune-modulating infection-fighting, antioxidant properties, Promote reproductive power, relieve constipation, decrease cholesterol</td>
<td>Thangamattalam et al. (2013),  Stahl and Sies (2012),  Xiao et al. (2012)</td>
</tr>
<tr>
<td>Cucumber</td>
<td><em>Cucumis sativus</em></td>
<td>Cucurbitaceae</td>
<td>No active principle</td>
<td>Have cooling effect, Helpful in fevers, acidosis constipation, high blood pressure, rheumatism, obesity</td>
<td>Shohag et al. (2012)</td>
</tr>
<tr>
<td>Radish</td>
<td><em>Raphanus sativus</em></td>
<td>Brassicaceae</td>
<td>Raphanin</td>
<td>Anti-microbial, antiviral and secretolytic property; Helpful in uterine involution, bronchitis, hyperlipidemia</td>
<td>Ghayar and Gilani (2005),  Beerei et al. (2005),  Sacan and Yanardag (2010)</td>
</tr>
<tr>
<td>Beet</td>
<td><em>Beta vulgaris</em></td>
<td>Amaranthaceae</td>
<td>Betacyanin</td>
<td>Beneficial effect in tuberculosis, constipation, poor appetite, obesity, gout, pimples and tumors, hepatic disorders</td>
<td>Lee et al. (2009),  Meghvansi et al. (2010),  Zimmer et al. (2012)</td>
</tr>
<tr>
<td>Chilli</td>
<td><em>Capsicum</em></td>
<td>Solanaceae</td>
<td>Capsaicinoids, Lignan</td>
<td>Antioxidant and anti-inflammatory properties; Helps in uterine involution</td>
<td></td>
</tr>
<tr>
<td>Tomato</td>
<td><em>Solanum lycopersicum</em></td>
<td>Solanaceae</td>
<td>Lycopene, Betacarotene</td>
<td>Potent antioxidant, helpful in prevention of arterial diseases and cancer</td>
<td>Panigrahi and Sahoo (2011)</td>
</tr>
<tr>
<td>Pea</td>
<td><em>Pisum sativum</em></td>
<td>Fabaceae</td>
<td>Antioxidant and anticancer, anti fertility and abortifacient effect. Inhibit osteoporosis and obesity</td>
<td></td>
<td>Dahl et al. (2012)</td>
</tr>
<tr>
<td>Beans</td>
<td></td>
<td>Fabaceae</td>
<td></td>
<td>Beneficial in anaemia, cancer; Helps in regulation of blood sugar level and cholesterol</td>
<td>Villegas et al. (2008a, b),  Panigrahi and Sahoo (2011),  Terashima et al. (2013)</td>
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Table 2: Conitains

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</tr>
</thead>
<tbody>
<tr>
<td>Potato</td>
<td>Solanum tuberosum</td>
<td>Solanaceae</td>
<td>glycoalkaloids, alpha-chaconine and alpha-solanine aliin, alliin, ajoene, allicydeprop, diallyl, trisulfide, allylsulfoxide, vinylideneallil, S-allylmercaptoaceteycystein, and others</td>
<td>Useful in dyspepsia, skin diseases and cancer. Due to high potassium, beneficial in high blood pressure and strokes</td>
<td>Vlahogiannis et al. (2010)</td>
</tr>
<tr>
<td>Garlic</td>
<td>Allium sativum</td>
<td>Amaryllidaceae</td>
<td>Quercetin, volatile sulfur compounds</td>
<td>Helpful in anemia, skin disorders, stomach cancer, bacterial infection, eye infection, reducing low density lipoprotein, suppress plate; Commonly used to treat cold, cough, bronchitis and influenza; Prevent asthma attack</td>
<td>Augusti (1996)</td>
</tr>
<tr>
<td>Onion</td>
<td>Allium cepa</td>
<td>Amaryllidaceae</td>
<td>Petroseoline acid, Lovastin, flavonoids, phenolic acids and mucilage (a soluble fiber), curcumin, carnosol, limonone, borneol, camphor, eugenol and limonene</td>
<td>Beneficial in tumsympy, food poisoning, diarrhea, constipation, indigestion and dyspepsia; Useful in treatment of diabetes, epilepsy, depression, hypertension; Potent diuretic and neuroprotective effect</td>
<td>Hofmann et al. (2001)</td>
</tr>
<tr>
<td>Coriander</td>
<td>Coriandrum sativum</td>
<td>Apiaceae</td>
<td>Coriander's flavonoids include quercetin, kaempferol, rutin and epigallocatechin</td>
<td>Antioxidant, antibacterial properties, Combats travel sickness. Helpful in cough and cold</td>
<td>Park et al. (2012)</td>
</tr>
<tr>
<td>Ginger</td>
<td>Zingiber officinale</td>
<td>Zingiberaceae</td>
<td>terpenes and oleoresin, Gingerol, shogaol</td>
<td>Have potential to treat wounds, cancer, bacterial infection, intestinal worms; Improves appetite, Prevent stroke</td>
<td>Wong and Kita (2006)</td>
</tr>
<tr>
<td>Steaphal</td>
<td>Annona squamosa</td>
<td>Anonaceae</td>
<td>Annonotonin, annonaceousin</td>
<td></td>
<td>Sun et al. (2012)</td>
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Huat et al., (2012); pesticides, insecticides and herbicides residues, if they are grown in contaminated water (Huat et al., 2012). Therefore a due care is required, while consuming these fruits and vegetables, especially the green one as salad (Knee, 2002).

CONCLUSION AND FUTURE PROSPECTS

There is an increased awareness among the people for the beneficial effect of nutraceuticals in day to day life. Fruits and vegetables are commonly used by us can serve an important prophylactic and therapeutic role ingredient of food in our day to day life. Increase in their consumption is a potent practical strategy to optimize health of human as well as their companion animals. For a developing undernourished country like India, their plausible pivotal role in promotion of human and animal health and well being can never be exagerrated. Due to their multifactorial health benefits, they are designated as millennium food of century. The present information is just the beginning, yet a large volume of indigenous folklore and undiscovered values remains to be paved through. Therefore, there is an urgent need to explore the beneficial and medical properties of fruits and vegetables.

REFERENCES


