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Nutraceuticals from Fruits and Vegetables at a Glance: A Review

¹Mahima, ²Amit Kumar Verma, ³Ruchi Tiwari, ⁴K. Karthik,
⁶Sandip Chakraborty, ⁷Rajib Deb and ⁵Kuldeep 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 Vishvidhyalaya 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, tympany, 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 (Patyal *et al.*, 2011), salmonellosis (Verma *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 longtime 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-Aghsaghali, 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; Umashanker and Shruti, 2011). Now-a-days, herbs are also gaining popularity in veterinary medicine for treating mastitis, foot-and-mouth disease, skin allergies, food

Corresponding Author: Mahima, Department of Animal Nutrition, Uttar Pradesh Pandit, Deen Dayal Upadhyay Pashu Chikitsa Vigyan Vishvidhyalaya Evum Go-Anusandhan Sansthan, Mathura U.P., 281001, India

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, vitamin, minerals and essential amino acids (Murphy *et al.*, 2012; Bumgarner *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 beneficiary 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 (Khanuja 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*), bael (*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.ezhealthydiet.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 (Azadbakht *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 anemia and cardiovascular disease (Adams *et al.*, 2006; Vazquez-Prieto and Miatello, 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 pirus, 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; Schmid *et al.*, 2011; Mercanoglu Taban and Halkman, 2011; Santana *et al.*, 2012; Castro-Rosas *et al.*, 2012);

Table 1: Fruits, their scientific name, active principle and health benefits

Common name	Scientific name	Family name	Active principle	Beneficial health effects	References
Pine apple	<i>Ananas comosus</i>	Bromeliaceae	Bromelin	Styptic, Emmenagogue, Anthelmintic, Vermicide, Diaphoretic, Aperient Uuripe fruit improves digestion and can be used for dyspepsia. Uterine tonic. Helps in faster wound healing. Also have anti diabetic, anti oxidant and anti hyperlipedemic properties.	Khan <i>et al.</i> (2011)
Common plum	<i>Prunus domestica</i>	Rosaceae	Amygdalin, emulsin and a little of malic acid	Coolant, Laxative, 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 hyperlipedemia in check so useful to prevent atherosclerosis. They are good source of selenium and boron hence preserve bone density	Halloran <i>et al.</i> (2010), Shivhare <i>et al.</i> (2011), Tanaka <i>et al.</i> (2011)
Lime, Lemon	<i>Citrus limonum</i>	Rutaceae	Geraniol, 1-linalool, Citral and hesperidin Glucosides	Refrigerant, Pithasamani, Antiscorbutic, Rind of fruit-stomachic, carminative. Rich source of vitamin C thus increases resistance to cold/fever. As 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	Bertuzzi <i>et al.</i> (2013)
Sour orange, bitter orange	<i>Citrus aurantium</i>	Rutaceae	d-linalool and glucoside hesperidin	Refrigerant, stomachic, tonic. Blood purifier. Rich in vitamin C and betacarotene, thus anticancer property. Helpful in asthma attacks, bronchitis, atherosclerosis, gum disease, boost fertility and healthy sperm	Haaz <i>et al.</i> (2006), Peixoto <i>et al.</i> (2012)
Guava	<i>Psidium guajava</i>	Myrtaceae	Eugenol, essential oil and minerals	Laxative. Anti bacterial activity against diarrhoea causing organisms like <i>Staphylococcus</i> , <i>Shigella</i> , <i>Salmonella</i> , <i>Bacillus</i> , <i>E. coli</i> , <i>Clostridium</i> and <i>Pseudomonas</i>	Gutierrez <i>et al.</i> (2008), Kamath <i>et al.</i> (2008), Rai <i>et al.</i> (2009)
Custard apple, sugar apple	<i>Annona squamosa</i>	Annonaceae	acrid	Coolant, Tonic, Haematinic. Seeds have anti tumour effect. Helps in wound healing. Enhances immunity. Helpful in prevention of cancer. Have potent antibacterial property. Curbs appetite. Reduces fat absorption. Prevents strokes. Seeds used in managing enlarged prostate glands in man and for control of intestinal worms	Pandey and Barve (2011) Chen <i>et al.</i> (2012)
Jambul	<i>Eugenia jambolana</i>	Myrtaceae	Jamboline, a pale yellow essential oil, ellagic acid	Stomachic, Diuretic, hepatoprotective, Tonic, Haematinic and semen promoter	Grover <i>et al.</i> (2000), Sisodia and Bhatnagar (2009)
Indian gooseberry, Emblic myrobalan	<i>Phyllanthus embelica</i>	Euphorbiaceae	Essential oil, Emblic acid, Phyllanthin	Refrigerant, Diuretic, Laxative, 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, antiallergic, anti-bacterial properties	DebMandal and Manda (2011), Dhale and Mogle (2011)
Papaw or papaya tree	<i>Carica papaya</i>	Caricaceae	Papain or papayotin, papayic acid, carpaine and carposide	Laxative, digestive, diuretic, anthelmintic, emmenagogue, alterative. Antibacterial, antiviral, anti-inflammatory and antipyretic. Fibrinolytic helps in dissolving the blood clots. Aids digestion Contains high manganese content which is good for preventing osteoporosis and bone fractures	Anibijuwon and Udeze (2009), Singh and Ali (2011)
Mangosteen	<i>Garcinia mangostana</i>	Guttiferae	Mangosim, Mangostin	Astringent, Febrifuge	Pedraza-Chaverri <i>et al.</i> (2008), Obolskiy <i>et al.</i> (2009)
Mango	<i>Mangifera indica</i>	Anacardiaceae	Gallic acid	Laxative, diuretic, tonic, anthelmintic. Rich in iron, thus helpful in anemia. 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.	Wauthoz <i>et al.</i> (2007)
Pomegranate	<i>Punica granatum</i>	Punicaceae	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 Ursolic acid	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. Fibre content maintains the bowels movements and help in preventing hemorrhoids and constipation during pregnancy	Jurenka (2008)

Table 1: continue

Common name	Scientific name	Family name	Active principle	Beneficial health effects	References
Plantain or Banana	<i>Musa paradisiaca</i>	Scitamineaceae	Vitamin A, Tannin and minerals like Ca, Mg, P, S, Fe and Cu	Demulcent, laxative, nutritive, emollient. astringent. Smoothens the stomach. Good for dyspepsia. Strengthens the mucosa of stomach against acid and ulcers	Imam and Akter (2011)
Stone apple/bael	<i>Aegle marmelos</i>	Rutaceae	Mucilage, pectin, sugar, tannin (tannic acid), volatile oil and bitter principle	Astringent, laxative, stomachic	Sharma <i>et al.</i> (2011)

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

Vegetable	Scientific name	Family name	Active principles	Beneficial health effects	References
Ladies finger	<i>Abelmoschus esculentus</i>	Malvaceae	mucilage	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	Kahlon <i>et al.</i> (2007), Sabitha <i>et al.</i> (2011)
Tamarind	<i>Tamarindus indica</i>	Leguminosae	cardiac glycosides, tartaric acid	Have anti microbial effect, anti-inflammatory properties, hypolipomic and antioxidant activities	Doughari (2006), Iftekhar <i>et al.</i> (2006)
Coconut	<i>Cocos nucifera</i>	Arecaceae	Phytohormones, peroxidase, RNA polymerases	Coconut juice has estrogenic effect. Have both anti bacterial and anti viral properties, antidote effect, antioxidant effect, antithrombotic effect	Esquenazi <i>et al.</i> (2002)
Egg plant	<i>Solanum melongena</i>	Solanaceae	Rich source of iron, calcium, potassium, phosphorus, vitamin B complex	Antihemorrhoidal and hypotensive effect. Lowers blood cholesterol level	Guimaraes <i>et al.</i> (2000), Diab <i>et al.</i> (2011)
Drum stick	<i>Moringa oleifera</i>	Moringaceae	its leaves are particularly rich in potassium, calcium, phosphorous, iron, vitamins A and D	Can be used for diabetes, hypertension, or HIV/AIDS	Dieye <i>et al.</i> (2008), Mbikay (2012)
Cabbage	<i>Brassica oleracea</i>	Brassicaceae	Beta carotene	Have anticancer, antioxidant, antiasthmatic, analgesic properties. Improve digestion, circulation and remove constipation	Beecher (1994)
Broccoli	<i>Brassica oleracea</i>	Brassicaceae	Quercetin, sulphoraphane, polyphenols, glucosinolates	Potent antioxidant, anticancer activity; Reduces cholesterol; Rich source of Chromium that regulates insulin	Mahn and Reyes, (2012), Soengas <i>et al.</i> (2012)
Carrot	<i>Daucus carota</i>	Apiaceae	Acid oligosaccharides	Potent anticancer, artery-protecting, immune-modulating infection-fighting, antioxidant properties; Promote reproductive potential; relieve constipation; decrease cholesterol	Thangam <i>et al.</i> (2013) Stahl and Sies (2012) Xiao <i>et al.</i> (2012)
Cucumber	<i>Cucumis sativus</i>	Cucurbitaceae		Have cooling effect, Helpful in fevers, acidosis constipation, high blood pressure, rheumatism, obesity	Shohag <i>et al.</i> (2012)
Radish	<i>Raphanus sativus</i>	Brassicaceae	Raphanin	Anti-microbial, antiviral and secretolytic property; Helpful in uterine involution, bronchitis, hyperlipidemia	Ghayur and Gilani (2005) Beevi <i>et al.</i> (2009)
Beet	<i>Beta vulgaris</i>	Amaranthaceae	Betacyanin	Beneficial effect in tuberculosis, constipation, poor appetite, obesity, gout, pimples and tumors, hepatic disorders	Sacan and Yanardag (2010)
Chilli	Capsicum	Solanaceae	Capsaicinoids, Lignan	Antioxidant and anti-inflammatory properties; Helps in uterine involution	Lee <i>et al.</i> (2009), Meghvansi <i>et al.</i> (2010), Zimmer <i>et al.</i> (2012)
Tomato	<i>Solanum lycopersicum</i>	Solanaceae	Lycopene, Betacarotene	Potent antioxidant, helpful in prevention of arterial diseases and cancer	Panigrahi and Sahoo (2011)
Pea	<i>Pisum sativum</i>	Fabaceae		Antioxidant and anticancer, antifertility and abortifacient effect. Inhibit osteoporosis and obesity	Dahl <i>et al.</i> (2012)
Beans		Fabaceae		Beneficial in anaemia, cancer; Helps in regulation of blood sugar level and cholesterol	Villegas <i>et al.</i> (2008a, b) Panigrahi and Sahoo (2011), Terashima <i>et al.</i> (2013)

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Vegetable	Scientific name	Family name	Active principles	Beneficial health effects	References
Potato	<i>Solanum tuberosum</i>	Solanaceae	glycoalkaloids, alpha-chaconine and alpha-solanine	Useful in dyspeptia, skin diseases and cancer. Due to high potassium, beneficial in high blood pressure and strokes	Vlachojannis <i>et al.</i> (2010)
Garlic	<i>Allium sativum</i>	Amaryllidaceae	alini, allicin, ajoene, allylpropl, diallyl, trisulfide, sallylcysteine, vinylthiines, S-allylmercaptocystein, and others	Antiparasitic, anticancer, antiviral, antibacterial, antiallergic, immunomodulating, antihypertensive activities Helpful in reducing migraine, blood pressure.	Tan and Vanitha (2004), Park <i>et al.</i> (2012)
Onion	<i>Allium cepa</i>	Amaryllidaceae	Quercetin, volatile sulfur compounds	Helpful in anaemia, 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	Augusti (1996) Hofgen <i>et al.</i> (2001) Tan and Vanitha (2004), Ahmed and Bassuony (2009) Lanzotti <i>et al.</i> (2012) Wagensten <i>et al.</i> (2004)
Coriander	<i>Coriandrum sativum</i>	Apiaceae	Petroselinic acid, Linalool, flavonoids, phenolic acids and mucilage (a soluble fiber), carvone, geraniol, limonene, borneol, camphor, elemol and linalool. Coriander's flavonoids include quercitin, kaempferol, rhamnetin and epigenin	Beneficial in tympany, food poisoning, diarrhoea, constipation, indigestion and dyspepsia; Useful in treatment of diabetes, epilepsy, depression, hypertension; Potent diuretic and neuroprotective effect.	Wong and Kitts (2006) Tan and Vanitha (2004) Park <i>et al.</i> (2012)
Ginger	<i>Zingiber officinale</i>	Zingiberaceae	terpenes and oleoresin, Gingerols, shogaol	Antioxidant, antibacterial properties, Combats travel sickness. Helpful in cough and cold	Wong and Kitts (2006) Tan and Vanitha (2004) Park <i>et al.</i> (2012)
Sitaphal	<i>Annona squamosa</i>	Aunonaceae	Annotemoyin, annosquamosin	Have potential to treat wounds, cancer, bacterial infection, intestinal worms; Improves appetite; Prevent stroke	Sun <i>et al.</i> (2012) Pourasu and Suguna (2012)

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 exaggerated. 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.

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