Review Article

PHYTOTHERAPY OF MALNUTRITIONAL CANCERS IN ANIMALS

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ABSTRACT

In the so called 'Third World', where poverty is common, millions of poor people are engaged in hard labours. Millions and millions of animals like horses, donkeys, bullocks and he-buffaloes, etc. work day in day out in cart or for other carriage. All of them don't get good food and don't get enough to drink. They have to work in the burning sun, on busy and dusty roads, without one moment of rest. Next to that, some individuals don't even know that 'What is pain'. A lot of poor people and different species of animals have to work till they drop dead, and that often happens in the streets. They are day-to-day exposed to numerous environmental hazards and disasters, including xenobiotics, contaminants, radiations, genetic factors, etc. All these result in 'malnutrition' which may cause 'cancer', i.e., "malnutritional cancer". Overall, the poverty and decreased dietary intake of good quality are the most important causes of malnutritional cancer. From ancient times we, in India have endowed food with magical qualities. The episodes in the history of man's battle against disease clearly illustrate the fact that food can cure many diseases. Thus, food or 'phytotherapy' can be the best remedy for malnutritional cancer. The medicinal plants, including fruits and vegetables have versatile immunomodulatory and anticancer activities. Consumption of large amounts of fruits and vegetables can prevent the development of cancer. Many doctors recommend that people wishing to reduce risk of cancer eat several pieces of fruits and several portions of vegetables every day. This review article, therefore, explore out the certain phytotherapies (remedies) against malnutritional cancers occurring in the animals.

Keywords: Animals, malnutritional cancers, phytotherapy (edible plants), vegetables and fruits.

INTRODUCTION

Cancer, a disease of human and other multicellular animals, is formed as a result of abnormal, excessive, autonomous and purposeless proliferation of cells. Cancer is the largest (or second leading) cause of mortality in the world, is and caused by a complex, poorly understood interplay of genetic and environmental factors. Reports show that several environmental factors, including air, water and industrial pollutants, environmental chemicals and radiations, etc. may cause various cancers[1-2]. The incidence of cancer is increasing worldwide, and millions and millions of humans and animals are died every year. The animals like horses, donkeys, bullocks and he-buffaloes, etc. work day in day out in cart or for other carriage. All of them don't get good food and don't get enough to drink. They have to work in the burning sun, on busy and dusty roads, without one moment of rest. A lot of animals have to work till they drop dead, and that often happens in the streets. They are day-to-day exposed to numerous environmental hazards and disasters, including xenobiotics, contaminants, radiations, genetic factors, etc. All these result in 'malnutrition' which may cause "malnutritional cancer". Overall, the poverty and decreased dietary intake of good quality are the most important causes of malnutritional cancer. Now, the cancer is a burning problem in this westernized 'Ultra-Modern Era' even in our country.

Eating too little or too much will result in poor health. The food eaten must not only be nutritious but it must also be complete and clean, otherwise the individual eating the food would get ill even the food is nutritious. So, if the right food is not consumed in right amounts it results in "malnutrition" (mal-noo-trish-un) which may lead to either 'undernutrition' and 'overnutrition'[1]. Malnutrition occurs when we do not get enough calories or nutrients and hence, it may cause several diseases, including cancer. Malnutrition acts as carcinogen in many ways to produce cancer in human beings and animals, and so the aetiological role of malnutrition preceding clinical cancer has been firmly established[1,3]. In India, malnutrition is the single largest cause of the mortality and morbidity not only in infants, children and working or pregnant women, but also in livestock animals. The single major factor responsible for the wide prevalence of malnutrition in India is the poverty[1]. Like many countries, India is also facing a great problem of malnutrition. Thus, similar to the human beings, the animals (viz., horse, cattle, buffalo, sheep, goat, pig, dog, poultry, and also wild animals, etc.) suffering from malnutrition need special attention. Those in moderate and mild degree of malnutrition require additional food in order to bring their weight to normal; whereas, those suffering from a severe degree of malnutrition need special attention by the owner as well as veterinarian because such animals usually suffer from diarrhoea, respiratory infections and other diseases. It has been clearly stated[1,4] that malnutrition predisposes to

infection, or infections lead to malnutrition. The body requires energy to carry out the different activities, and proteins are necessary for growth and repair. Deficiency of these two basic nutrients in our body leads to "protein energy malnutrition" (PEM). This disorder has very serious consequences, leading to cancer and/or death.

From ancient times we, in India, have endowed food with magical qualities. In the Vedic times, food was associated with divine attributes. This tradition was prevalent in other societies as well- ancient Egypt, for example. Ancient people discovered the healing powers of food-perhaps initially by accident. Later, these patterns became well established and were described in medical and veterinary texts. It is quite evident that the diseases which can be cured by food or nutrient concentrates are caused by deficiency of particular nutrients. Thus the malnutritional disorders can be cured by giving food sources rich in the nutrient that is otherwise lacking in the diet, and there is no doubt that food can help to control several ailments[1]. The treatment of malnutrition may include increasing the calories and nutrients in diet. If malnutrition results in cancer, it is very difficult to treat, but some improvements can be brought about by proper foods and drugs[1,5]. Modern (allopathic) drugs being a major treatment modality for the treatment of diseases, exhibit severe toxicity on normal tissues, so the 'phytotherapy' is needed. The edible plants serve as a food and medicinal sources, which maintain the health and vitality of the individuals with no ill effect. India is the largest producer of medicinal plants and is rightly called the "Botanical garden of the World". In the indigenous system of medicine, numerous medicinal plants and their formulations are now being used for the treatment and control of various diseases, including cancer. More than 50% of all modern drugs in clinical use are of natural products, many of which have the ability to include apoptosis in various tumour cells. Medicinal plants are known to have good immunomodulatory properties. They act by stimulating both non-specific and specific immunity. They may promote host resistance against infection by re-stabilizing body equilibrium and conditioning the body tissues[1,7-8]. Some medicinal plants and their products, including vegetables, fruits and crops play an important role for cancer prevention. Consumption of large amount of vegetables and fruits may prevent from the cancer. Many doctors recommend that people wishing to reduce their risk of cancer eat several pieces of fruits and several portions of vegetables every day. Many plant-derived products exhibit potent anticancer activity against several cancers. Thus, it is distinct that medicinal plants, including edible plants (fruits and vegetables) elicit immunomodulatory and anticancer activities[8-11].

With the above backgrounds, an attempt has been taken through this review article to elucidate on the malnutritional cancers occurring in animals, and their remedial approach by phytotherapy (edible plants) with special reference to vegetables and fruits.

MALNUTRITIONAL CANCERS IN ANIMALS

If an individual eats the right kind of foods in the required amounts, that individual will keep good health provided no other factors intervene. On the other hand, a poor eating pattern or eating too little or too much will result in poor health. These are both facets of "malnutrition". When the diet supplies too little of one or more nutrients, a kind of malnutrition called 'undernutrition' occurs. When the diet provides too much of one or more nutrients, another form of malnutrition called 'overnutrition' results. Malnutrition most often refers to undernutrition resulting from an inadequate consumption, poor absorption, or excessive loss of nutrients, but the term can also encompass overnutrition resulting from excessive intake of specific nutrients. An individual will experience malnutrition if the appropriate amount of, or quality of nutrients comprising a healthy diet are not consumed. An extended period of malnutrition can result in starvation or many other diseases such as scurvy and cancer. The individual suffering from malnutrition almost always have infections such as diarrhoea and respiratory infections. Just as infections are common in cases of severe malnutrition, infections like diarrhoea and whooping cough can also cause malnutrition. Thus, malnutrition can increase the risk of infections and infections can, in turn, lead to malnutrition. This inter-relationship and synergistic effect of malnutrition and infections often lead to a high incidence of cancer and/or deaths. Malnutrition leads to infection by reducing the diseases-fighting capacity of the body[1]. Many environmental or pollution factors, including poverty that contribute to eating disorder or malnutrition.

In animals, PEM may result due to deficiency of energy and protein. This disorder is of three types, namely: (a) Marasmus (deficiency of both carbohydrate and protein); (b) Kwashiorkor (deficiency of only protein); and (c) an intermediate state of marasmus and kwashiorkor[1,4,12]. 'Marasmus' is characterized by very low body weight and weight loss due to growth failure, stunting, loss of subcutaneous fat, gross muscle wasting, emaciation and failure to thrive. In addition, watery diarrhoea is associated often with dehydration, irritation (does'nt allow to touch), decreased responsiveness, behavioural changes, no oedema and wrinkled dry skin dry. Other deficiencies particularly, vitamin A deficiency may occur. 'Kwashiorkor' is characterized by oedema of whole body (especially belly), wasted muscles and retarded growth. Other signs and symptoms include psychomotor changes, hepatomegaly (enlarged, fatty liver), irritability, skin changes (flaky paint appearance and mosaic skin appearance), vitamins A and B deficiencies and associated diseases such as watery diarrhoea, severe respiratory infection (cough), etc. In intermediate type of PEM, the features of both marasmus and kwashiorkor PEM are seen. Associated symptoms like vitamin C deficiency, zinc deficiency, atrophy of the papillae on the tongue, angular stomatitis, xerophthalmia, etc. may occur[12]. PEM can

result in marked hypoalbuminemia, anemia, oedema, muscle atrophy, delayed wound healing, impaired immunocompetence, weight loss, reduced basal metabolism, depletion of subcutaneous fat and tissue, bradycardia and hypothermia. The patient with PEM is typically emaciated, elderly and chronically ill. Thus, malnutrition places stressed patients at a greatly increased risk for morbidity, leading to cancer and mortality. Moreover, there may be a longer recovery period, impaired host defenses and sepsis, impaired wound healing, anemia, impaired gastrointestinal tract function, muscle atrophy, impaired cardiac function, impaired respiratory function, reduced renal function, brain dysfunction, delayed bone callus formation and atrophic skin[1,4].

Cancer is primarily an environmental disease. In animals, the common environmental factors leading to cancer may be bad feed or diet, infections, radiation, hard working and environmental pollutants. These environmental factors cause abnormalities in the genetic material of cells. Cell reproduction is an extremely complex process, which is normally tightly regulated by several classes of genes, including oncogenes and tumor suppressor genes. Hereditary or acquired abnormalities in these regulatory genes can lead to development of cancer[12]. Abnormal diets such as fad or limited diet and recent decrease in food intake usually cause malnutrition[4]. There is an increased risk of malnutrition associated with chronic diseases such as cancer, and diseases of intestinal tract, kidney and liver. Patients with these chronic diseases, especially cancer may lose weight rapidly. Studies show that malnutrition is closely linked to the income level of the owner of animal. The animals given with high drug doses are also at increased risk of malnutritional cancer. They tend to maintain inadequate diets for long periods and their ability to absorb nutrients is impaired by the drug's effect on body tissues, particularly the liver, pancreas and brain. Malnutrition usually develops in stages over a long period of time. Some early signs and symptoms may include: irritable (bad mood) and tired, slower growth than normal, or no growth, and weight loss. Bone or joint pain, weak muscles, bloated abdomen, swelling in other parts of the body, change in the colour of skin and hair, hair loss, loss of appetite, slow wound healing, and easily get infections are noticed. All these signs and symptoms are correlated with those of many cancers. There is an increased risk of malnutrition associated with chronic diseases, e.g., diseases of intestinal tract, kidney and liver, and cancer. Animals with these chronic diseases, especially cancer may lose weight rapidly and become susceptible to undernourishment because they cannot absorb valuable vitamins, calories and iron[1].

In relation to cancer, malnutrition is the carcinogenic effect produced by nutritional variables through multiple endogenous involvements. Nutritional factors act as primary effectors in four situations: carcinogens in food articles, affected bioavailability of nutrients, non-nutritive dietary items and harmful contaminants. Nutritional carcinogenesis may occur due to ingestion of toxins, malnutrition, non-bioavailability of the micronutrients and inactivation of the metabolic enzymes (i.e., mixed-function oxidases) present in the liver. Thus the aetiological role of malnutrition preceding clinical cancer has been firmly established[1,3]. There are certain environmental substances (contaminants or hazards) which can cause malnutritional cancer both in humans and animals. Several reports indicate that environmental and food contaminants, including xenobiotics (environmental or foreign chemicals) such as oestrogenic endocrine disruptors (xenoestrogens), certain therapeutic agents (e.g., antibiotics, antihypertensive drugs, etc.) may cause various types of cancer. The 'endocrine disruptors' influence the normal functions of oestrogens, thereby cause the cancers of several organs. Chemicals, industrial wastes, pesticides, oral contraceptives (OCs) or oestrogens, detergents, food additives and plastics, all are sources of environmental toxins and endocrine disruptors. The potential endocrine disrupters such as antibiotics, hormones, plasticizers and non-ionic surfactants are becoming the priority pollutants. Most of these have been shown as carcinogenic, or they may contaminate the diet or food, thereby causing malnutrition. Many factors have a major effect on increasing the rates of oral, colon, lung and mammary gland cancers. Some of these factors include increased infections, more use of pesticides, low consumption of fruits and vegetables, high industrial pollution, more exposure to sun, decreased physical activity, etc. Almost every fruit, vegetable, etc. contains natural carcinogenic pesticides. Endocrine disruptors are xenobiotic (environmental/foreign) chemicals that adversely interfere with the natural functions of hormones[13-14].

Malnutrition is very common in sick animals and is thought to affect up to 50% of hospitalized dogs and cats. Within days malnutrition can begin to have deleterious effects on immune function, healing and, most importantly, quality of life. While human patients will follow their doctor's instruction to eat even though they don't feel well or have a good appetite, it is impossible to convince a sick pet to eat if they don't feel like it[15]. Due to malnutrition, different types of cancer may develop in dogs. Some symptoms of dog cancer are rather indistinct and, especially at the onset of the disease, it is difficult to tell whether a dog showing some cancer-like symptoms is in fact suffering from canine cancer or some other illnesses. Some cancers (e.g., lymphomas, mast cell tumors, fibrosarcomas) can arise as lumps and bumps on the dog's skin. Very often, benign growths such as warts, fatty tumours, cysts, etc. can arise in a dog's skin as well. Usually, any lumps and bumps that appear, then decrease in size or even disappear, and finally reappear in a larger size are more likely to be cancer than benign lumps. While coughing and sneezing are common symptoms of dog cancer, there are also quite a few other dog illnesses that have the same symptoms. Chronic disorders of the gastrointestinal tract such as vomiting and diarrhea can

be symptoms of dog cancer of the gastrointestinal tract, or cancer anywhere else. Appetite loss is also one of those symptoms of dog cancer that is indistinct, as many other diseases (e.g., dental or gum diseases, inflammatory bowel disease, heart disease, kidney disease, etc.) can cause appetite loss in dogs as well. Also, older dogs tend to eat less. Chronic skin diseases such as skin sores, itch and lesions, and wounds that do not heal, can be indicative of canine skin cancer. Blood in urine or urinary incontinence can be caused by some types of dog cancer (e.g., bladder cancer), but they can also be caused by urinary tract infections, bladder stones, kidney disease, diabetes, Cushing's disease, etc. While cancer can cause a lot of pain to a dog, so can many other diseases, such as arthritis, ear infections, dental or gum diseases, etc. Bone cancer in dogs can cause lameness. However, lameness can also be caused by arthritis, hip dysplasia, or some form of injuries. Perhaps lethargy and weakness are one of the vaguest symptoms of all diseases. A dog can be lethargic due to a various reasons, e.g., pain from arthritis, anemia, fever caused by infections, etc. Oral cancer in dogs can cause bad breath, but perhaps more frequently, bad breath is caused by indigestion, dental/gum diseases, liver disease and kidney disease. Brain tumours in dogs can cause seizure, but it can also be seen in thyroid problems, kidney disease, liver disease, hypoglycemia and poisoning. Many of the above symptoms of dog cancer are not unique to cancer. That is why very often cancer is not diagnosed until it is at a later stage. Finally, whenever a dog has a disorder that does not respond well to treatment in one to two months, and is showing some symptoms of dog cancer, then the possibility of cancer should be considered and a more thorough examination should be done[16].

The owners of the horses and donkeys are often very poor. The owner really needs the money, because he has to take care of his family. When the animal becomes sick, the owner is not able to make money because he doesn't have the horse or donkey to pull. In malnutrition, the horses grow out of shape. Because of all the heavy work, the horses cannot develop physically; often legs and ankles become crooked. They have often a bad back also, since they have to carry a too heavy load and because it is loaded in a wrong manner. The animals have to work in the burning sun with terribly high temperature. The owners don't give them enough to drink so they dehydrate. Due to less consumption of water and food the animals are exhausted and overly tired. Through malnutrition, starvation, dehydration and exhaustion occur. In the countries like Netherland, Egypt, Jordan, Pakistan and India, the cars are expensive so horses pull the carriages that transport people; and horses and donkeys have to pull carts with heavy loads such as building materials. These animals are seen as 'motor' to do the heavy works. These countries are usually very hot and we cannot cope with that, but the horses and donkeys have a problem with it also. In World War I (1914-1918), the British army was present in Egypt. In the beginning of this war, about 20,000 horses and donkeys from the UK were brought ashore. When the war ended in 1918, the horses and donkeys were sold to Egyptian people so the poor animals were left there[17].

EDIBLE PLANTS AS PHYTOTHERAPY FOR MALNUTRITIONAL CANCER

Treatment for malnutrition depends on the cause. Vitamin or mineral supplements are needed if the body is low in vitamins and minerals. Medicines may also be given if health problem appears due to malnutrition. Diet therapy helps patients to lead a full life. To prevent energy deficiency, carbohydrate-rich foods (e.g., sugars, cereals, roots and tubers, fruits like banana, sapota and mango) and fat-rich foods (e.g., nuts, oilseeds, vegetable oil, ghee, vanaspati and butter) should be consumed. If protein is lacking in the diet, pulses, nuts and oilseeds should be given. If vitamins and minerals are deficient in the diet, green leafy vegetables, nuts, pulses, etc. are to be eaten. In addition, fibre also plays role in the prevention of diseases like constipation and cancer of the colon. Some complex carbohydrates (e.g., cellulose) and non-carbohydrate forms of fibre are available, which may be helpful in treating the colon cancer. In PEM, high energy foods in the case of mild to moderate diarrhoea, a high energy-high protein diet when tolerance improves for solid foods, and mineral and vitamin supplements, etc. are given. In chronic diseases like cancer in which tissue wasting takes place, a high caloric-high protein diet is the best[1].

Besides above, 'phytotherapy' plays an important role in the prevention and treatment of many cancers. It has been reported that the diets rich in plant foods can lower the risk of many chronic diseases, including cancer[18]. Similarly, the herbivorous animals suffering from malnutritional cancer must be given the feed containing sufficient quantity of fruits and vegetables. The studies strongly suggest that vegetables and fruits have strong protective effect against major diseases, including cancer. The protective action of fruits and vegetables against cancer has been attributed to the presence of antioxidants, especially antioxidant vitamins. Fruits and vegetables contain several phytochemicals which possess strong antioxidant activities. Thus the fruits and vegetables prevent from cancer and other diseases by protecting cells from damage caused by 'free radicals'- highly reactive oxygen compounds. Certain phytochemical antioxidants with anticancer activity include vitamins (A, C, E, K), carotenoids, terpenoids, polyphenols (ellagic acid, gallic acid, tannins), flavonoids (quercetin, anthocyanins, catechins, flavones, flavonones, isoflavones), enzymes (superoxide dismutase, catalase, glutathion peroxidase), minerals (Cu, Mn, Se, Zn), polysaccharides, saponins, lignins and xanthones[6,9-10,19-20].

Some agricultural plants and their products such as vegetables, fruits and crops play an important role for the prevention of cancer. Many naturally occurring substances present in the diet/food have been identified as potential chemopreventive agents. Various agriculture

plants and their products have been used traditionally for the treatment of various livestock diseases since times immemorial. The dependence of rural mass on the plant-based medicines for curing animals is mainly because of the limited access to the modern (allopathic) medicine system, cheaper and easy availability, and the simplicity of their applications. The herbal drugs also do not possess toxicity or have very less side effects[21]. The edible plants are used not only for food but also employed to cure different ailments of livestock. The medicinal uses of such plants may help veterinarians, medicos and agriculture/bio scientists or researchers in discovering new drugs against various diseases of human and animals[22].

Many dietary agricultural plants and their products which have been reported to possess versatile anticancer and immunomodulatory properties. They are commonly consumed by humans as well as animals as food matters, and prevent from malnutritional cancer and various other diseases. Some of the dietary plants which have been reported by various authors[9,11,18,21-26] as 'phytotherapy' against malnutrition and cancer are described below:

The bulb of *Allium cepa* (Piyaz) has been reported to contain diallyl disulphide (a sulphurous product), quercetin flavonoid, allicin, allin, amino acids and vitamins (folic acid, C and E). Diallyl disulphide inhibited the cancerous cells in stomach. Quercetin, because of its antioxidant properties has been found to treat lung cancer and some other cancers. The bulb of *Allium cepa* var. *aggregatum* (Shallot) contains allyl propyl disulphide (a sulphurous product), flavonoid, phenolic content, proteins and vitamins (folic acid and C). Allyl propyl disulphide, phenolic content and flavonoid inhibited the cancerous cells in liver, stomach and other organs. It also eliminated the toxins to inhibit and kill yhe cancer cells in liver. *Allium sativum* (Lasun) bulb contains sulphur compounds (diallyl sulphide, diallyl disulphide, allyl propyl disulphide), allicin, allin and amino acids. The sulphur compounds inhibit cell proliferation, modulate cell cycle activity and interfere with hormone action in cancer cells. Allicin inhibits the proliferation of cancerous cells of mammary gland, endometrium and colon. Lasun is also used in gastric and liver cancers. In animals, the bulbs also are given in malnutritional disorders of skin and lung, flatulence, and dyspepsia. *Annona squamosa* (Sitaphal) contains annoaine, higenamine and amino acids. Its leaves and seeds are externally applied over malnutritional wounds, boils and swelling in animals. The riped fruit (sitaphal) is rich of carbohydrate (energy), so it can be given to cure marasmus PEM. *Brassica campestris* (Sarson) seed oil contains glycerides of palmitic, stearic, oleic and linoleic acids. It is used in various tumours. In animals, the oil is also given in rheumatism, cancer and ulcer. *Brassica juncea (B. nigra,* Rai) plant contains essential oils, while its seed contains 2 antithiamines and flavonol glycosides. In animals, oil along with rock salt is used in the diseases of gum. Seeds and oil of rai are used in malnutritional rheumatism, paralysis and skin diseases. The sprouts (flowers) of *Brassica oleracea* var. *botrytis* (Phoolgobhi) contain cysteine, ascorbigen, sulphoxide, indole-3-carbinol, glucaric acid, sulphoraphane glucosinolates, ischiocyanates and vitamins (A, C). These components possess anticancer activities against lung, stomach, colon, bladder, mammary and rectum cancers. Its leaves contain vitamin C, and are externally used in gout, rheumatism, skin diseases and blister in animals; while phoolgobhi is cardiotonic and anti-inflammatory, and may be used in biliousness and urinary diseases. *Brassica oleracea* var. *capitata* (Pattagobhi, cabbage) contains glucaric acid, sulphoraphane, glucosinolates, ischiocyanates, cysteine, ascorbigen, sulphoxide, indole-3-carbinol, allyl isothionate and vitamins (A, B, C). These have anticancer activities against bladder, lung, stomach, colon, rectum and mammary cancers. *Brassica rapa (*Shaljum) leaves and roots contain ascorbigen and vitamins (A, C), and are used in various tumours. *Cajanus cajan* (Arhar) leaves contain cajanol, while roots contain cajanone and cajaquinone. Its seeds are quite rich in proteins, so the seeds (or cooked 'dal') can be given in marasmus and kwashiorkor PEM. The expressed juice of leaves, with salt is given in animals to cure malnutritional jaundice.

The fruits of *Capsicum annum* (Lalmirch) contain amino, ascorbic and folic acids, glutathione, and flavonoids. In animals, the fruit powder with oil cures foot diseases. Fruits are stimulant and stomachic, and are used in dyspepsia, neuralgia, rheumatism and diarrhoea. *Carica papaya* (Papita) fruit contains papin and cryptoflavin, while the seeds contain carpasemine. In animals, the seeds and fruits are given to cure hepatitis, diarrhoea and dysentery. The fruits are digestive, stomachic, carminative and diuretic too. *Cicer arietinum* (Chana) seed contains isoliquiritigenin, while the plant contains amino acids and vitamins (A, D, E). Its fresh leaves juice is given to livestock in constipation. The macerated seeds in water are used as tonic. The seeds are astringent, diuretic and antibilious, and are given in debility, scurvy and jaundice. Chana seeds (or cooked 'dal') are quite rich in proteins, so the seeds (or cooked 'dal') can be very useful in marasmus and kwashiorkor PEM diseases. *Citrus limon* (Baranibu) fruit contains flavonoid, flavone, limonoid, limonene, nobiletin, tangeretin and vitamin C. The flavonoid, tangeretin and nobiletin are potent inhibitors of tumor cell growth and can activate the detoxifying P-450 enzyme system. Limonoids inhibit tumour formation by stimulating the enzyme glutathione S-transferase (GST). The limonene (a terpenoid) also possesses anticancer activity. Nibu fruit is used for inhibition of mammary cancer cell proliferation and delaying of mammary tumorigenesis. It is also used in metastasis and leukemia. The Leaves of *C. limon* contain bergapten, citropten and limettin. The fruits are antiseptic, appetizing, astringent and stomachic, and are given in scurvy, rheumatism, dysentery, diarrhoea and liver disorders of animals. *Curcuma longa* (Haldi) rhizome contains curcumin, zingiberine and curcuminoids. Haldi is reported to act against colon, bladder and prostate

cancers, intravesical tumour, fibrosarcoma, hepatocellular carcinoma, oesophagal carcinogenesis, leukaemia, stomach papilloma and solid tumour cell lines. In large animals, the rhizome powder is used in pain, swelling, wound, mastitis, tumour and liver diseases. *Daucus sativa* (Gajar) root contains pyruvate kinase, acyltransferase and alkane; while the seeds contains sitosterol and amino acids. The boiled roots are given to cattle to fatten them. The roots and seeds are stimulant and carminative, and are used in dropsy and kidney diseases. In animals, the decoction of roots and leaves of *Elephantopus scaber* (Gobhi) are given in dysuria, diarrhoea, dysentery, swelling or pain in stomach, ulcer and eczema. Its whole plant is astringent and cardiac tonic. *Emblica officinalis* (Amla) fruit contains ascorbic acid (vitamin C) and phyllembic acid. It inhibits cellular mutation and may prevent cancer. Its 18 compounds inhibit the growth of gastric and uterine cancer cells. Amla also inhibits the growth of *in vitro* breast cancer cells. *Glycine javanica* (Soybean) seed contains phytates, protease inhibitors, phytosterols, saponins, isoflavonoids and isoflavones. The soybean is contributing factor in the low incidence of breast, prostate, stomach, colon, rectum and lung cancers. Its isoflavonoids inhibit the growth of hormone-dependent and hormone-independent cancer cells in culture; however, its isoflavones inhibit the growth of mammary and prostate cancers. The soy seeds (or cooked 'dal') are quite rich in proteins, so the seeds (vegetables) may potentially treat both marasmus and kwashiorkor PEM. *Lens culinaris* (Masur) plant contains lenticin, tricetin and luteolin; while seed contains protein. In large animals, masur gruel is given in haematuria, and paste of seeds is applied on the wounds and broken horns. The seeds are laxative and given in constipation. Since the seeds of *L. culinaris* are rich in protein, these (as masur dal) can be used to cure both marasmus and kwashiorkor PEM diseases.

Lycopersicon esculentum (Tamatar) fruits contain lycopene, which acts as an antioxidant and inhibits the proliferation of cancer cells. Higher intake of tamatar is correlated with protection from cancer; the protective effect was strongest for cancers of prostate, lung and stomach but some protective effects also appeared for cancers of pancreas, colon, rectum, esophagus (throat), mouth, mammary gland and cervix. Tomato fruits also contain oxalic, citric and mallic acids, and vitamins (A, C); while its seeds and herbage contains solanine. Its pulp and juice are intestinal antiseptic, blood purifier, cholagogue, stimulant and digestive, and are given in pulmonary diseases and dyspepsia of animals. *Momordica charantia* (Karela) leaf, fruit and seed contain linolenic acid, momordin, palmitic acid, proteolytic enzymes and vitamins (A, B, C). These parts are used in colon, mammary and bladder carcinomas, lymphoma, leukemia and other tumours. The fruits and seeds are carminative and stomachic, and are prescribed in rheumatism, gout and liver diseases of animals. The silver skin of *Oryza sativa* (Chaaval) contains oryzanin; while bran contains a glucoside nukain, which yields aglucone nukagenin. In animals, chaaval with dal is used as a perfect food in dysentery and can alone support life as it contains protein, carbohydrate, fat, vitamins and minerals. Thus, chaaval may cure both marasmus and kwashiorkor PEM diseases. Decoction of grains is used internally as antiinflammatory for digestive tract.

Picrorhiza kurroa (Kutki) fruits/seeds contain kutkin and kurrin. In animals, the fruits are given in loss of appetite, dropsy, fever, and foot and mouth disease (FMD). The roots are bitter, stomachic and purgative. *Psidium guajava* (Amrud) plant contains leucocyanidin and quercetin, while the leaves contain eugenol. In animals, the decoction of root bark and leaves is given in chronic diarrhoea. Its root bark is astringent and fruits are laxative; while the leaves are astringent, and applied in wounds and ulcers. *Raphanus sativus* (Muli) root contains glucoside, enzymes and methyl mercaptan. In animals, the roots are used in dysentery, indigestion, urinary disorders and gastrointestinal pain. Its seeds are diuretic, laxative and carminative. *Sesamum orientale* Linn. (Til) seeds contain essential oil, proteins sesamin and sesamolin, so its seeds and oils can be given in PEM diseases of animals. *Solanum melongena* (Baingan) fruit contains vitamins A, B and C; while seed contains linoleic and oleic acids. In animals, the fruits and leaves are given in weakness, dysuria, liver disorders and ulcers. The seeds of *S. melongena* are stimulant. *Solanum tuberosum* (Alu) plant contains solanine, solasodine and lutein. In livestock, a portion of raw tuber (alu) is grated over the sore to cure leg ulcers. Alu is full of carbohydrate, it can be given in weakness, particularly in PEM. *Spinacia oleracea* (Palak) plant contains vitamins, iodine, lecithin, carotene and amino acids. The whole plant and leaves of *S. oleracea* are used in inflammation of lung, liver and bowel, fever and jaundice in animals. Its seeds and fruits are laxative, demulcent and diuretic. *Trachyspermum ammi* (Ajwain) fruits yield essential oil containing thymol. In animals, the fruits are given in weakness after pregnancy and low lactation. They are also employed in gastric disorders and diarrhoea, and have antiseptic, carminative and stimulant properties. *Trigonella foenumgraecum* (Methi) leaves and seeds contain choline, trigonelline, amino acids, proteins, vitamins and quercetin. These parts are used in various cancers. In animals, its leaves and seeds are used in rheumatism, cancer, intestinal inflammation, indigestion and bilious disorders. Its seeds are carminative and tonic too. *Triticum aestivum* (Gehun) grains contain ellagic, linolenic and oleic acids, oligosaccharides, fat, sterols, phytases, tocotrienols and vitamin E. Whole grains protect against lymphomas and cancers of pancreas, stomach, colon, rectum, breast, uterus, mouth, throat, liver and thyroid. In animals, the flour of wheat is given in weakness and gastric disorders. *Zea mays* (Makka) grains contain oxalic acid, carbohydrate, fat, protein and vitamins. The grains are astringent, nutritive and nourishing in humans and animals. *Zingiber officinale* rhizome (called adrak and the dried rhizome called as sonth) contains a volatile oil containing camphene, gingerol, zingiberene, borneol,

cineol and proteins. It is used in various cancers. In livestock animals, the rhizomes are given with salt before feed to increase appetite and in weakness after pregnancy. They are also given in swelling, indigestion, flatulent colic, and are stimulant and carminative. Apart from the above edible plants (phytotherapy), some other dietary plants which have been reported to exhibit anticancer properties are *Amorphophallus companulatus* (Suran), *Avena sativa* (Oat), *Cajanus cajan* (Arhar), *Hordeum vulgare* (Jau), *Lens culinaris* (Masur), *Mentha arvensis* (Podina) and *Zea mays* (Makka)[9,24-26].

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