

# The Journal of Phytopharmacology

(Pharmacognosy and phytomedicine Research)

## Research Article

ISSN 2230-480X  
JPHYTO 2013; 2(6): 46-51  
© 2013, All rights reserved

### Sanjar Alam

Department of Pharmaceutics,  
KIET School of Pharmacy,  
Ghaziabad, India

### Deepti Katiyar

Department of Pharmacognosy,  
KIET School of Pharmacy,  
Ghaziabad, India

### Richa Goel

Department of Pharmacognosy,  
KIET School of Pharmacy,  
Ghaziabad, India

### Amita Vats

Department of Pharmaceutics,  
KIET School of Pharmacy,  
Ghaziabad, India

### Ashu Mittal

Department of Pharmaceutics,  
KIET School of Pharmacy,  
Ghaziabad, India

### Correspondence:

#### Sanjar Alam

Assistant Professor  
Department of Pharmaceutics,  
KIET School of Pharmacy,  
Ghaziabad 201206, India  
Tel: +91-9891674226  
E-mail: sanjaralam10@gmail.com

## Role of herbals in cancer management

Sanjar Alam\*, Deepti Katiyar, Richa Goel, Amita Vats, Ashu Mittal

### Abstract

Herbal medicines have a vital role in the prevention and treatment of cancer. A great deal of pharmaceutical research done in technologically advanced countries like USA, Germany, France, Japan and China has considerably improved quality of the herbal medicines used in the treatment of cancer. With advanced knowledge of molecular science and refinement in isolation & structure elucidation techniques, we are in a much better position to identify various anticancer herbs and develop the remedy that might cure cancer. The therapeutic effect of anticancer herbs is executed by inhibiting cancer-activating enzymes, stimulating DNA repair mechanism, promoting production of protective enzymes, inducing antioxidant action and by enhancing activity of the immune cells. Some herbs protect the body from cancer by enhancing detoxification functions of the body. Certain biological response modifiers derived from herbs are known to inhibit growth of cancer by modulating the activity of specific hormones and enzymes. Some herbs reduce toxic side effects of chemotherapy and radiotherapy. Scientists all over the world are concentrating on the herbal medicines to boost immune cells of the body against cancer. By understanding the complex synergistic interaction of various constituents of anticancer herbs, the herbal formulations can be designed to attack the cancerous cells without harming normal cells of the body.

**Keywords:** Herbal medicine, Cancer, *Podophyllum peltatum*.

### Introduction

Cancer is a term that is used to refer to a number of conditions where the body's cells begin to grow and reproduce in an uncontrollable way. This rapid growth of cancerous cells is known as a malignant tumour. These cells can then invade and destroy healthy tissue, including organs.<sup>1, 2</sup> Cancer sometimes begins in one part of the body before spreading to other parts. This process is known as metastasis.

### How common is cancer?

Cancer is a common condition and is a serious health problem, both in the UK and across the world. It is estimated that 7.6 million people in the world died of cancer in 2007. In the UK, cancer is responsible for 126,000 deaths per year. One in four people die from cancer.<sup>3</sup>

### Types of cancer

There are hundreds of different types of cancer. The most common cancers in the UK are: Breast cancer, Prostate cancer, Lung cancer, Cancer of colon or rectum, Blood cancer, Bladder cancer, ovarian cancer etc. Risk factors for cancer include smoking,

drinking alcohol, obesity, poor diet, lack of exercise, and prolonged exposure to sunlight.

## Treatments of Cancer

Treatments of cancer include Surgery, Chemotherapy and Radiotherapy. Some cancers can be cured if detected early enough.

## Herbal medicine in cancer treatment

### Plants having anticancer activity

1. *Podophyllum peltatum* (American May Apple) and *Podophyllum hexandrum* (Himalayan May Apple) contain podophyllin, which has similar therapeutic action on the dividing cancerous cells as that of the vinca alkaloids. Podophyllin arrests multiplication of cancerous cells by breaking down the microtubules into smaller subunits, thus inhibiting the cell division. Podophyllotoxin, an active principle of podophyllin, is used in the treatment of Hodgkin's disease, non-Hodgkin's lymphoma, leukaemia, bronchogenic carcinoma and cancers of the ovary & the testis.<sup>4</sup>

2. *Taxus brevifolia* (Pacific Yew Tree), *Taxus yunnanensis* (Yunnan Yew Tree), *Taxus baccata* (European Yew Tree) and *Taxus wallichiana* (Himalayan Yew Tree) contain taxanes, which include paclitaxel (Taxol) and docetaxel (Taxotere). Taxanes have a different mode of action on the cancerous cells than that of the podophyllin and the vinca alkaloids. Taxanes arrest multiplication of cancerous cells by cross-linking the microtubules, whereas vinca alkaloids and podophyllin act by breaking down the cytoskeletal organelle (microtubule) into smaller subunits. Taxanes are used to treat leukaemia and cancers of the breast, ovary, colon & the lung. Taxol was first isolated from bark of *Taxus baccata* by Indian born scientist, Mansukh Wani, and his colleague Monroe Wall in 1992. Three mature Yew trees (60-100 years old) were consumed to extract one gram of Taxol. Later, in 1994, Taxol was synthesised successfully by two teams of American scientists, one headed by K. C. Nicalaou at the Scripps Research Institute, La Jolla, California and the other led by Robert Holton of Florida State University.<sup>4</sup>

3. *Allium sativum* (Garlic) has been used for thousands of years to treat various diseases. The earliest use of *Allium sativum* as a medicine has been recorded in ancient Egypt, Greece, India, China, Rome, Russia and Europe. Hippocrates was the first to recommend its use for cancer.

*Allium sativum* contains more than 100 biologically useful secondary metabolites, which include alliin, alliinase, allicin, S-allyl-cysteine (SAC), diallyldisulphide (DADS), diallyltrisulphide (DATS) and methylallyltrisulphide. Garlic oil contains an amino acid known as alliin, which is converted to allicin when its bulbs are crushed. Allicin is a precursor to several sulphur-containing compounds that are responsible for the flavour, odour and pharmacological properties of *Allium sativum*. Recent studies revealed presence of bioflavonoids quercetin and cyanidin, which are responsible for antioxidant properties of garlic. Ajoene, a sulphur-containing compound, found in garlic oil, inhibits mutagenesis. Garlic oil prevents prostaglandin-dependent cancers by inhibiting lipoxygenase and cyclooxygenase enzymes. Garlic contains a rich content of selenium, which is a cellular antioxidant. Diallyltrisulphide, diallyldisulphide and S-allyl-cysteine, found in *Allium sativum*, have anticarcinogenic properties. Diallyltrisulphide prevents metastases in the lung cancer. Garlic has shown significant therapeutic effect in cancers of the stomach and the intestines. The Chinese Academy of Medical Sciences has reported inverse relationship between garlic consumption and incidence of the stomach cancer. *Allium sativum* inhibits genesis as well as growth of cancer by enhancing activity of the natural killer cells (NK cells) and the macrophages. Studies have revealed that *Allium sativum* increases count of the suppressor T cells and makes the lymphocytes more cytotoxic to cancerous cells. *Allium sativum* also inhibits metastases by preventing adhesion of the circulating cancerous cells to the blood vessels. A Japanese garlic expert, Wakunaga, worked with a German researcher in the Virgin Woodlands of Hokkaido, Japan and prepared a product called "Kyolic Aged Garlic Extract" in 1954 by using 20-month Cold Ageing Process. This ageing process removes toxic compounds and offensive odour of garlic as well as strengthens its therapeutic properties. The Aged Garlic Extract protects DNA from the damaging effect of carcinogens, increases activity of detoxifying enzymes, speeds up excretion of chemical carcinogens and enhances immunity of the body. The Aged Garlic Extract is found to inhibit growth of many cancers including those of the breast, bladder, skin, colon, oesophagus, stomach and the lung. The research done at National Medical Centre and Hospital in Japan has revealed that the Aged Garlic Extract reduces side effects of radiotherapy and chemotherapy.<sup>5</sup>

4. *Gyrophora esculenta* (Maitake) is a mushroom that inhibits growth of cancer by enhancing activity of the natural killer cells (NK cells). A study done by Dr. Hiroaki Nanba, Department of Immunology at Kobe Women's

College of Pharmacy, Japan has shown that Maitake inhibits carcinogenesis and metastases. Another study conducted at the National Cancer Research Centre in Japan revealed that the extracts of *Gyrophora esculenta* (Maitake), *Lentinus edodes* (Shiitake) and *Ganoderma lucidum* (Reishi) have completely eliminated tumours in 80 per cent cases.<sup>6</sup>

**5. Bioflavonoids** (flavonoids) are the water-soluble pigments, found in vegetables and fruits. These were known as “Vitamin P” till 1950. The list of bioflavonoids includes citrin, hesperidin, rutin, quercetin, epicatechin, flavones, flavonols, proanthocyanins and anthocyanins. Most of the bioflavonoids possess antioxidant properties. Bioflavonoids enhance therapeutic effect of vitamin C by increasing its absorption in the liver, kidneys and the adrenal glands. Anthocyanins found in citrus fruit and grape seed are known to inhibit growth of cancer by scavenging free radicals. Quercetin is known to inhibit growth of the stomach cancer.<sup>7</sup>

**6. Bromelain** is a mixture of proteases and some other enzymes. It is isolated from the stem and fruit of *Ananas comosus* (Pineapple). Bromelain stimulates defence mechanism of the body against cancer by enhancing cytotoxic activity of the monocytes and the macrophages, thus inhibiting growth of cancer. It is used in the treatment of leukaemia. Rectal administration of Bromelain is preferred, however it can be given orally.<sup>8-10</sup>

**7. *Curcuma longa*** (Turmeric) contains curcumin, which inhibits the growth of cancer by preventing production of harmful eicosanoid such as PGE-2. The anticancer effect of curcumin has been demonstrated in all the steps of cancer development, i.e. initiation, promotion and progression of cancer. Data obtained from several studies suggest that curcumin inhibits the genesis of cancer as well as promotes the regression of cancer. Curcumin suppresses mutagenic effect of various mutagens including cigarette smoke condensates, 7, 12-dimethylbenz (a)anthracene (DMBA) and benzopyrene. Curcumin is found to decrease levels of urinary mutagens. It also possesses anti-inflammatory and antioxidant properties. The protective effects of *Curcuma longa* and its derivatives are partially due to direct antioxidant effect. Studies have revealed that *Curcuma longa* inhibits production of nitrosamine that enhances natural antioxidant functions of the body. *Curcuma longa* increases levels of glutathione and other non-protein sulfhydryls. It acts directly on several enzymes. Curcumin is used to treat squamous cell carcinoma of the skin and the ulcerating oral cancer.

*Curcuma longa* also prevents malignant transformation of leukoplakia.<sup>11,12</sup>

**8. *Betula utilis*** (White-barked Birch Tree) contains betulin that can be easily converted into betulinic acid. Studies have revealed that betulinic acid inhibits growth of malignant melanoma and cancers of the liver and the lung.<sup>13</sup>

**9. *Silybum marianum*** (Milk thistle) protects the body against liver cancer by accelerating regeneration of the liver cells. Bioflavonoids found in *Silybum marianum* such as silymarin and silybin are known to protect the liver tissue. *Silybum marianum* also contains antioxidant compounds.<sup>14</sup>

**10. *Echinacea angustifolia*** contains arabinogalactan, which protects the body from cancer by activating the macrophages. *Echinacea angustifolia* is used to treat metastatic carcinoma of the oesophagus and the colon.<sup>15</sup>

**11. *Uncaria tomentosa*** (Cat’s claw) is a rain forest climber that has been traditionally used in Peru to treat tumours. *Uncaria tomentosa* contains many antioxidant compounds including polyphenols, triterpines, campesterol, stigmasterol and beta-sitosterol. Cat’s claw is used to treat the brain tumours.<sup>16</sup>

**12. *Camellia sinensis*** (Green tea) contains epigallocatechin gallate, which protects against cancer by preventing covalent bonding of carcinogens to the DNA. It also inhibits growth of cancer by eliminating free radicals from the body. Gallates found in green tea protect the body from damaging effects of radiation. A regular use of green tea protects the body against many cancers including those of the liver, oesophagus, stomach, intestine and the lung. Studies have shown that there is lower incidence of stomach cancer in habitual tea drinkers as compared to those, who do not drink tea. It has been observed that daily consumption of 5 grams of green tea inhibits synthesis of nitrosamine (a major carcinogen) in the body.<sup>15,17</sup>

**13. *Aloe vera*** contains aloe-emodin, which activates the macrophages to fight cancer. *Aloe vera* also contains acemannan, which enhances activity of the immune cells against cancer. *Aloe vera* is found to inhibit metastases.<sup>18</sup>

**14. *Chlorella pyrenoidosa*** contains a very effective detoxifying agent, known as lysine. *Chlorella pyrenoidosa* also contains high content of albumin that neutralises free

radicals. *Chlorella pyrenoidosa* protects the body from cancer.<sup>18, 19</sup>

**15. *Laminaria japonica*** (Kombu) possesses a strong anticancer activity and inhibits the growth of cancer. Studies have shown that a regular use of *Laminaria japonica* reduces risk of the breast cancer considerably.<sup>19</sup>

**16. *Withania somnifera*** contains withanolides, which possess immuno- modulatory activity. Withaferin A & withanolide D found in *Withania somnifera* are known to inhibit growth of cancer. Studies have revealed that *Withania somnifera* enhances the therapeutic effect of radiotherapy.<sup>20</sup>

**17. *Gossypium barbadense*** contains gossypol. Recent studies have revealed that gossypol possesses selective toxicity towards cancerous cells.<sup>17, 21</sup>

**18. *Combretum caffrum*** (African Willow Tree) contains combretastatin, which has been isolated recently. Combretastatin executes its therapeutic action against cancer by inhibiting blood supply to the tumour.<sup>22</sup>

**19. Camptothecin** is a pyridoindole (quinoline) alkaloid, which is isolated from seeds of *Camptotheca acuminata* and *Mappia foetida*. Camptothecin is a well-known anticancer agent. Derivatives of camptothecin such as 18-OH-camptothecin, 11-OH-camptothecin and 10-OH-camptothecin have been found to possess a strong antileukaemic activity.<sup>23</sup>

**20. Ellipticine** and **9-methoxy ellipticine** are pyridocarbazole (monomeric indole) alkaloids that have been isolated from *Ochrosia elliptica*. These act as potent anticancer agents. Ellipticine and its derivatives are used to treat cancers of the breast and the kidney. Lipophilic derivatives of ellipticine act by binding to the DNA.<sup>24, 25</sup>

**21. *Actinidia chinensis*** (Yang-t'ao) root is used by the Chinese physicians in the treatment of cancer. *Actinidia chinensis* contains a polysaccharide known as "ACPS-R" that possesses immune-enhancing and anticancer activities.<sup>26</sup>

**22. *Polyporus umbellatus*** (Zhu Ling) is found to increase the life span of cancer patients by enhancing activity of the immune cells against cancer.<sup>27</sup>

**23. *Panax ginseng*** (Ren Shen/Ginseng) is a forest herb that has been used by the Chinese medical practitioners for

more than 2000 years. It inhibits growth of cancer by interfering with the DNA synthesis. *Panax ginseng* contains several active constituents, which include saponins, essential oils, phytosterols, amino acids, peptides, vitamins and minerals. Saponins enhance activity of the natural killer cells (NK cells), stimulate the macrophages and promote production of the antibodies. Studies have shown that *Panax ginseng* decreases incidence of the liver cancer by 75 per cent. *Panax ginseng* is used by the Chinese doctors to treat cancers of the ovary and the stomach. Studies have revealed that *Panax ginseng* regenerates the natural killer cells (NK cells), which are damaged by chemotherapy and radiotherapy.<sup>27, 28</sup>

**24. *Ginkgo biloba*** (Yin Guo/ Bai Guo) contains Ginkgolide-B, which protects the body against cancer. It inhibits growth of cancer by regulating activity of the platelet-activating factor. A recent study done on the workers of nuclear power station at Chernobyl in Russia has shown that *Ginkgo biloba* protects the DNA from damaging effects of nuclear radiation.<sup>29</sup>

**25. *Angelica sinensis*** (Dang Gui) is used by the Chinese physicians to treat cancer of the cervix. The polysaccharide fraction of *Angelica sinensis*, known as "AR-4" possesses immunostimulating activities such as induction of interferon production, stimulation of the immune cell proliferation and enhancement of antitumour activity of the immune cell.<sup>17, 30</sup>

**26. *Catharanthus roseus*** or ***Vinca rosea*** (Periwinkle) contains vinca alkaloids, which were the first phytoconstituents ever used to treat cancer. Intense work on *Catharanthus roseus*, a folklore hypoglycaemic drug, led to isolation of more than 70 dimeric indole alkaloids, which include vinblastine, vincristine (leucocystine), alstonine, ajmalicine and reserpine. Vinca alkaloids execute anticancer effect by binding to the tubulin (microtubule protein) thereby breaking down the microtubules, thus inhibiting formation of mitotic spindle in the metaphase that arrests division of the cancerous cells. Vinblastine is used in the treatment of Hodgkin's disease, non-Hodgkin's lymphoma and cancers of the kidney & the testis. Vincristine is usually given in combination with other anticancer agents to treat acute lymphocytic leukaemia, Wilm's tumour, neuroblastoma, rhabdomyosarcoma, Ewing's sarcoma, lymphoma and cancers of the breast, lung, bladder & the cervix.<sup>31</sup>

Other important anticancer herbs includes *Benincasa hispida*, *Brassica oleracea*, *Calendula officinalis*, *Dirca*

*occidentalis*, *Feddiea fischeri*, *Larrea divaricata*, *Larrea tridentata*, *Morus alba*, *Ostodes paniculata*, *Passerina vulgaris*, *Piper futokadsura*, *Soulamea soulameoides*, *Thymus serpyllum*, *Trichosanthes kirilowii* and *Urtica dioica* which has great potentials in the treatment of cancer.<sup>32</sup>

## Conclusion

Due to the increased adverse affect caused by the chemotherapy in treatment of cancer with the common drugs like alkylating agents, antibiotic, steroid analogue, herbs and drug obtained from these such as vincristine, vinblastine, taxols, Etoposide shows lesser toxicity and better effectiveness in numbers of oncological conditions for example in breast cancer, testicular cancer, leukaemia, brain tumour etc. With the enhancement in the technology for the study of effectiveness, quality control and rationale based approach for the disease treatment it seems that in future use of medicines obtained from the herbal source will be a potentials means of treating the disease and will also be economical and cost effective.

## References

1. R. Paridaens, L. Biganzoli, P. Bruning, J. G. M. Klijn, T. Gamucci, S. Houston, R. Coleman, J. Schachter Journal of Clinical Oncology 2000; 18(4): 724.
2. Gatzemeier U, Heckmayr M, Neuhauss R, Schlüter I, Pawel JV, Wagner H, Dreps A. Lung Cancer. 1995 Jun;12 Suppl 2:S101-6.
3. Health Encyclopaedia: Cancer. NHS Direct. <http://www.nhsdirect.wales.nhs.uk/encyclopaedia/c/article/cancer/>
4. Thomson M.; Ali M. Current Cancer Drug Targets 2003; 3(1): 67-81
5. S. Shibata, Y. Nishikawa, M. Tanaka, F. Fukuoka and M. Nakanishi Journal of Cancer Research and Clinical Oncology 1968; 71(1): 102-104.
6. Mauro Piantelli, Nicola Maggiano, Riccardo Ricci, Luigi M Larocca, Arnaldo Capelli, Giovanni Scambia, Giulio Isola, Journal of Investigative Dermatology 1995; 105: 248–253.
7. Tysnes BB, Maurer HR, Porwol T, Probst B, Bjerkvig R, Hoover F. Neoplasia. 2001; 3(6):469-79.
8. Goel A, Kunnumakkara AB, Aggarwal BB. Curcumin as "Curecumin": from kitchen to clinic. Biochem Pharmacol. 2008 Feb 15; 75(4):787-809. Epub 2007 Aug 19.
9. Sagar SM, Yance D, Wong RK. Curr Oncol. 2006; 13(3): 99-107.
10. Surh YJ, Chun KS. Cancer chemopreventive effects of curcumin. Adv Exp Med Biol. 2007;595:149-72.
11. Waheed Roomi M, Ivanov V, Kalinovsky T, Niedzwiecki A, Rath M. In vivo and in vitro antitumor effect of a unique nutrient mixture on lung cancer cell line A-549. Exp Lung Res. 2006 Oct; 32(9):441-53.
12. Pastore RL, Fratellone P. Potential health benefits of green tea (*Camellia sinensis*): a narrative review. Explore (NY). 2006 Nov-Dec;2(6):531-9.
13. Kametani S, Kojima-Yuasa A, Kikuzaki H, Kennedy DO, Honzawa M, Matsui-Yuasa I. Biosci Biotechnol Biochem. 2007 May;71(5):1220-9.
14. Huntimer ED, Halaweish FT, Chase CC. Proliferative activity of Echinacea angustifolia root extracts on cancer cells: Interference with doxorubicin cytotoxicity. Chem Biodivers. 2006 Jun;3(6):695-703.
15. Gonzales GF, Valerio LG Jr. Medicinal plants from Peru: a review of plants as potential agents against cancer. Anticancer Agents Med Chem. 2006 Sep;6(5):429-44.
16. Vermeil C, Morin O. Experimental role of the unicellular algae Prototheca and Chlorella (Chlorellaceae) in anti-cancer immunogenesis (murine BP8 sarcoma). C R Seances Soc Biol Fil. 1976 Oct;170(3):646-9.
17. Hu KW, Li QW, Zuo MH, Sun T, Jiang M. Clinical observation on the combined treatment of 57 cases of non-small cell lung cancer using argon-helium cryosurgery and Chinese herbal medicine. Chin J Integr Med. 2007 Sep;13(3):224-7.
18. Xu L, Lao LX, Ge A, Yu S, Li J, Mansky PJ. Chinese herbal medicine for cancer pain. Integr Cancer Ther. 2007 Sep;6(3):208-34.
19. Luk JM, Wang X, Liu P, Wong KF, Chan KL, Tong Y, Hui CK, Lau GK, Fan ST. Traditional Chinese herbal medicines for treatment of liver fibrosis and cancer: from

- laboratory discovery to clinical evaluation. *Liver Int.* 2007 Sep;27(7):879-90.
20. Seifried, H. E., McDonald, S. S., Anderson, D. E., Greenwald, P., Milner, J. A. *Cancer Res.* 2003; 63: 4295-4298.
21. Efferth T, Giaisi M, Merling A, Krammer PH, Li-Weber M (2007) Artesunate induces ROS-mediated apoptosis in doxorubicin-resistant T leukemia cells. *PLoS One* 2: e693.
22. Eberding A, Madera C, Xie S, Wood CA, Brown PN, Guns ES. Evaluation of the antiproliferative effects of Essiac on in vitro and in vivo models of prostate cancer compared to paclitaxel. *Nutr Cancer.* 2007;58(2):188-96.
23. Lu X, Li D, Dalley NK, Wood SG, Owen NL. Structure elucidation of compounds extracted from the Chinese medicinal plant *Patrinia heterophylla*. *Nat Prod Res.* 2007 Jul 10;21(8):677-85.
24. Bright JJ. Curcumin and autoimmune disease. *Adv Exp Med Biol.* 2007;595:425-51.
25. Tamayo C, Diamond S. Review of clinical trials evaluating safety and efficacy of milk thistle (*Silybum marianum* [L.] Gaertn.). *Integr Cancer Ther.* 2007 Jun;6(2):146-57.
26. Post-White J, Ladas EJ, Kelly KM. Advances in the use of milk thistle (*Silybum marianum*). *Integr Cancer Ther.* 2007 Jun;6(2):104-9.
27. Ye F, Jiang S, Volshonok H, Wu J, Zhang DY. Molecular mechanism of anti-prostate cancer activity of *Scutellaria baicalensis* extract. *Nutr Cancer.* 2007;57(1):100-10.
28. Cheuk W, Chan JK, Nuovo G, Chan MK, Fok M. Regression of gastric large B-Cell lymphoma accompanied by a florid lymphoma-like T-cell reaction: immunomodulatory effect of *Ganoderma lucidum* (Lingzhi)? *Int J Surg Pathol.* 2007 Apr;15(2):180-6.
29. Ye B, Aponte M, Dai Y, Li L, Ho MC, Vitonis A, Edwards D, Huang TN, Cramer DW. Ginkgo biloba and ovarian cancer prevention: epidemiological and biological evidence. *Cancer Lett.* 2007 Jun 18;251(1):43-52. Epub 2006 Dec 27.
30. Srinivasan S, Ranga RS, Burikhanov R, Han SS, Chendil D. Par-4-dependent apoptosis by the dietary compound withaferin A in prostate cancer cells. *Cancer Res.* 2007 Jan 1;67(1):246-53. Epub 2006 Dec 21.
31. S. Shibata, Y. Nishikawa, M. Tanaka, F. Fukuoka and M. Nakanishi. Antitumour activities of lichen polysaccharides. *Journal of Cancer Research and Clinical Oncology* 1968; 71(1): 102-104.
32. S. Shibata, Y. Nishikawa, M. Tanaka, F. Fukuoka, Wang CZ1, Xie JT, Zhang B, Ni M, Fishbein A, Aung HH, Mehendale SR, Du W, He TC, Yuan CS. Chemopreventive effects of *Panax notoginseng* and its major constituents on SW480 human colorectal cancer cells. *Int J Oncol.* 2007 Nov;31(5):1149-56.