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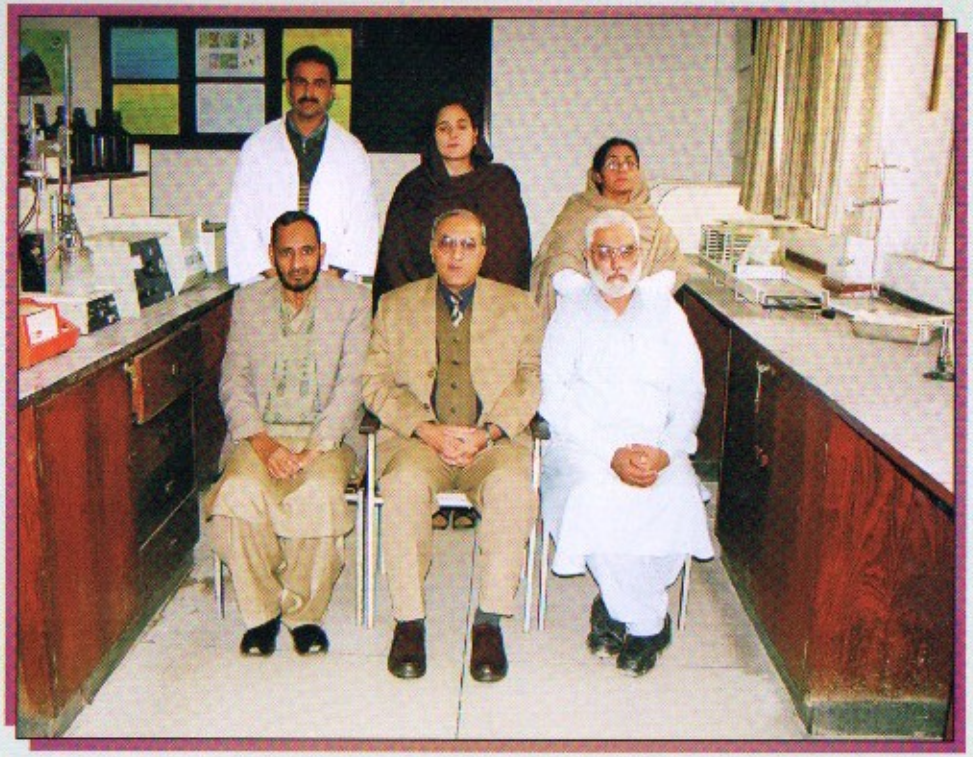
IONIZING RADIATION - AN ADVANCED PHYTOSANITARY TREATMENT FOR HERBAL RAW MATERIALS AND FINISHED PRODUCTS

NUCLEAR INSTITUE FOR FOOD & AGRICULTURE (NIFA), PESHAWAR, PAKISTAN.

ONLY NIFA, CONDUCTS RESEARCH ON GAMMA STERLIZATION OF HERBAL RAW MATERIALS AND FINISHED PRODUCTS IN PAKISTAN



Scientists Working in Herbal Radiation Chemistry Group

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IRRADIATION TECHNOLOGY FOR HERBS

A Technique for Improving the Quality of Herbal Raw Materials and Herbal Products

GAMMA IRRADIATION OF HERBAL RAW MATERIALS AND FINISHED PRODUCTS IS THE ONLY SAFE, NON TOXIC METHOD WITH STERILITY FACTOR HIGHER THAN ALL OTHERS

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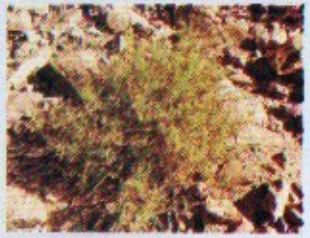
INTRODUCTION

Plants are precious natural industries, making a variety of chemical compounds. These natural compounds are extensively used in a wide range of chemical enterprises, including those of pharmaceutical, food, cosmetic, chemical, fabric, construction, insecticide, fungicide, bactericide, paper etc. Dry herbs are used as spices, condiments and flavouring aids. Their extracts and concentrates are used in preparation of refreshing drinks, teas, cakes, beverages and in cosmetic industries. Plants have a broad range of therapeutic activity, ranging from antihypertensive to analgesic, anticholinergic, cardiovascular, antimalarial, stomachic etc. The curative actions of the plants are due to a relatively small number of biologically active units called "active principles". These include alkaloids, glycosides, terpenoids, steroids, tannins, flavonoids, vitamins, mucilages, minerals, organic acids etc. In pharmaceutical industry certain plant products are presently irreplaceable because of their therapeutic actions. Herbs also have a great potential in the emerging nutraceutical industry in that these are often considered foods as well as medicines and are used in preventive and curative treatments throughout the world.

The intellectual faculty of man examined the vegetable kingdom around him and selected herbs for the cure of different ailments. Ancient nations, the Assyrians, the Babylonians, the Greeks, the Chinese, the Indians, the Persians and especially the Egyptians profoundly believed in the curative effects of plants. In China herbal medicines have been used for at least 7000 years. Although, with the discovery of the synthetic drugs, plants still make a major contribution to the pharmaceutical industry, comprising some 25% of prescribed drugs and providing a market yield of billions of dollars worldwide. According to WHO about 80% population of the developing countries uses herbal products. Medicinal plants are more esteemed than using synthetic chemicals for being safe, easily available, cost effective, synergistic effects of their other active ingredients and presence of certain minerals. The worldwide worry from hazards and side effects of synthetic chemicals led health authorities in many developed countries to ban their use in food and drugs industries.

STATUS OF HERBS IN PAKISTAN

Pakistan has a rich medicinal flora due to climatic diversity. There are around 6000 types of wild plants, out of which about 2000 are considered to be of medicinal importance. A very large number of drug plants are found in NWFP, Baluchistan, and Azad Kashmir. About 70% of Pakistani population uses herbs for various health disorders. The Tibbi Pharmacopoeia of Pakistan



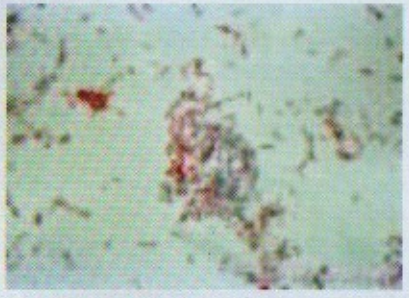
(Pharmacopoeia of Traditional Drugs compiled by Tibbi Board) has listed around 900 single drugs and about 500 compound preparations made out of medicinal plants. According to a survey of National Institute of Health (NIH), around 400 plants are traded in different drug markets of the country and are used by leading manufacturing units of Unani and Homoeopathic medicines. According to a recent study conducted by Pakistan Forest Institute, Peshawar the total turn-over of crude drugs in the country is worth about Rs. 120 million. Around 50,000 tabibs (practitioners of Greco-Arab medicine) and a number of unregistered practitioners scattered in rural and remote hilly areas are utilizing various plants in traditional and folk medicines. There are about 30 main commercial herbal manufacturing companies in the country. The annual turn over of some large herbal manufacturers is comparable to multinational companies. Medicinal plants are also exported to certain foreign countries,

apart from their local use. Pharmaceutical companies have not developed over the years according to the resource available. As a result, a large number of national and multinational pharmaceutical firms import raw materials. Further, no finished or intermediary pharmaceutical products are made due to lack of information about availability of plants, which hampers the commercial utilization of this renewable natural resource.

QUALITY ISSUES

The number of patients experiencing negative health consequences caused by the use of herbal medicines have been increasing worldwide. One of the major causes of reported adverse events is directly linked to the poor quality of plant materials. Due to the creation of mass markets for herbal products, manufacturers and suppliers sell inferior products right beside high quality products. Quality is extremely essential to obtaining the desired results from using any herb. The problem with the quality of herbs is that when we purchase herbs or herbal products, we do not know the quality, nor do we have a good way to evaluate the relative quality of different products. These are the issues that are becoming a major concern with the growing popularity of herbal products.

Plants harbour a variety of microorganisms and insects due to tropical weather, unhygienic handling and processing procedures such as that prevailing in Pakistan. Contamination can occur at any stage during harvesting, drying, processing, transportation and storage. Insect pests infesting aromatic and medicinal plants include cotton leaf worm, caterpillars, beetles, bugs, aphids, white flies, stemborers, cutworms etc. Microorganisms reported from herbs and their products include *Streptococcus, Staphylococcus, Salmonella, Pseudomonas, Klebsiella, Escherichia, Enterobacter, Corneybacterium, Clostridium, Bacillus, Acinetobacter, Citrobacter, Alternaria, Aspergillus, Cladosporium, Fusarium, Monospora, Penicillium, Trichoderma, Rhizopus, Mucor* etc.

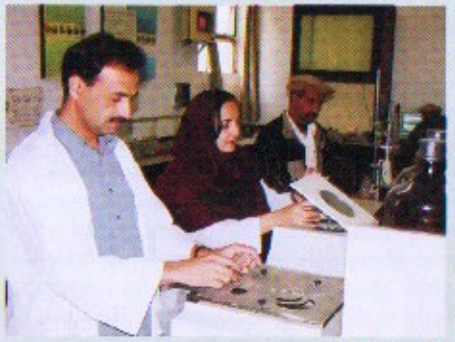


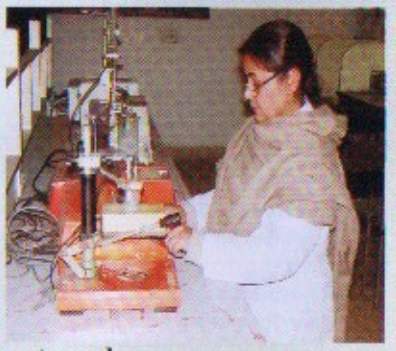
INTERNATIONAL STANDARDS

According to the pharmaceuticals requirements a good quality of herbal raw materials, should be free from all kind of pathogenic microorganisms, while the spoilage bacterial and fungal counts should not be exceeded than 10 /gm/ml and 10 /gm/ml, respectively.

Group Leader

Cobalt-60 radiation source





Scientists at work

EFFECTS ON HEALTH

The presence of harmful pathogenic microorganisms in herbal raw materials/products represents a direct health hazard to the consumers. In addition, plant materials may also be infected with a variety of microorganisms that will cause spoilage and other quality defects in the drugs when added as ingredients.

TRADE/QUARANTINE

Contaminated plant materials may also disseminate microorganisms and insect of quarantine importance. Regulatory requirements of many countries

are becoming continually tightened and more demanding. The governments of most industrialized countries insist that plant products be inspected before it is allowed into the country, because many botanicals can be contaminated with microorganisms or bring unwanted form of animal life. Exporting countries are now required to furnish phytosanitary certificates. Pakistan has limited resources to supply the value added products to the world market that meet the standards of quality control and the strict regulatory requirements of international buyers. Exporters of crude medicinal plants do not find sufficiently re-numerative prices and export large quantities at very cheap prices. The plants are collected by grocers and hakims using traditional methods. Drying is usually done by spreading plants on a sheet of cloth or plastic on the ground in the presence of sun. The process of drying is generally very crude as plants often get infected with insects and fungi. Storage is not done usually in hygienic condition. It is very important to improve the quality of medicinal plants consumed extensively in this region, to meet the standards of quality control and the strict regulatory requirements of international buyers.

CONVENTIONAL TECHNIQUES

In the past, fumigation was used for disinfestation during storage, and for quarantine requirements. Fumigants use such as methyl bromide, methyl iodide, sulfuryl flouride and carbonyl sulfide cause residual effect and pests may develop resistance. Most of these chemicals are carcinogenic and has serious adverse effect on human health. These chemicals may no longer be available for post-harvest use, especially in developing countries. Because of the ban, many countries have had to either limit or stop the export of some agricultural commodities. This will eventually result in economic loss, further balance-of-trade deficits and curtailment of consumer choices. Other conventional methods like cold and hot water extractions, tincture preparations, microwave treatment and ultraviolet irradiation are now considered unsuitable for decontamination of herbs and herbal products. The development of alternative procedures for long term preservation of herbs is therefore very important.

IRRADIATION

Irradiation has a clear edge over other phytosanitary treatments, because of its versatility in controlling a variety of microorganisms and insects. Controlled and optimum levels of irradiation effectively kill insects, bacteria, moulds and yeast and thus extend the shelf life and improve the quality of the treated materials. Irradiation has the following advantages:

- Internationally accepted as a safe preservation method
- Can resolve technical problems in trade and allow different levels of quarantine security
- Does not affect physicochemical and nutritional characteristics
- The process is called "cold pasteurization technique" as it effectively destroys harmful bacteria without heating
- Does not leave any residues in the products
- Can be done after packaging
- Reduces dependence on refrigeration and refrigerants
- Reduces or eliminates the number of disease-causing bacteria

IRRADIATION STATUS IN WORLD

Irradiation treatments of food materials have been approved by International Atomic Energy Agency, Food and Agriculture Organization and World Health Organization. Over 42 countries in the world including Pakistan, Bangladesh and India have given clearance for radiation processing of Food. United States is leading in production of irradiated herbs. It is expected that this procedure will be a legal requirement in the US in the near future. A total of some 80 commercial irradiators are now available globally while several more facilities are under construction in Argentina, Australia, Bangladesh, Brazil, China, India and USA.

IRRADIATION RESEARCH AT NIFA

Nuclear Institute for Food and Agriculture (NIFA), an organization of Pakistan Atomic Energy Commission, was established in 1982. The main objective of the institute is to promote peaceful application of atomic energy in the fields of food and agricultural research. The institute is well equipped and has excellent trained manpower. It is the only institute in Pakistan where food irradiation related work is conducted. These studies are spread over diversified approaches involving laboratory, pilot and commercial scale experiments. Preliminary research work on herbal materials indicated high microbiological counts in commercially available medicinal plants. Applying 6.0 to 10.0 kGy radiation doses from Co-60 gamma radiation source, microbiological loads of irradiated herbs have reduced to permissible levels. It was also found that irradiation treatment exhibited almost negligible influence on the proximate nutrients and elemental composition. Further no significant effects were observed on physicochemical characteristics and biological activities of the treated herbal materials.

Answers to Basic Fears about Irradiation

What is irradiation?
Irradiation is a processing technique that exposes materials to electron beams, X-rays or gamma rays, and produces a similar effect to pasteurisation, cooking or other forms of heat treatment.

Irradiation sources
Radiations which may be applied in irradiating food and herbs are:

- Gamma rays from the radionuclides ^{60}Co or ^{137}Cs.
- X-rays generated by machine sources operated at or below an energy level of 5 MeV.
- Electrons generated by machine sources operated at or below an energy level of 10 MeV.

Amount of radiation used (Absorbed dose)
The amount of energy absorbed in the radiation process is called 'absorbed dose', which is measured in units of Gray (Gy). One Gy is equal to the absorption of one joule per kg.

Why irradiate herbs?
Irradiation destroys insects, fungi and bacteria that cause herbs/herbal products to spoil, or may cause herbs borne illness to the consumers. Irradiation makes it possible to keep herbs longer and in better condition.

Irradiation conditions?
Irradiation of herbal materials is carried out at ambient conditions.

How does irradiation work?
Irradiation, at the energy levels commonly used for spices, (a minimum dose of 5.0 kGy) effectively kills bacteria, molds and yeasts. A dose of 5-10 kGy results in an immediate minimum 2-3 log cycle reduction of bacteria. Storage further enhances the sanitation effect because injured cells are unable to repair and die off over time.

In what forms herbs can be irradiated?
Irradiation can serve as a pasteurization treatment for herbal powder samples and herbal products like tablets, capsule etc.

Do biological activities change after irradiation?
The biological activities of herbs are well maintained between 5.0-15 kGy. In contrast, herbs are mostly damaged by chemical/fumigants treatment.

Does Storage affect the quality of irradiated herb?
Irradiation does not alter the quality of irradiated herbs and storage causes no greater loss of quality than that which occurs with non-irradiated herbs.

Is irradiation alone sufficient for improving the quality of herbs?
Irradiation is not a cure-all for all problems. Proper handling and storage by the herbal industry and the consumer are still important. Irradiation leaves no protective residues, so proper packaging is needed to prevent recontamination by insects or microorganisms.

Who recommends irradiation?
International standards such as CODEX have accepted it as a beneficial treatment. The irradiation of herbs is allowed in USA, Canada, Australia, India, France, Netherlands, Indonesia, Russia, China and South Africa etc.

Is irradiated herbs/herbal products safe?
Food irradiation has been examined thoroughly by joint committees of the World Health Organization (WHO), the United Nations Food and Agriculture Organization (FAO), by the European Community Scientific Committee for Food and the United States Food and Drug Administration. In fact, irradiation is the only treatment effective enough to meet standards set by processors operating under Hazard Analysis Critical Control Points (HACCP) or International Standards Organization (ISO) standards.

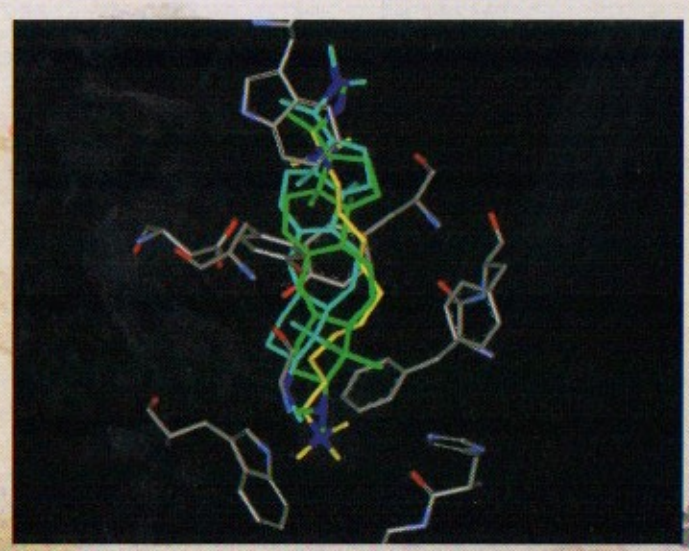
Packaging issues
Most packaging materials are compatible with irradiation. Irradiation can be done in bulk packages, retail packages, in gas impervious packages and heat scaled plastics. Irradiation allows the herb package to remain closed and scaled at all times.

Toxicological concerns
All reliable scientific evidence indicates that there is no risk to humans using irradiated products. It does not make herbs radioactive.

Environmental and occupational health concerns
Irradiation of food and herbs can only be carried out in special plants to avoid serious consequences for workers and the environment.

FACILITIES AT NIFA

Sterilization services
Analytical services
Consultancy services
Trainings
Seminars
Exhibitions



A three dimensional structure of plant compound

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