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Review Article

Education as a health tool: Adulterations and falsifications in natural medicine

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Abstract: The teaching-learning relationship of natural medicine is key to avoid health problems in the population; adulterations and falsifications of frequently used plants are evident. The aim of this study is to raise public awareness and to urge institutions to incorporate contents in the student's curriculum. The curricula of different educational levels are analyzed to check the level of knowledge on the use of medicinal plants, as well as some regulations on quality controls. Of the wide range of species that are consumed by the population, some are detected in which adulterations and falsifications occur, although there is no danger in some cases, such as chamomiles, if a falsification occurs when consuming the whole plant instead of the flowering tops, which is where the properties reside. In other cases, adulteration occurs, generally unintentional, but very dangerous to health, such as horsetail. For a more effective quality control, we need public awareness and highly specialized personnel, with the capacity to inspect crops, markets and companies.

Keywords: Educational Centers; Ethnobotany; Medicinal Applications; Public Awareness; Soils; Teaching; Phytotherapy

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1. Introduction

Faced with environmental and public health deterioration, the school should be a center of reflection, acting on the contents in teaching [1], new contents should be mandatory and not voluntary, which requires training future teachers [2,3].

At present there are two serious dangers that affect health in general and especially children and adolescents, so our goal is to raise awareness and teach the basics of natural medicine. Dangers that are a consequence of the lack of knowledge that children, adolescents and the general population have about medicinal plants [4].

Counterfeiting is the act of substituting a plant for a different one. However, if the composition of the preparation is modified using the same species, such as substituting officinal parts of a plant for others that are not, we would be dealing with adulteration [5,6].

The use of natural medicine has increased in the last 40 years, due to the skepticism of a certain part of the population towards modern medicine, which may be due to their low cultural level. At present there is a high consumption of plants, which are sold in herbalists, parapharmacies and commercial stores [6].

However, the knowledge of plants is increasingly scarce, both in primary, secondary and vocational training centers, as well as in universities, despite the fact that the use of

medicinal plants has been part of the different pharmacopoeias [7,8], there is a lack of knowledge of the phytochemistry of numerous species. Therefore, research in phytochemistry is essential for a better knowledge of the active principles that act in phytotherapy [9-11].

Plants, in addition to producing immediate principles, present "active principles" as a product of their metabolism, which provide plants with their therapeutic properties. Essentially, the active principles found in plants are: heterosides, essential oils, tannins, resins, mucilages, vitamins, minerals, antibiotics, alkaloids and toxic compounds, it is necessary to promote studies on plant diversity, favoring the teaching of biodiversity, with special attention to medicinal species [12, 20].

Compounds that affect health, either positively or negatively, so it is necessary to teach children, adolescents and the general population, this being the fundamental objective of this study, for which requires good training and coordination of the teacher with medical professionals [13].

The frequent use of natural medicine requires that the population has a better knowledge of plants, to avoid health problems due to adulteration, falsification and intoxication. Currently there is a tendency for the population to lose weight, in most cases without professional advice, which leads to nutritional deficiencies. In this case, the use of plants rich in mucilage is appropriate for their ability to retain water and produce a feeling of satiety in slimming regimes, being species of *Mallow*, *Portulaca* and algae such as *Fucus vesiculosus* rich in mucilage, an intake of vitamins would be advisable in these circumstances, this is the case of vitamins C, B complex and E, the first is very common in citrus fruits and especially in watercress, the second in cereals, nuts, legumes and the third E in oils, especially in olive oil (hojiblanca variety) [5].

But perhaps the most important compounds for medicine are the alkaloids, compounds that are located in different parts of the plant, for example, the nicotine in tobacco (*Nicotiana tabacum* L.) is synthesized in the root, but accumulates in the leaves; the alkaloids of *Papaver somniferum* L. are located in the latex of the fruit, from which the opium and morphine [14] are extracted, with hypnotic, sedative and analgesic properties, so its use should be restricted to physicians.

Other alkaloids, with the ability to inhibit cell mitosis, are present in *Vinca* [15] or compounds such as taxanes that have antineoplastic properties, present in the leaves of *Taxus baccata* L..

There are a number of botanical families with alkaloids that can be used as anesthetics, such as morphine and cocaine, the former extracted from the *Papaveraceae* and the latter from the *Erythroxylaceae*. The *Coffea* (coffee) cultivated in subtropical-tropical environments belongs to the *Rubiaceae* family, from which caffeine is obtained, which is digestive, bronchodilator, diuretic and stimulant due to the release of catecholamines. The species *Humulus lupulus,* bacteriostatic in nature, belongs to the *Cannabaceae,* but its excessive consumption causes a strong inhibition of libido. *Cannabis sativa* L. also belongs to this family, from which drugs are extracted for their hypnotic and analgesic character [16]. Tobacco, widely used by the population, belongs to the *Solanaceae* family, with the consequences of its consumption [17].

Due to the scarce knowledge of natural medicine by the population and by teachers and health personnel, it is necessary to focus on the training of teachers and health professionals in this subject [13,18,19]. Currently, the consumption of medicinal plants by society has increased, however, there is little botanical knowledge, so the main objective of this work is to raise awareness among the population, especially parents, students and teachers about the danger involved in the use of plants without a control mechanism. The main objective is to train teachers and sensitize the population through young people about the use of medicinal plants. This would require the incorporation of botanical content on medicinal plants in university courses and in educational centers.

2. Materials and Methods

We analyzed the curricula of students in Primary, Secondary, Vocational Training and University (Spain), in order to predict the need or not to implement studies of Natural Medicine and Botany in the curricula. For this purpose, we followed the guidelines of ethnobotanical and pharmacological studies on medicinal plants, toxic species to be taken into account according to health regulations [6], so we devoted special attention to quality controls to avoid adulterations and falsifications [7,20-23]. There are no guidelines or contents in the curricula for students. When we consulted the Spanish regulations on this matter, there is no information available, so we reviewed different Spanish laws published in the Official State Gazettes (BOE).

3. Results and Discussion

Medicinal plants have been used since historical times [24], to which energetic and curative power has been attributed [25-28]. The traceability of medicinal flora begins with cultivation [14], for which it is necessary to know the edaphology, climatology and autoecology of the species, and to carry out a previous preparation of the soil [29,30]. One of the fundamental aspects is to know the species by their scientific name and not by their vulgar name, since this leads to confusion, which is one of the causes of involuntary intoxications; in addition, as some authors [5,20] affirm, it is necessary to know the details of the cultivation, the origin of the plant, the techniques of drying, packaging and commercialization; since throughout the process there may be errors that give rise to adulterations and falsifications, some of which do not alter health, as in the case of chamomiles, although they deceive the population and have socioeconomic repercussions, and others are really serious, as is the case with *Valeriana wallichii* L. (Indian) and horsetail. These facts imply an exhaustive knowledge of the whole process, so it is necessary an education of society in general, and especially of rural societies [4], since at this social level begins the manipulation of plants, so it is necessary the teaching of Agronomic, Medical and Food Safety Botany. Despite the existence of several Royal Decrees in Spain and the European Commission Regulation [9-11,31], there are anomalies in terms of quality controls, which requires greater sanitary controls at the national and international level and at the customs level greater sanitary inspection, which requires highly specialized personnel.

This study focuses on several aspects, such as ethnobotanical knowledge of the population on quality controls, benefits and harms, preparation and administration of medicinal plants, therapeutic applications and control of their use, socioeconomic repercussions [32,33] and teaching-learning [34,35]. Taking these aspects into account, in teaching-learning the student should acquire knowledge about the nutritional nature of plants, and about some disorders for which plants can be used: hepatobiliary conditions, hypercholesterolemia, digestive disorders, constipation, blood pressure, respiratory conditions, menstrual disorders, weight loss, urinary and circulatory disorders.

For each of the aforementioned disorders there are plants that act on it to a greater or lesser degree; but the lack of knowledge of the species in question about its development, its official organs, root, stem, leaves, fruit, seed, where the active principles accumulate, but the processing and marketing, endangers the health of the individual; among other issues by adulterations and unintentional forgeries. These issues can be minimized if they are taught in schools, and if teachers are sufficiently trained for it.

For all this, a clear traceability of the product that reaches the population is required, which is really a quality control, in which, taking into account the above [20], the following aspects should be considered: 1- Scientific name of the plant. 2- Official part to be used. 3- Region or country of origin. 4- Cultivation or harvesting data: whether it is wild or

cultivated, date of harvesting, vegetative development at the time of harvesting, phytosanitary treatments applied. 5- Drying process, storage, environmental conditions of temperature, humidity, packaging, transport. 6- Macro and microscopic, organoleptic and phytochemical analyses to detect possible adulterations, forgeries. Therefore, plants with medicinal properties should not be sold in markets and stalls without sanitary control.

This traceability (quality control) from cultivation and harvesting to the consumer must be carried out by expert personnel, and should not be sold without sanitary control, since it is known that there are adulterations in this regard.

We report some of them; in the case of *Pimpinella anisum* L. its fruits should be harvested in August-September and are used as officinal organs, and its conservation should be in a cool place, protected from light and moisture, plant with digestive, carminative and antispasmodic properties, which should be used with caution due to its essential oil content whose main component is acetol [21], in this case adulterations have been found with the fruits of *Conium maculatum* L. that is highly toxic due to its content in cicutin. In the microscopic analysis of its berries, adulteration is easily detected. Green anise is also adulterated with *Petroselinum sativum* and very frequently with *Coriandrum sativum* L.

The fruits of these three species have the following differences:

1. Fruit mericarps covered by 5 ribs with hairs..... *P. anisum*
2. Fruit with wavy ribs, glabrous……..... *C. maculatum*
3. Fruits glabrous and smaller than *P. anisum* .....,,,,,,,,,,.. *P. sativum*
4. Fruit mericarps with 5 sinuous and 4 straight lines…….. *C. sativum*

Matricaria chamomilla L. belongs to the chamomile group, widely used after meals for its digestive properties, frequently used as an infusion in digestive and menstrual disorders due to its essential oil containing sesquiterpenes, mucilages and flavonoids. Although the properties are located in the heads of the plant, it is common to use the whole plant, so we would be facing a case of counterfeiting [36]. At the commercial level, it can also happen that it is replaced by other species of the same family, but without its properties, which is the case of *Anthemis cotula* L., *Anthemis tuberculata* Boiss., *Chamaemelum mixtum* (L.) All. among others, in some cases the common chamomile is replaced in its entirety, and we are facing adulteration and counterfeiting, and there may be cases of contamination due to lack of quality control. In the case of the Roman chamomile *Chamaemelum noble* (L.) All. with anti-inflammatory, antispasmodic and antiseptic properties, it presents the same adulterations and falsifications as the common chamomile.

In the case of hepatobiliary affections there is a group of species with choleretic action, such as the dandelion *Taraxacum officinale* (L.) Weber ex F.H.Wigg., the root and leaves are used as the officinal organ, a species frequently adulterated with *Leontodon* species, whose achene is larger and with feathery hairs, the root of the dandelion is adulterated with that of other *Taraxacum* species and with the root of *Cichorium intybus* L. with choleretic, cholagogue and hepatoprotective character, *Cynara scolymus* L. is used, species indicated in hepatic insufficiency, for biliary retention and in gallstones, both *Cynara scolymus* L. and *Cynara cardunculus* L. are of interest in the diet of diabetics, since they contain inulin instead of starch. However, they should be used with caution, as they are contraindicated in case of bile duct obstruction.

When there are high cholesterol levels, garlic *Allium sativum* L. with a high content of essential oil, is hypocholesterolemic and slightly hypotensive due to peripheral vasodilatation, with other properties such as hypoglycemic, diuretic, bacteriostatic and bactericidal. Something similar occurs with ispaghula or *Plantago ovata* Forssk., in this case counterfeits occur with other species of plantago, but without danger of intoxication because they present the same active principles [5,21,37,38].

The olive tree *Olea europea* L. is of some importance, being used the fruit and leaves, the latter for its hypotensive action by exerting a spasmolytic action on the walls of blood vessels by peripheral vasodilatation, besides being diuretic and hypoglycemic due to glucose uptake and increased insulin release [35], the fruits (olives) are rich in monounsaturated fatty acids, with a high percentage of oleic acid, and in vitamins such as E (alpha-tocopherol), which is more abundant in the hojiblanca variety, olive oil is laxative, cholagogue and is indicated for hypercholesterolemia, cardiovascular and neurovegetative conditions.

As for respiratory ailments, in addition to licorice and thyme, we highlight the eucalyptus with two species cultivated in the Iberian Peninsula *Eucalyptus globulus* Labill. and *E. camaldulensis* Dehnh., the leaves are used as the official organ, which should be harvested from April to September, its expectorant and fluidizing character gives it bronchodilator, antiasthmatic and decongestant properties due to its eucalyptol content, can be used as a balsamic in pulmonary affections, it is normally used by inhalation.

In case of menstrual disorders, *Adiantum capillus-veneris* L., *Calendula arvensis* L. and *Achillea millefolium* L. are used in infusion. In slimming can be used those species rich in mucilage for its satiating character, is the case of ispaghula, *Fucus vesiculosus* with a high content of mineral salts and iodine that promotes thyroid function, *Portulaca oleracea* L. [38,39].

Green tea *Thea sinensis* L. is widely used as a diuretic and horsetail *Equisetum arvense* L. and *Equisetum telmalteia* Ehrh. for its content of potassium mineral salts and flavonoids, horsetail is a potent diuretic due to potassium salts, so it is often used in urinary conditions. In this case, there is a serious danger with counterfeits, as they can be confused with *Equisetum palustre* L. and *Equisetum ramosissimum* Desf. which are toxic, hence the need to raise awareness and train the population as much as possible in this matter [40].

Due to the stress that the population is under, the consumption of plants that act as tranquilizers, sleep inducers and regulators of the neurovegetative system has increased: *Valeriana officinalis* L, *Passiflora incarnata* L., *Melisa officinalis* L, *Tilia platyphyllos* Scop. In the case of *Valeriana,* according to pharmacological studies, the dose should be 400 mg/day, this entails a certain danger in case of adulteration with *V. wallichii* DC. (India), being this adulteration frequent, and its side effects potent due to its greater sedative power. Linden is frequently adulterated by *Tilia cordata* Mill., which is very common in parks and gardens, however, the differentiation of both lindens is easy, as their fruits are different, since *T. platyphyllos* Scop. has fruits with prominent ribs and *T. cordata* Mill. has them little prominent.

Great danger is posed by species rich in alkaloids due to their analgesic-narcotic character, such as the opium *Papaver somniferum* L., from which morphine is obtained, which should be used to relieve acute pain, should be used exclusively under medical control, as well as a large number of plants that should not be used by the population because they are drugs or because of their toxicity [6,40,41].

4. Conclusions

There is a great demand for the consumption of plants for food and medicinal purposes, despite the existence of certain sanitary control mechanisms by the institutions, the desired control over traceability is not always achieved, and the consumption of plants escapes the controls that are detrimental to health. The consequence is adulteration and counterfeiting, whose risk is high, due to the botanical ignorance of the species, it is common for the population to confuse some species with others.

To avoid this risk we propose several aspects to be taken into account: quality controls in markets, public awareness, teaching-learning of natural medicine.

Due to the lack of content in the curricula, it is necessary for the educational system to incorporate it, so teachers should be trained in this regard. Even in the higher studies of the degree of Medicine, knowledge of Medical Botany is not taught. All this can be

verified by consulting the Official Bulletins of the Spanish State and consulting the study plans of the different Faculties of Medicine. However, in spite of the fact that the application of many medicinal species must be under medical control, this discipline is not taught in the Faculties of Medicine.

Conflicts of interest: "The authors declare that they have no conflicts of interest".

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