

ABSTRACT

Fruit growing is one of the main branches of Romanian and global agriculture, both contributing to the diversification of horticultural production and to maintaining the balance of agroecosystems. In recent decades, socio-economic changes have influenced the reconfiguration of consumer priorities in favor of foods with high nutritional value and increased content of bioactive compounds with proven benefits for human health.

In this context, *Prunus domestica* L. species has experienced steady expansion, especially in plantations managed according to the principles of ecological farming. This species is valued for its rich content of polyphenolic compounds, flavonoids, including anthocyanins with antioxidant effects, as well as vitamins, minerals, and essential micro/macronutrients. Due to these bioactive components, plums are classified as functional foods with preventive and therapeutic properties, which have been widely documented in scientific literature.

The transition to sustainable farming systems that seek to address the shortcomings associated with conventional practices is becoming a strategic necessity in the current context. This goal can be achieved by optimizing technological efficiency, increasing profitability, ensuring food safety, and reducing the negative impact on agricultural ecosystems.

However, the agronomic and nutritional potential of *Prunus domestica* L. species is conditioned by a number of interdependent factors, among which the pedoclimatic conditions and the applied agrotechnical practices stand out. Although it is a relatively resistant species, it remains vulnerable to abiotic stress associated with climate variability and intensified agricultural practices, especially in regions with high anthropization. In these areas, the accumulation of contaminants in soil and plants is favored, thus affecting the quality of production and the balance of the agroecosystem.

In this context, the plum orchard from Vasile Adamachi educational farm in Iasi constitutes a relevant research base for investigating the relationships between cropping systems, fruit nutritional quality, and the agroecological status of the soil. The location of this farm in a region characterized by high agricultural potential but with a history of industrial pollution justifies the need for an applied study to analyze the impact of agrotechnical practices on fruit quality and soil health.

The research is part of an effort to scientifically substantiate sustainable fruit-growing strategies adapted to local soil and climate conditions and global challenges. The aim is to optimize cropping systems in plum orchards in correlation with fruit quality parameters and soil ecological functionality.

The doctoral thesis entitled "*MANAGEMENT SYSTEMS USED IN THE FRUIT ORCHARD OF VASILE ADAMACHI FARM, IAȘI AND THEIR INFLUENCE ON THE AGROECOSYSTEM*" is structured in two parts:

Part I contains review of literature, reflecting the current state of research in the field.

Chapter I is devoted to the study of *Prunus domestica* L. species, including information on its origin, distribution, economic importance, and morphological, physiological, and technological characteristics.

Chapter II addresses the issue of agroecosystem contamination with heavy metals and pesticides, summarizing information from national and international scientific literature regarding the sources, transfer processes, dispersion, and accumulation of these substances in soil and plants, as well as their impact on ecosystem health and food safety.

Part II integrates our own contributions, resulting from experimental work carried out in the field and in the laboratory, and is structured in six chapters.

Chapter III describes the natural conditions of the study area (pedological, climatic, hydrological, and geomorphological), as well as the physical and chemical characteristics of the soil and irrigation water. Climatic trends in the fruit-growing area of Central Moldavia, relevant to plum cultivation, were also assessed for the period 2010–2024.

Chapter IV presents the objectives of the study, the research methodology, the biological material that was used (five plum varieties: *Stanley*, *Minerva*, *Tuleu Gras*, *Record*, and *Anna Späth*) and the cultivation technologies (ecological and conventional).

Chapter V includes the results physico-chemical and phytochemical characterization of plum fruits harvested from conventional and ecological systems, using modern methods such as ultrasound-assisted extraction, UV-Vis spectrophotometry, and scanning electron microscopy (SEM). Sensory analyses and statistical interpretations highlighting the influence of cultivation system on the quality of the final product are also included.

The analyses carried out in this chapter highlighted the differentiated influence of the cultivation system on the quality of plum fruits, with a clear superiority of the ecological system in terms of phytochemical, nutritional, and sensory parameters. In the ecological system a higher accumulation of phytochemical compounds was observed, especially polyphenols, flavonoids, and anthocyanins, correlated with an increase in antioxidant activity in both the epicarp and mesocarp.

At the same time, fruit from the ecological system had a nutritional profile characterized by increased levels of protein, carbohydrates, and vitamin C, along with superior firmness, with favorable implications upon post-harvest shelf life and technological potential.

The conventional system resulted in a higher fruit weight, along with an increase in lipid content, which, although commercially advantageous, may negatively affect the overall nutritional profile. Sensory evaluation, supported by main component analysis (PCA), confirmed that the dominant organoleptic attributes, particularly taste and aroma, are sensitive both to cropping system and genotype, suggesting a superior potential of the ecological system in optimizing perceived quality.

Therefore, the obtained results validate the contribution of the ecological system not only as a sustainable alternative in the context of modern agriculture, but also as a strategic vector for obtaining fruit with high nutritional, functional, and sensory value, thus contributing to the orientation of horticultural practices towards higher standards of quality and sustainability.

Chapter VI analyzes the concentrations of heavy metals (Cu, Zn, Fe, Co, Ni, Pb, and Cd) in soil (0-42 cm) and in plum fruits, depending on the phenophase of development (BBCH 73, BBCH 76, and BBCH 89) and the cropping system (conventional and ecological). The metals were quantified by flame atomic absorption spectrometry (fAAS), following classical mineralization (in an open system) and microwave mineralization. Also, at BBCH 89, the pXRF technique was used as a complementary, rapid, and non-invasive method to identify differences in metal accumulation depending on the applied cropping system.

Comparative analysis of mineralization methods revealed differences in heavy metal accumulation in plum fruits, influenced by the cropping system, phenological stage, and genotype. The ecological system favored the accumulation of essential elements (Cu, Zn, Fe), while Pb and Cd recorded higher values in the conventional system, associated with agrochemical inputs. Microwave digestion provided more accurate and consistent results, with differences <10% comparing to the classical method, confirming its analytical superiority. Cu, Zn, and Fe concentrations reached maximum levels at BBCH 76, decreasing significantly at maturity (BBCH 89), which suggest a physiological redistribution of these elements during fruit development.

In terms of genetic variations, *Minerva* variety stood out with a detectable accumulation of Ni at BBCH 76 (0.96 mg/kg), which was no longer detectable at maturity, suggesting a potential genetic resistance to accumulation. *Record* and *Tuleu Gras* varieties proved to be stable in terms of metal accumulation, regardless of the cropping system.

The pXRF method indicated higher values for some metals, but with limitations related to soil depth and surface contamination, requiring further validation, especially in the conventional cropping system.

Correlations between soil and fruit metal content were stronger in the ecological system, where the transfer factors were <1 for all metals evaluated, indicating a low risk to human health. In addition, carcinogenic risk assessment based on cultivation technology indicated a high level of safety for fruit consumption.

Chapter VII completes the analysis of contaminants by studying the persistence of pesticide residues in fruit and soil from both systems (ecological and conventional) using high-resolution chromatography. Differences between those two systems were identified in terms of contamination levels, which were below the limit of quantification (LOQ).

Three pesticides were identified in soil samples from the ecological system: DDT, Cypermethrin, and Lambda-cyhalothrin, indicating long-term contamination.

Nine pesticides were detected in the conventional system, including herbicides and insecticides (Terbutylazine, Propizamide, Malathion, p,p-DDE, Fludioxonil, o,p-DDT, p,p-DDT, Piperonyl butoxide, and Lambda-cyhalothrin), some of which have high persistence in soil.

The detection of chlorpropham (banned in the EU), a pesticide not included in the treatment plan, indicates accidental contamination of crops from an external source, probably through air drift from other neighboring farms or through indirect contamination of equipment, water sources etc.

The presence of DDT suggests historical contamination, as it has been banned for over 40 years, reflecting its high persistence in the environment and highlighting the need for long-term remedial measures in the affected areas.

Chapter VIII summarizes the general conclusions of the research and suggests recommendations for the implementation of sustainable agrotechnical practices in plum orchards in areas with high anthropogenic pressure.

Preliminary results indicated a higher nutritional quality of fruits from the ecological system, with lower concentrations of contaminants and higher concentrations of bioactive compounds. It was also found a significant influence of cultivation system and phenophase of development upon the bioaccumulation of heavy metals. These findings support the need to implement sustainable agricultural practices in order to protect consumer safety and the environment.