



## The *Rosaceae* Mountain Products, As Functional Food and Behavior: Evidence From Mountain Farming

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**Abstract:** The article shows the importance of *Rosaceae* mountain products in the context of the current pandemic, focusing on the importance of healthy food. The analyzed mountain products are cherries (*Prunus avium*), sour cherries (*Prunus cerasus*), apples (*Malus domestica*), pear (*Pyrus communis*), peaches (*Prunus persica*), apricots (*Prunus armeniaca*) and nectarines (*Prunus persica* var. *Nucipersica*), and plums (*Prunus domestica*). The paper develops the value chains of these agricultural products, pointing to the importance of agronomical treatments and remedies on these trees to obtain more qualitative and quantitative mountain products. Mountain pomology is particularly important for the development of this area, especially the fruit orchards analyzed in the paper, as it ensures the sustainability of this underprivileged area, the mountain regions being known as disadvantaged compared to the plains. The research of the paper was agronomical, territorial profile, experimental, and statistical according to the Register of Mountain Products.

**Keywords:** functional food • behaviour • *rosaceae* family • mountain farming • mountain product

### Introduction

The paper proposes a specific *Plantae* kingdom, a specific *Rosaceae* family, as a value chain model for mountain farming. The value chain analyzed has as groups mountain production – agronomical research, mountain producers – territorial profile research, and mountain consumers – health research. The paper presents the importance of *Rosaceae* mountain products in the context of human necessity for a healthier life, especially due to the COVID-19 pandemic.

Egyptian professors carried out experimental research on the essential oils of apple (*Malus domestica*) and pear (*Pyrus communis*), concluding that the antimicrobial effects of these mountain products on various diseases are multiple, one of them being the effect of *Pyrus communis* against *Salmonella typhimurium* (El-Hawary et al 2018).

A series of research on mountain products in India and Nepal highlights the importance of

the mountain ecosystem on essential oils. Studies on Pomelo essential oil, as well as the entire spectrum of upland plants in the genus *Citrus*, demonstrate that they have strong antimicrobial properties against pathogenic microorganisms. Mountain essential oils of the *Cymbopogon* genus have the same antimicrobial properties against various fungi and diseases such as *Staphylococcus aureus*, *Staphylococcus epidermidis*, *Candida albicans*, *Microsporum canis*, and so on (Dangol et al 2023). A Norwegian study, supported by a study from Kosovo, highlights the excess of sabinene (a significant component of various plant essential oils, with important positive effects on the neurological system and so on) in mountain juniper, compared to limonene primarily found in lowland plants (Looman et al 1992, Vasić et al 2016). Works on Iranian mountain products show that the composition, structure, viscosity, and so on, but especially the efficiency of



essential oils vary significantly from low to high mountain altitude (Moghaddam et al 2023; Bidgoli et al 2013). These studies are supported by a multitude of experimental research on positive and direct connections between altitude and essential oil components of some mountain products from different parts of the world, namely Greece, Crete, Spain, and Iran (Kofidis et al 2008; Karousou et al 2005; Kozłowska et al 2018; Layegh Haghighi et al 2017; Torras et al 2007).

The health benefits of cherries are numerous, with various phenolic substances identified in different varieties of fresh cherries. The phenolic substances found in sweet and sour cherries, including phenols and anthocyanins, exhibit anti-neurodegenerative effects. Considerable amounts of by-products are derived from cherries after processing, comprising pomace (skin and pulp) and seeds (pit) left behind after fruit juice extraction. Sour cherry pith is notably rich in phenolic compounds, while the seed yields a substantial amount of oil with advantageous effects on human health, attributed to its antioxidant, antimicrobial, and anti-inflammatory properties (Yılmaz et al., 2019). Worldwide there is great interest in sour cherry by-products due to the increase in sour cherry production rate and increasing efforts to search for bioactive compounds from natural sources as functional food.

Vegetable resources from the peach, apricot, nectarine, and plum range have been part of the human diet for thousands of years. They are abundant in phytochemicals, encompassing phenolic compounds, carotenoids, vitamins, volatile substances, and organic acids. The antioxidant properties of peaches are attributed to their phenolics, carotenoids, and vitamins. Notably, phenolic compounds like quercetin and cyanidin derivatives in peaches play crucial roles, exhibiting antimicrobial and anti-inflammatory properties. Both experimental and clinical studies present evidence of their preventive effects on various chronic and age-

related conditions, including diabetes, obesity, hypertension, inflammation, cardiovascular, neurodegenerative, and oncological diseases. Numerous studies examining the phenolic content of peach extracts highlight their significant potential as free radical scavengers, providing protection against several chronic and aging-related diseases (Bento et al., 2022).

### Material and Methods

The research develops an entire value chain regarding *Rosaceae* mountain products. The agronomical research was conducted in different parts of the European Carpathian Romanian mountains, especially Maramures, Neamt, and Dambovită counties. Territorial profile research refers to mountain producers from European Carpathian Mountains and all the mountain counties in the development regions of Romania. Health research focuses on experiments regarding macro-nutritional laboratory analysis according to the author's and mountain producers' information.

Cherries (*Prunus avium*) and sour cherries (*Prunus cerasus*), fruits important for health, represent markets with considerable productive fluctuation in Romania. The Romanian producer who applied the agronomic remedial solutions for these mountain products is from the Neamt county.

From an entrepreneurial point of view, the apples (*Malus domestica*) market represents one of the most important fruit trades in Romania. The rise of the Romanian pear market (*Pyrus communis*) in recent years places it among the most competitive in the category of plant resources. Mountain pear producers in Romania face the problem of ensuring good management of the pest complex. The producers of mountain apples and pears are from Dambovită County.

Among the most consumed plant resources are the fruits of the peach range, namely peaches (*Prunus persica*), apricots (*Prunus armeniaca*), nectarines (*Prunus persica* var. *Nucipersica*), and plums (*Prunus domestica*).



Mountain plums are the most productive and unpretentious trees. The mountain production related to these fruits is faced with recent climate changes, especially in the area of Neamt where the mountain producer who carried out the remedial agronomy proposed in this work is located.

The paper shows that regulating the agronomic production system, problematic for Romanian mountain producers given the recent reduction in productivity, can ensure increased economic sustainability in mountain pomology.

### Results and Discussion

For the Cherries (*Prunus avium*) and sour cherries (*Prunus cerasus*), the solutions to increase productivity concerned cutting, respectively manual thinning. Pruning always took into account the age of the trees. The orchard, being in its early stages, prioritized the establishment of a crown (the shape and topological structure of a tree) to ensure consistent production in the future years. Consideration of growth and fruiting characteristics is crucial at this point. Spur varieties grafted on dwarf rootstocks, with limited vigor, tend to produce few new shoots but bear a substantial number of fruits in their initial years of production. To facilitate the swift formation of the crown, such trees necessitate more pronounced thinning during the early years. Observations from a mountain producer indicate that dormant period pruning restricts the number of flower buds, serving as an initial thinning stage. Pre-growth season pruning offers the advantage of preserving elements accumulated in branches, trunk, and roots for remaining buds. This, in turn, ensures better nutrition, leading to improved quality parameters for the resulting fruits. Mechanized thinning, applicable to both branches and flowers or fruits, is recommended, especially in mountainous regions where farming is more challenging, and the effort required to move up slopes is substantial (Rutkowski et al., 2022). The

mountain manufacturer considering this solution.

The Romanian cherry and sour cherry market appreciated and depreciated in the last five years (2017-2021), with cherry exports ranging from \$486,000 to \$951,000 (+95.67%) and cherries from \$292,000 to \$25,000 (-91.43%) (ITC 2022). The mountain producers of cherries and sour cherries are mainly located in Valcea, followed by Caras-Severin, then Maramures and Sibiu (Fig 1) (ANZM, 2022 & 2023).



**Fig 1:** Territorial profile of mountain producers of Cherries, Sour cherries

The production of apples (*Malus domestica*) in the mountainous area of Romania requires solutions for the use of foliar fertilizers, a solution partially applied by the considered mountain entrepreneur. A good technique for supplementing apple productivity in the mountain area, proposed in the contractor's work and applied by him, is the systematic use of foliar fertilizers - mineral foliar fertilizer system - during the growing season. Producers prefer the usual, chemical, technical fertilization of the soil that negatively affects the environment. It was observed in the mountain entrepreneur that mixing foliar nutrition with plant protection presents the best way of productivity in mountain apples. A study on the ecological plant protection system – based on bacterial and mildly toxic preparations (Kuzin et al 2019) – considered making tank mixes with



foliar fertilizers based on seaweed extracts. The researchers of this study considered fertilizer yield, tree bark development, and calcium content of leaves and fruit as the main criteria of ways to check productivity development in apples. It was found that the protection of plants in the traditional system in combination with mineral foliar fertilizers ensured a higher calcium content in leaves and fruits, less damage from the bark of the tree, and higher productive yields. This fact was also confirmed by the studied mountain producer who transforms apples into juice, for which different nutritional parameters are analyzed. Another study that may help upland farmers considered the beginning of the flowering stage in apples and pear (Drepper et al 2020). The study was carried out for the period 1950–2018. Phenological trends were analyzed as a function of dormancy temperatures. Two different phenological models were adapted and evaluated – forced or normal transition from cold to warm season and vice versa. Mean flowering dates in apples averaged 9.5 days faster after warm dormancy and 11.5 days in pear. The results of the study suggest the overlap of cooling and heating processes, forcing the transition phase between the two. Advances in flowering dates after warmer dormancy periods were found to be stronger for pear than for apples. This study can partially help fruit growers in the mountain area so that the problem of delayed flowering due to the colder climate in this area is solved. The proposal for the fruit grower who made the mountain products studied in the work, apple, and pear juices, aimed at applying techniques of forced transition from the cold season to the warm season, with the wrapping of the crowns in case of accidental frost. The positive results were obvious. Thus, mountain apples/pears and their products will be marketed at the same time as plain ones, reducing the gap between the best-paid fruit crops - the initial crops.

The best-known varieties of mountain apples in Romania are Eisenhauer, London Pepping, Tirol, Renet de Landsberg, Parmen auriu, several varieties of Voinesti (used by producers and experimentally analyzed products), Redix, Iris, Ponoma, Chindia, etc. (Borhan 2013).

The apple market is relevant from the point of view of health, their benefits on the body's immunity being indisputable. Apples and their by-products are beneficial for health, both in their natural state and processed by the pharmaceutical industry. The specialized literature highlights the progress in optimizing the process of apple derivatives through vinegar, cider, pomace, and spirits technologies. Apples have numerous antioxidant, anti-inflammatory, and antimicrobial properties, as well as antidepressant and anti-cancer effects. In addition, these compounds also protect against arteriosclerosis, diabetes, and neurodegenerative, cardiovascular, and oral diseases. Apple compounds such as phenolic acids, flavonols, and others. Apples from mountain areas with less polluted ecosystems are more beneficial for health (Guiné et al., 2021). Apples are fruits with a strong antioxidant character, annihilating free radicals and strengthening the immune system. The optimal level of daily calories, protein, and carbohydrates should be provided from foods that strengthen the immune system, as many as possible in natural form and rich in antioxidants (**Table 1**). The number of calories in an adult, according to the Harris-Benedict equation (which calculates the basal metabolic rate), should be approximately 2500 kcal (Mancas et al., 2005).

Being among the sweetest fruits, pears have a high concentration of water and sugar. Researchers Reiland and Slavin (2015) conducted research on bile acids in various fruits: bananas, peaches, pineapples, grapes, pears, apricots, and nectarines. Pears contain



fructose and sorbitol. Although most fruits contain sucrose, pears, and apples have the highest content of fructose, in addition to glucose, sucrose, and sorbitol.

Apple juice and pear juice recommended in the paper meet the necessary nutritional requirements for protein and carbohydrates. Apple juice (*Malus domestica*) Parmen has high nutritional values, ensuring a balanced intake of *calories* (10.5 kcal per 100 g), *protein* (0.45% per 100 g), *carbohydrates* (10.15% per 100 g), and *fat* (0% per 100 g).

Artesana apple juice, made from plain products, has lower nutritional values than the mountain one.

Pear juice (*Pyrus communis*) Parmen presents a nutrition declaration for 100 g of the product containing an *energy value* of 450 kcal/1895 kJ, *protein* of 0.5%, *inverted sugar* of 9%, *fiber* of 2.8%, and *carbohydrates* of 8.2%. Profructta pear juice, made from plain products, has lower nutritional values than the mountain one.

**Table 1.** Comparative analyzes between mountain and plain/hill fruit products

| Calories / Energy value   |              | Protein |         | Carbohydrates |         | Fat / Invert sugar / Fibre |         |
|---|--------------|---------|---------|---------------|---------|----------------------------|---------|
| <i>Mountain apple juice</i> * / <i>Plain/hill apple juice</i> # |              |         |         |               |         |                            |         |
| 10.5 kcal *   | 51.67 kcal#  | 0.45% * | 0.56% # | 10.15% *      | 4.40% # | 0% *                       | 0.03% # |
| <i>Mountain pear juice</i> * / <i>Plain/hill pear juice</i> ^   |              |         |         |               |         |                            |         |
| 450kcal/1895kJ*   | 48.54 kcal ^ | 0.5% *  | 0.5% ^  | 8.2% *        | 9.8% ^  | 9%/2.8% *                  | 0.4% ^  |

Source: According to Parmen (mountain juice\*) (2021), Artesana (apple juice#)(2023), Profructta (pear juice^) (2023)

The Romanian apple market decreased considerably annually during the period 2017-2021, by -46%, reaching \$182,000 in 2021 (ITC, 2022). The Romanian mountain counties with the most important apple production are Maramures, Valcea, and Caras-Severin (**Fig 2**) (ANZM, 2022; ANZM, 2023).



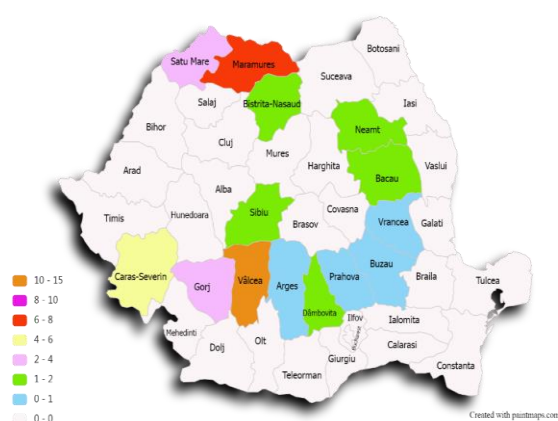
**Fig 2:** Territorial profile of mountain apple producers

For mountain trees, in the present case pear (*Pyrus communis*), the most important productive factor is the management of all pest complexes, including weeds and diseases. The mountain entrepreneur studied in the paper applied this type of management. The purpose of this type of management was to provide preventive, monitoring, and regulatory measures with biological, physical, and chemical control agents based on warning systems for mountain orchards. Considering that the mountain ecosystem is less polluted than the others, especially the one in the mountain area of Dambovita County, the mountain entrepreneur applied natural pest control mechanisms. Natural pest control was supported by measures to protect and improve beneficial organisms. The pollination service of pollinating insects has been significant for the production of mountain fruit crops. In the paper presented as a remedial agronomic model by Belien et al., on pear cultivation and valid for mountain areas, relevant ecosystem services were identified. A major role in



sustainable ecosystem control of various hair pests is played by arthropods. The communities of predatory arthropods and the influences of local factors and the landscape prove to be strongly shaped by orchard management practices, a fact also observed by the studied Romanian mountain entrepreneur. The role of local biodiversity features such as hedgerows and flower borders has been highlighted in several studies of hair orchards. In the pear orchard of the studied Romanian entrepreneur, what was demonstrated in the study by the authors Belien et al. was confirmed, namely that the positive impact of a mixed hedge represents a specific element of biodiversity to improve integrated pest control (Belien et al 2021).

The Romanian pear market experienced a 386.36% increase in exports between 2017-2021, from \$22,000 to \$107,000 (ITC, 2022). The most active mountain pear producers are found in Valcea, followed by Maramures and Caras-Severin (Fig 3) (ANZM, 2022; ANZM, 2023).



**Figure 3.** Territorial profile of mountain pear producers

More than for other pomology production, in the case of peaches (*Prunus persica*), apricots (*Prunus armeniaca*), and nectarines (*Prunus persica var. Nucipersica*) it is necessary to highlight the importance of climate change for mountain orchards. A study on the influence of climate change on fruit trees shows that mountain orchards require urgent adaptations

to this issue. The study presents a model that demonstrates that the phenology of the trees with the most important mountain production is part of an annual cycle sensitive to the climate, an aspect also observed in the area of the studied mountain apricot producer. The model combines temperature-dependent submodels of dormancy, flowering, fruit survival, and ripening, using as benchmarks cooling units, forcing units, frost occurrence, and the day-night temperature difference, which in the mountain case is significantly more pronounced than in the plain. Climate change has divergent effects on mountain fruit production. On one hand, an earlier occurrence of flowering would be advantageous, as warmer temperatures could reduce the risk of spring frosts, facilitating fruit ripening well before the onset of autumn. On the other hand, milder winters might hinder the breaking of the plant's buds from endodormancy (dormancy induced by internal factors), resulting in abnormal fruit development patterns or even a failure to flower. The latter impact would dramatically change the geographic range of sites where peach, apricot, and nectarine production would be profitable. For example, for the northern areas of Romania where the studied mountain producer is also located, where winter cooling is more pronounced, additional measures are required in these mountain areas. The mountain grower noticed that wrapping the trees before flowering is a good solution to solve this problem. The south of Romania, with higher temperatures including in the mountainous area, favors the production of peaches, apricots, and nectarines more than the north of the country (Vanalli et al 2021).

The peach fruit market has developed over the past five years, with exports increasing for peaches and nectarines by 307.05% (from \$85,000 to \$346,000) and for apricots by 66.4% (from \$125,000 to \$208,000) (ITC, 2022). The most representative mountain counties with plum production are Valcea and



Caras-Severin (**Fig 4**) (ANZM, 2022; ANZM, 2023).



**Fig 4:** Territorial profile mountain producers of Peaches, Apricots, Nectarines

In Romania, for peaches, apricots, nectarines, and plums (*Prunus domestica*) production factors such as the use of fertilizers, irrigation, pruning and training, and plant protection practices, play an important role in the yield per tree, which is recommended to carry them out in the mountainous area. The most useful agricultural practices are aimed at influencing the final quality of the mountain fruits, such for example the application of calcium sprays after flowering, an action that definitively affects the quality and quantity of the fruits. The aspects observed in the last sentences were also noted by the mountain producer in the studied Neamt area. The use of gibberellin at the pre-harvest stage has also been reported to delay ripening and improve fruit firmness. Common pests and diseases of Romanian plums include European red mites, brown rot, leaf spot, and black knot. The mountain producer from the Neamt area studied facing only leaf spots and black spots. It is indicated that when combating them, farmers should consider the marginal yield of productivity as the objective to follow. In this sense, pest control focused on organic methods is recommended, so that the soil and other coordinates of the mountain ecosystem are not significantly affected. For example, the studied mountain producer applied pest control with ash, steam, and smoke, the

positive results being significant (Siddiq 2006).

The Romanian plum export market varied during the period 2017-2021 by +3.21% (from \$560,000 to \$578,000) (ITC, 2022). Mountain producers from Maramures, Valcea, Satu Mare, and Caras-Severin are among the top plum entrepreneurs in Romania (**Fig 5**) (ANZM, 2022; ANZM, 2023).



**Figure 5.** Territorial profile of mountain plum producers

### Conclusion

Paper demonstrates that by adopting the system of cutting and thinning at mountain cherries (*Prunus avium*) and sour cherries (*Prunus cerasus*), the optimal ratio between effort and productivity is ensured, the investment in appropriate equipment being minimal compared to the result obtained. The technique of wrapping the crowns in case of accidental frost for the apples (*Malus domestica*), peaches (*Prunus persica*), apricots (*Prunus armeniaca*), and nectarines (*Prunus persica var. Nucipersica*) develops the value chain of these trees. The solution of natural pest control mechanisms for pear (*Pyrus communis*) was the best agronomical remedy. Regarding plums (*Prunus domestica*) dosing is important, with particular attention being paid to flammable conditions and the surrounding environment. The development of these markets depends on the mountain area by applying special remedies and treatments to different types of fruit crops.



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