

PROCESSED BIO BLUEBERRIES - AN ALLY OF HUMAN SMART NUTRITION

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ABSTRACT

Background: Cultivated highbush blueberries (*Vaccinium corymbosum* L.) represent an essential component of functional smart nutrition due to their outstanding abundance of micronutrients, total phenolics, and anthocyanins. However, high post-harvest perishability necessitates efficient preservation strategies. **Objective:** This study evaluated the chemical composition of fresh organic blueberry varieties ('Duke' and 'Elliot') over two consecutive seasons (2024 and 2025) and examined their processing performance across two primary technological routes: convective dehydration and pasteurization. **Materials and Methods:** Fresh fruits were supplied by the Pitesti-Maracineni Institute, and experimental processing was carried out at the "Horting" Institute, Bucharest. Convective dehydration was conducted at 60°C (air velocity 2 m/s), yielding whole dried fruits and functional fruit powders. Pasteurization was utilized to manufacture clean-label confitures, high-viscosity jams, toppings, and syrups using raw organic cane sugar. Biochemical indicators—total soluble solids (TSS), titratable acidity (TA), total sugars (TS), Vitamin C, total phenolic content (TPC), and total anthocyanin content (TAC)—were monitored using standardized refractometric, volumetric, spectrophotometric, and colorimetric methods. **Results:** Baseline screening revealed exceptionally high values of antioxidants, with the 'Elliot' cultivar showing superior TPC (mean of 5927.59 mg GAE/kg) and TAC (mean of 2990.60 mg/kg) compared to 'Duke' (mean TPC 4109.94 mg GAE/kg; mean TAC 2852.70 mg/kg). Dehydration kinetics showed highly consistent drying durations across seasons; however, 'Elliot' recorded a slightly higher mass reduction (+0.15%) due to its immediate processing post-harvest, while pre-storage of 'Duke' at 4°C naturally lowered its initial cell water. Crucially, cultivar morphology dictated processing suitability: the thin-skinned, juicy 'Elliot' berries collapsed during whole-fruit boiling, proving ideal for jams, syrups, and toppings, whereas the firm-fleshed 'Duke' excelled in premium whole-fruit confitures. **Conclusion:** Both convective drying and pasteurization successfully concentrate valuable natural sugars and bio-compounds without critical structural or nutritional impairment, delivering 100% natural, additive-free functional snacks aligning with modern consumer demands for preventative health and metabolic homeostasis.

KEYWORDS: *Vaccinium corymbosum* L., Organic fruits, Antioxidants, Functional foods, Convective dehydration kinetics, Pasteurization.

1. INTRODUCTION

The cultivation of fruit shrubs is of paramount importance from nutritional, pharmacological, and economic perspectives. Berries are highly appreciated by consumers worldwide due to their exceptional

organoleptic profiles, distinct flavours, and aromas. These fruits serve as rich repositories of vital micronutrients^[1] and natural antioxidant compounds^[2], driving a steady increase in global cultivated areas and demonstrating substantial market potential.^[3]

Romania possesses a long-standing tradition in fruit cultivation, favoured by highly suitable soil and weather conditions. Shrub cultivation enables the sustainable utilization of diverse land typologies, ranging from mechanizable hilly areas to sandy soils.^[4] Furthermore, it constitutes a vital socio-economic pillar, providing stable income for a significant segment of the population engaged in orchard management, processing, trade, and related agricultural industries. Beyond their economic value, numerous fruit shrub species are integrated into urban landscaping and family gardens for decorative and therapeutic purposes. This residential cultivation actively improves air quality, mitigates environmental pollution^[5], and fulfils an educational role by promoting the conservation of horticultural ecosystem biodiversity.

The cultivated highbush blueberry (*Vaccinium corymbosum* L.), native to North America, was developed through multi-species crossbreeding and introduced to Romania in the late 1960s. Belonging to the *Vaccinium* genus within the *Ericaceae* family, it is a perennial deciduous species characterized by woody branches. It develops as a vigorous shrub reaching heights of 1.5 to 2 meters, subject to variety specificities, climate, edaphic conditions, irrigation regimes, and pruning practices. Highbush blueberries require acidic soils and a thermal budget exceeding one hundred warm days per year to reach optimal fruit maturity, which typically occurs 2 to 3 years post-planting.^[6] Flowering takes place in May, progressing sequentially from the base of the cluster to the apex. The fruit is a spherical or spherical-flattened berry, displaying a colour spectrum from bright light blue to dark blue, heavily coated in a natural waxy pruin. The pulp is translucent with colourless juice - distinguishing it from wild bilberries, which feature highly pigmented juice - and encloses 15–60 small seeds. The flavour profile ranges from sweet to sweet-sour, accompanied by a refined aroma. Ripening occurs progressively, with the initial harvest yielding larger berries with higher seed counts.^[7]

In recent years, public health campaigns and a shifting paradigm toward proactive wellness have stimulated interest in functional foods. Smart dietary choices represent a critical factor in mitigating the risk of chronic metabolic or cardiovascular disorders. World Health Organization (WHO) data indicates that insufficient consumption of fresh horticultural products accounts for approximately 31% of ischemic heart diseases, 11% of strokes, and 14% of gastrointestinal cancer deaths globally.^[8] Consequently, contemporary food science focuses on identifying and preserving biologically active compounds capable of maintaining homeostasis and reducing disease susceptibility.

Modern urban lifestyles have further accelerated consumer demand for accessible, nutrient-dense, and minimally processed foods^[9] (e.g., fruit bars, dehydrated snacks) capable of rapidly replenishing energy reserves without exposing the organism to chemical additives or

excessive refined sugars. Unlike conventional intensive agriculture, which frequently leaves trace pesticide residues, bio-hormones, or growth stimulants in early-season or forced crops, organic farming produces clean, safe food while preserving environmental equilibrium. Processing local organic fruits into value-added nutraceutical products is therefore an imperative public health measure to enhance the nutritional status of the population.

In Romania, about 60% of fruit consumption is covered by fresh products, and the remaining 40% is supplemented by processed fruits in the form of jams, marmalades, juices, nectars, smoothies, compotes, and dehydrated fruits. In this context, the use of local fruit to obtain nutraceutical and innovative products is not only a compensatory and recovery measure, but, above all, an imperative measure to improve the health of the Romanian population by offering nutritionally valuable food.

Nowadays, a trend prioritizing sensible nutrition has emerged; consequently, consumers are selectively gravitating toward natural products that are minimally processed, low in sugar, and free from unhealthy ingredients. There is a growing demand for ecological foods - also known as 'bio' or 'organic,' depending on the country of origin and preferred terminology - despite their higher prices. Consumers have come to realize that it is wiser, easier, and more cost-effective to invest in prevention and quality of life than in treating the various ailments and imbalances that may arise later. Consumer confidence in ecological products has grown alongside the increasing variety and traceability of these goods, as well as their promotion in the media. Today, we are witnessing a rise in public awareness, which fosters informed dietary choices and heightens interest in healthy, sustainable food. This has led to a deeper understanding of the 'eco' concept, one that considers not only human health but also animal welfare and environmental protection.

Fruit from trees grown using conventional methods may contain traces of pesticides, even when the criteria regarding the choice of pesticides, application rates, and residue persistence periods have been strictly observed. Due to intensive & super-intensive cultivation systems in conventional agriculture which involve 'forcing' plants to achieve higher yields and earlier harvests (including out-of-season production) - as well as the increasing resistance of pathogens to pesticides, residues of pesticides, bio-hormones, or growth stimulators can be found in the fruit.

As concerns blueberries, they are consumed fresh or processed into juice, syrup, confiture, granola, brandy, wine, etc. Blueberries have a good shelf life; they can be stored fresh for consumption or industrial processing for up to 4 weeks in cold storage at a temperature of 0–2°C. In addition to their delicious taste and flavour, the fruits

of *Vaccinium corymbosum* have impressive therapeutic effects, being unanimously recognized for their health benefits. They contain antibacterial and antiseptic substances and a natural equivalent of insulin. Blueberries are low in calories and rich in vitamins (A, C, E, F, PP, B1, and B2), minerals (calcium, sodium, magnesium), and antioxidants (phenols, flavones, flavonoids, phenolic acids). Structurally, 100 grams of fresh blueberries contain approximately 84% water, 12.5 g carbohydrates, 0.7 g protein, 0.3 g lipids, 2.4 g fibre, and 57 calories.^[10] Moreover, blueberries represent a valuable source of proteins and vitamins. The role of these bio compounds is to boost immunity, improve blood circulation, and inhibit the production of LDL cholesterol, supporting bone, muscle, skin, nails, and hair health. Furthermore, blueberries are recognized for their ability to prevent or alleviate cardiovascular disease^[11], diabetes^[12], and cancer.^[13]

These berries are recommended for patients suffering from rheumatoid arthritis, gout, urinary tract infections, macular degeneration, vision disorders, inflammation of the respiratory and circulatory systems (e.g., varicose veins, capillary fragility), atherosclerosis, and digestive disorders (constipation, diarrhoea, fermentation colitis),

and serve as an adjuvant in chemotherapy, radiotherapy, chronic fatigue, and amnesia. Regular consumption can also delay the onset of brain aging^[14] and neurodegenerative disorders^[15] due to strong antioxidant and anti-inflammatory properties.^[16] Crucially, these beneficial effects are well-preserved whether the fruits are consumed fresh, frozen, or processed via dehydration or pasteurization. The fundamental pharmacological screenings of domestic fruit shrubs demonstrate that species belonging to the *Vaccinium* genera serve as an exceptional reserve of natural bioactive components and tissue-protecting compounds.^[17]

2. MATERIALS AND METHODS

Experimental processing trials of organic blueberries (Figure 1) were conducted during the 2024 and 2025 seasons at the Research and Development Institute for the Processing and Marketing of Horticultural Products - "Horting", Bucharest, Romania. Certified organic raw materials of the 'Duke' and 'Elliot' highbush blueberry cultivars were supplied by the Research and Development Institute for Fruit Growing, Pitesti-Maracineni, Arges County.



Figure 1: Fresh organic highbush blueberry varieties 'Duke' and 'Elliot'^[18-20]

- **'Duke' Variety:** Highly productive cultivar characterized by large, firm berries with a sweet, aromatic flavour and frosted blue colour; resistant to mechanical handling and matures in early July.
- **'Elliot' Variety:** High-yielding cultivar producing light blue berries with a very juicy, sweet, and highly aromatic pulp; matures in late July.

2.1. Bio Blueberry Processing

A quarter to a third of fruit production is wasted due to retail inefficiencies and inadequate storage capacity. Preserving food to extend its shelf life is a central

concern for the food industry, with the race against time beginning immediately after harvest. Various types of preservation have been used since ancient times, allowing the preserved products to be consumed throughout the year, while also offering increased versatility.

2.1.1. Convective Dehydration Protocol

One of the ancestral methods of preserving fruit is to dry it in well-ventilated conditions (e.g. sheds, parapets, etc.). Nowadays, the fruit drying, known as dehydration, has been perfected reaching new dimensions. By

reducing moisture, or water activity, food products can be preserved for a long period of time.^[21] Dehydrated fruits can be stored for a long time (averagely, minimum 2 years) at ambient temperature. Through the process of dehydration of fruits, the water content of the fruit is reduced to a certain limit, intended to prevent the activity of microorganisms, without destroying its tissues or depreciating the bio compounds of pharmacological and nutraceutical importance and without significant modification of their sensory properties (taste, colour, smell and flavour). Thus, a balance must be found in order to achieve the objective - obtaining whole, divided or powdered fruits. By setting a temperature that is too high or keeping them in the dryer for too long (which especially affects heat-sensitive vitamins, such as vitamin C, but also anthocyanins - sensitive to light and heat). Setting a temperature that is too low (below 35-40°C) causes a prolonged holding time in the dryer, which leads to fruit deterioration by intensifying oxidative processes, especially if the integrity of the fruit has been affected, but especially by the appearance of

colonies of spores, bacilli and bacteria, a process known as fruit mould. Ponting (1973)^[22] and Le Maguer (1988)^[23] reported enzymatic browning and flavour deterioration at a temperature above 49°C.

The reported temperature limit is 60°C.^[24] Drying whole fruits maintains a higher level of antioxidant bioactive components (especially anthocyanins) than drying divided fruits that have affected integrity.^[25] After dehydration, the main changes observed were: cell shrinkage, plasmolysis and cell wall folding.^[26, 27]

Dehydration was performed to reduce moisture activity and preserve the blueberries long-term at ambient temperature without destroying tissues or depreciating bio-compounds. Convective drying was executed using a professional stainless-steel dryer (B. Master model SR 18381, Tauro Essiccatori SRL, Italy)^[28] equipped with 4 compartments, 40 trays (14 m² total drying surface), and an automatic ventilation system (Figure 2).



Figure 2: Convective dehydration process of organic blueberries inside the dryer.

The operational parameters were strictly maintained at a constant temperature of 60°C with an air velocity of 2 m/s using non-stick waxed parchment paper. Pre-treatment methods such as hot-water blanching prior to drying were strictly avoided to prevent disruption of cell integrity and caramelized profiles. After dehydration, the main microstructural modifications including cell shrinkage, plasmolysis, and cell wall folding are carefully preserved under these fixed settings. Prior to processing, the surface water dynamics during the gentle hydro-cleaning phase were structurally catalogued to ensure maximum turgor preservation.

The standardized technological sequence comprised: raw material reception → initial weighing → qualitative

sorting → washing with potable water → surface dewatering → tray loading → convective dehydration → final weighing → mechanical grinding (exclusively for the powder variant) → vacuum packaging in BPA-free bags → labelling → storage.

2.1.2. Technical Pasteurization Protocol

Pasteurization is the operation that aims to destroy most microorganisms and, in particular, no sporulated pathogenic bacteria present in the product, with the least possible loss of its sensory qualities. Pasteurization also produces an inactivation of enzymes responsible for unwanted biochemical changes in order to ensure the biological and biochemical stability of the food product over time. Sterilization aims to destroy all

microorganisms, both vegetative and sporulated forms. Sterilization also destroys some of the microbial toxins and inactivates tissue and microbial enzymes in a food product. However, it is generally accepted that heat treatment below 100° C is called pasteurization, and heat treatment above 100° C is called sterilization.

Spores of *Bacillus* sp. and *Clostridium* sp. can be found on blueberries. The bacteria that produce these spores are naturally distributed in soil and dust, and can contaminate the surface of the fruit during harvest and handling. Because they grow naturally in the environment, the spores can easily adhere to the skin of berries (such as blueberries, raspberries, or blackberries) directly from the soil. *Bacillus cereus* is a sporulating species that can be frequently isolated from fresh berries. Its spores are resistant and can germinate if the berries are not refrigerated, producing toxins that cause digestive disorders. As for *Clostridium botulinum*, its spores can be present on agricultural products that come into contact with the soil. While eating fresh blueberries does not pose a direct risk of botulism for adults, storing the fruit in low-acid, oxygen-free preparations at room temperature creates an environment in which spores can germinate and produce botulinum toxin. Spores of *Bacillus* sp. and *Clostridium* sp., although very heat-resistant, are able to germinate and grow at a pH below 4.5.

Thermal processing below 100°C was applied to establish biological and biochemical stability by destroying vegetative pathogenic microflora and inactivating endogenous enzymes like polyphenol oxidases. All formulations incorporated raw organic cane sugar and organic lemon juice. Glass containers and artisanal bottles were thoroughly washed and pre-sterilized.

- **Confiture & Jam:** Prepared using a fruit-to-sugar ratio of 50:50. The technological flow involved raw material conditioning, immersion in prepared sugar syrup (or direct sugar mixing for jam until natural cellular juice release), slow boiling to facilitate solute diffusion, container filling, thermal pasteurization, cooling, and storage.
- **Topping:** Prepared using a fruit-to-sugar ratio of 67:33. Berries were blended into a smooth paste, combined with sugar syrup, boiled slowly, hot-filled into sterilized containers, pasteurized, and cooled.
- **Syrup:** Concentrated sugar-water syrup was prepared by dissolving organic sugar in cold water and boiling for 15 minutes, followed by fruit immersion, slow boiling, structural binding, addition of organic lemon juice, foaming, straining, hot bottling into artisanal bottles, pasteurization, and cooling.

The recipes followed the European Union (EU) regulations regarding the processing of organic fruits, being in line with the national quality standards (STAS) used in the food industry.

2.1.3. Physio-Chemical and Biochemical Analytical Methods

- **Total Soluble Solids (TSS):** Determined via the refractometric method using an Abbe refractometer (Zeiss JENA, Germany) according to STAS 5956-71.
- **Titrateable Acidity (TA):** Determined by volumetric titration according to STAS 5952-79 and expressed as a percentage of malic acid equivalent.
- **Total Sugars (TS):** Quantified as invert sugar percentage via the Bertrand chemical method.^[29]
- **Vitamin C (Ascorbic Acid):** Determined via spectrophotometric analysis utilizing 2,6-dichlorophenol indophenol extraction with xylene according to STAS SR ISO 6557-2.
- **Total Anthocyanin Content (TAC):** Measured via the pH-differential spectrophotometric method and expressed as malvidin-3-glucoside equivalents (mg/kg).^[30]
- **Total Phenolic Content (TPC):** Determined via the Folin-Ciocalteu colorimetric method using gallic acid equivalents (mg GAE/kg).^[31] **Advanced separation, profiling, and quantitative assessment of specific polyphenolic fragments were aligned with high-performance liquid chromatography (HPLC) protocols tracking calibration curves of gallic acid, catechin, chlorogenic acid, rutin, and cyanidin equivalents standard matrices.**^[32]
- **Moisture and Ash Content:** Regulated by SR 8613-1:2009 for fresh matrices, SR 12143:2003 for dehydrated products.
- **Sensory Evaluation:** Organoleptic indicators (appearance, colour, odour, taste) were validated according to the Romanian Pharmacopoeia.

3. RESULTS AND DISCUSSION

3.1. Biochemical Characterization of Fresh Organic Blueberries

The baseline biochemical screening of the fresh 'Duke' and 'Elliot' blueberry varieties across the 2024 and 2025 experimental seasons revealed high concentrations of antioxidant bioactive components (Table 1), harmonized with the studies of Zhang et al. (2021-b)^[33], Correia et al. (2024).^[34] The high antioxidant capacity observed is strongly correlated with the genetic profile of the highbush blueberry. However, environmental factors introduce visible fluctuations. Thus, anthocyanins are synthesized in autumn with a large difference in temperature between night and day and at an increased rate of photosynthesis.^[2] Comparatively, the 'Elliot' variety exhibited a distinctly superior baseline accumulation of total phenolics (mean of 5927.59 mg GAE/kg) and total anthocyanins (mean of 2990.60 mg/kg) alongside a higher titrateable acidity (0.76%) relative to 'Duke' (mean TPC 4109.94 mg GAE/kg; mean TAC 2852.70 mg/kg).

Table 1: Main physio-chemical and biochemical indicators of fresh organic blueberries (2024–2025)

Variety/Year	TSS	Water	Dry Mat	TA	TS	Vit C	TPC	TAC	Ash
Duke 2024	13.20	84.04	15.96	0.55	11.91	12.32	4016.52	2830.38	0.23
Duke 2025	13.40	83.42	16.58	0.55	11.76	11.86	4203.35	2875.02	0.25
<i>*Duke (mean)</i>	<i>13.30</i>	<i>83.73</i>	<i>16.27</i>	<i>0.55</i>	<i>11.84</i>	<i>12.09</i>	<i>4109.94</i>	<i>2852.70</i>	<i>0.24</i>
Elliot 2024	14.40	83.06	16.94	0.76	10.91	13.20	5789.66	2904.06	0.26
Elliot 2025	16.70	83.53	16.47	0.75	10.62	12.50	6065.52	3077.14	0.26
<i>*Elliot (mean)</i>	<i>15.55</i>	<i>83.30</i>	<i>16.71</i>	<i>0.76</i>	<i>10.77</i>	<i>12.85</i>	<i>5927.59</i>	<i>2990.60</i>	<i>0.26</i>

*Small seasonal variations between 2024 and 2025 reflect the local sunlight regimes and precipitation curves during fruit ripening.

Table 1 Analysis Comments

The multi-season biochemical screening demonstrates a highly pronounced antioxidant potential for cultivar 'Elliot', which displays an average increase of +44.22% in total phenolics (TPC) and +4.83% in total anthocyanins (TAC) compared to 'Duke'. Conversely, 'Duke' exhibits a higher baseline accumulation of total sugars (11.84%), balancing its lower titratable acidity (0.55%).

3.2. Dehydration Kinetics

Convective drying kinetics are heavily governed by physical parameters such as internal moisture diffusion, temperature, and cell structure modifications. Identical mean dehydration trends were observed across the

experimental seasons, confirming high technical reproducibility. Crucially, the 'Elliot' cultivar exhibited a slightly higher total mass reduction (+0.15%) compared to 'Duke' (87.34% vs. 87.19%). This behaviour is directly linked to the post-harvest state: 'Elliot' berries were processed immediately after harvesting while remaining fully turgid with maximum cellular water content, requiring longer total drying intervals (33 h for whole fruit). Conversely, 'Duke' berries recorded an overall shorter required drying phase (30 h for whole fruit) because they had been harvested approximately 4 weeks prior to dehydration and maintained under cold storage (4°C), during which a fraction of their internal cellular water evaporated naturally.

Table 2: Dehydration kinetics and mass reduction parameters of organic blueberries.

Variety	Product Type	Drying Time	Raw Mass	Dryer Mass	Final products	Mass Red (g)	Mass Red (%)
Duke	Whole/ Powder	30 h / 34 h	6400	5700	730 (incl. 150 g)	4970	87.19%
Elliot	Whole/ Powder	33 h / 37 h	6500	6400	810 (incl. 150 g)	5590	87.34%

Table 2 Analysis Comments

Dehydration kinetics show a remarkably high conversion efficiency into dry matrices for both cultivars, with absolute water losses securely exceeding 87%. Sub-samples (Figure 3) routed for high-potency functional fruit powders required a fixed extension of the dehydration window (+4 hours) to strip tightly bound cellular water and reach the structural brittleness necessary for uniform mechanical pulverization without causing caramelization reactions.

Maintaining a strict processing temperature of 60°C is vital. Thermal levels exceeding this threshold trigger enzymatic browning, flavour deterioration, and severe degradation of heat-sensitive components like ascorbic acid and anthocyanins. Conversely, lowering temperatures below 35–40°C excessively prolongs drying times, accelerating oxidative degradation and increasing water activity to levels that permit microbial vegetative growth and spore germination (*Bacillus cereus* or *Clostridium* sp. from soil dust), causing severe spoilage. Furthermore, processing whole uncrushed berries preserves a significantly higher percentage of

antioxidant compounds than processing sliced or structurally compromised fruits.^[24]



Figure 3. Sequential technological stages for manufacturing whole dried organic blueberries and bioactive fruit powders.

Factors influencing the kinetics of blueberry processing:

- temperature: rapid cooling and storage at low temperatures significantly slow down the ripening and degradation processes, extending the shelf life of the fruit;
- humidity: maintaining a controlled relative humidity prevents water loss and dehydration of the fruit, essential for preserving freshness;
- enzymatic activity: enzymes such as polyphenol oxidases (PPOs) can accelerate the oxidation and degradation processes of valuable compounds in blueberries, affecting colour and taste;
- processing processes: different fruit processing techniques directly influence kinetics by modifying enzyme composition and activity, but also by introducing new process factors;
- bioactive compounds: Anthocyanins, antioxidants, and other bioactive compounds in blueberries are

sensitive to environmental factors and processing, and their degradation kinetics is an important indicator of the quality of the finished product.

Studying the kinetics of blueberry processing has led to:

- Optimization of preservation processes: allows the choice of the most appropriate harvesting, handling and storage methods to extend the shelf life of the fruits;
- new product development: helps to formulate new types of blueberry-based products, such as syrups, toppings, jams or bioactive powder, maintaining as much nutritional value as possible;
- quality control: monitoring kinetics allows the evaluation of the quality of the fruits and derived products, guaranteeing a high-quality final product.

3.3. Pasteurization Indicators and Product Matrix Suitability

The physical properties of pasteurized products (Figures 4-6) are direct functions of the fruit-sugar blending dynamics and variety morphology. Due to its thinner epidermal tissue (skin) and substantially juicier pulp matrix, the 'Elliot' cultivar does not maintain structural integrity when subjected to boiling for traditional whole-fruit confiture. Attempted confiture processing resulted

in the structural collapse and disintegration of the whole berries (yielding an unstandardized final Brix of 57.30°). Therefore, 'Elliot' is highly recommended for applications requiring fruit disintegration, such as high-viscosity jams, purees, toppings, or syrup extraction. Conversely, the firmer structural integrity and thicker skin of 'Duke' makes it ideal for traditional premium confitures where whole-fruit retention is mandatory, achieving a high final concentration of 71.50° Brix.

Table 3: Refractometric metrics (°Brix) and product mass yields for Confiture and Topping (Season 2024)

Variety	Initial Brix	Fruit Mass (g)	Final Product Mass (g)	Final Product (Brix)
Duke	12.20	5000 / 4500	8400 / 4200	71.50 / 52.10
Elliot	11.50	3000 / 4500	5100 / 4200	57.30* / 45.60
Mean	11.85	4000 / 4500	6750 / 4200	64.40 / 48.85

Table 3 Analysis Comments

Due to its rigid histological structure, 'Duke' successfully bound raw organic cane sugar syrup to a high concentration of 71.50° Brix. The asterisk for 'Elliot' confiture reflects structural failure and juice macro-

diffusion, which yields a legally sub-optimal concentration for that specific preparation type, while proving exceptionally uniform and efficient when routed into clean-label functional toppings (45.60° Brix).

Table 4: Refractometric metrics (°Brix) and mass yields for Jam and Syrup formulations (Season 2025)

Variety	Initial Brix	Fruit Mass (g)	Final Product Mass (g)	Final Product (Brix)
Duke	14.00	5000 / 4500	8400 / 4200	67.00 / 65.00
Elliot	12.50	3000 / 4500	5100 / 4200	67.00 / 67.50
Mean	13.25	4000 / 4500	6750 / 4200	67.00 / 66.25

Table 4 Analysis Comments

Processing targets for the 2025 season were focused on matrices where cellular rupture is structurally acceptable. Jams achieved an identical standardized value of 67.00° Brix for both cultivars. In the case of syrup

manufacturing, the high juice yield and rapid disintegration kinetics of 'Elliot' facilitated superior solute diffusion, reaching an advanced concentration of 67.50° Brix.



Figure 4: Detail of organic blueberry confiture of "Duke" variety.



Figure 5: Premium finished organic highbush blueberry syrup packed in sterilized glass containers.



Figure 6. Functional organic blueberry topping, syrup, jam & confiture formulations developed at the "Horting" Institute.

CONCLUSIONS

1. Convective dehydration successfully reduces the moisture content and water activity of organic highbush blueberries to stable preservation thresholds without causing structural cell tissue destruction or critical loss of baseline nutraceutical values.
2. The biochemical profiles confirm that organic blueberries retain robust concentrations of health-promoting bio-compounds (phenols, anthocyanins, and essential vitamins) whether consumed as whole dried fruits, functional powders, or pasteurized matrices.
3. Cultivar morphology dictates industrial processing routing; the firm-fleshed 'Duke' variety is optimally suited for whole-fruit convective drying and premium confiture manufacturing, whereas the highly juicy and thin-skinned 'Elliot' variety achieves superior technical performance in jams, syrups, and topping pastes.

- The innovative food products developed at the 'Horting' Institute are 100% natural, safe, and free from synthetic additives, aligning with modern consumer demands for smart nutrition.

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CONFLICT OF INTEREST STATEMENT

The authors officially declare that they have no competing financial interests or personal relationships that could have appeared to influence the work reported in this paper. All co-authors from the respective participating institutions have reviewed the final version of the manuscript and approved its submission to WJPMR.

AUTHORS' CONTRIBUTIONS

- Mariana TOMA: Conceptualization, Project administration (fruit valorisation), Methodology, Investigation, Supervision, Writing - original draft.
- Mihaela SUMEDREA: Funding acquisition, Resources (Raw material sourcing), Data curation, Validation, Supervision.
- Mihaela PARASCHIV: Formal analysis, Methodology, Investigation (Biochemical assays and HPLC validation).
- Dorel HOZA: Conceptualization, Supervision, Validation.
- Ligia ION: Resources, Formal analysis, Supervision.
- Adriana-Eliza NIȚU: Investigation (Physiochemical monitoring), Data curation.
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