Biol. Stud., 2024, 18(4), 175–190 • doi: https://doi.org/10.30970/sbi.1804.793
www.http://publications.lnu.edu.ua/journals/index.php/biology

UDC: 582,631.5:634:635:664.87 (075)

# BLACKTHORN (*PRUNUS SPINOSA* L.): ECOLOGICAL FEATURES OF PROMISING FORMS AND THE VALUE OF THE NUTRIENT COMPOSITION OF THEIR FRUITS FOR THE PRODUCTION OF FUNCTIONAL PRODUCTS

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Moskalets, V., Hulko, B., Matkovska, S., Knyazyuk, O., & Polyvanyi, S. (2024). Blackthorn (*Prunus spinosa* L.): ecological features of promising forms and the value of the nutrient composition of their fruits for the production of functional products. *Studia Biologica*, 18(4), 175–190. doi:10.30970/sbi.1804.793

**Background**.The relevance of the research is determined by a constant striving to increase the possibilities of using rare fruit and berry crops, e.g. blackthorn, in plant breeding and the production of healthy food products. It can be achieved by scientifically based selection and evaluation of fruit taking into account their physiological, phytopathological and biochemical parameters. The purpose of the research is to expand the morphological diversity of blackthorn that combines high productivity and quality for further breeding.

**Materials and Methods**. Morphological characteristics and biological properties of the new forms of blackthorn as well as their biochemical parameters constitute the material for this research. A plethora of methods was applied: field, phenological, biometric, physiological and statistical ones.

**Results.** The study presents original data on the morphology and economic characteristics of various blackthorn forms (*Prunus spinosa* L.) obtained as a result of selection in semi-arid lands of the northern, central and western parts of Ukraine. The paper highlights morphological and biological properties of the selected forms of blackthorn,

biochemical parameters of fruits, including the content of polyphenolic substances as a source of antioxidants. The study revealed that the selected forms of blackthorn have high drought resistance and winter hardiness, in addition to resistance to low temperatures during the flowering phase. Phenological observations of plants of different forms of *Prunus spinosa* L. allowed establishing the time of onset of the ontogenesis phases: the development of vegetative and generative buds, budding and flowering, appearance of leaves, intensity of shoot growth, formation and development of ovaries, and fruit ripening, which is a significant scientific achievement for the prospective selection in the fruit gardening system.

The forms of blackthorn were differentiated by plant height, growth strength, thorniness, fruit size and weight and their potential use in the processing and manufacturing of functional foods. Biochemical analysis of the fruits, particularly the determination of polyphenols, allowed ascertaining their suitability for processing and manufacturing of healthy food products.

**Conclusions**. The obtained data on selected new forms of blackthorn is a potential source of material for prospective breeding. Moreover, technologies for the production of blended juices and syrups from the fruits of the best samples of blackthorn were developed regarding their biochemical properties and technological indicators.

***Keywords**:* blackthorn, new forms, biological characteristics, fruit quality

## INTRODUCTION

Nowadays, consumers display interest in food products that, while meeting their nutritional needs, significantly contribute to physical performance, nurture well-being, and at the same time lessen the risk of disease development (Araújo-Rodrigues *et al*., 2021; Santos *et al*., 2022).

One of the most valued products are those containing a high level of biologically active substances, including polyphenolic compounds. According to W. Koch, (2019) and R. Dias *et al*., (2020), it is common knowledge that polyphenols are compounds naturally synthesised through the secondary metabolism of plants, which has attracted meticulous attention of scientists attributable to their potential therapeutic effects on health. De Araújo-Rodrigues *et al*. (2021) state that the peculiarity of polyphenols lies in the ability of their molecules to have several phenolic groups (hydroxy groups attached to benzene rings). Moreover, their class includes simple phenols (hydroquinone), hydroxybenzoic acids, hydroxycinnamic acids coumarins, naphthoquinones, stilbenoids, flavonoids, isoflavonoids, anthocyanins, lignans, lignins, thickened tannins, thanks to which berries, fruits and vegetables get their colour, aroma and taste, and, most remarkably, their nutritional value. As reported by C. Le Bourvellec *et al.* (2019), F. Campos *et al*. (2021) and Y. Zhang *et al.* (2023), polyphenolic compounds are of considerable interest and have gained growing attention in the recent years because of their bioactive functions, being desirable phytochemicals as secondary metabolites of plants and possessing antimicrobial, antiviral and anti-inflammatory properties along with high antioxidant capacity.

However, the biological pecularities of polyphenolic compounds to a great degree are dependent on several factors. These include plant species (Fernandes *et al*., 2023), composition of plant material (Angulo-López *et al*., 2023), concentration in food (Guo *et al*., 2022), bioavailability after food consumption (Tarko *et al*., 2020), interaction with other molecules, degree of polymerisation (Iglesias-Carres *et al*., 2019a), etc. A. Farrag

*et al*. (2018) and S. Farag *et al*. (2023) suggest that in parallel to their biological properties, phenolic compounds also have a great scope for commercial application in food colouring, bioactive packaging, cosmetics, paints, fertilisers, surfactants, textiles, rubber, plastics and thickeners.

Nowadays, according to F. Beet *et al*. (2021), niche crops receive much attention, in terms of cultivated fruit plants not common in culture (Migicovsky *et al*., 2022), which grow in the wild in small quantities and do not need intensive care under cultivation conditions. This reduces environmental risks, making their raw materials environmentally safe for use and processing. Furthermore, niche fruit and berry crops considerably contribute to economic well-being and poverty reduction among small households by providing income and profit from the sale of fresh and value-added products. Yet, as R. Brumfield (2020) points out, their domestication has drawn less attention because they remain 'underutilised' and 'under-exploited'.

It is a fact that less common fruit crops also have enough biologically active substances, including polyphenols. These are hawthorn (Pawlaczyk-Graja, 2018), blackberry (Zafra-Rojas *et al*., 2018), viburnum (Polka *et al*., 2019), blueberry (Tagliani *et al*., 2019), olives (Ribeiro *et al*., 2021), sea buckthorn (Janceva *et al*., 2022), etc. In search of food products with anti-inflammatory effects, increased attention has recently been paid to the fruits of a niche crop – *Prunus spinosa* L., whose fresh fruits are commonly used for dietary needs and in medicine for diseases related to inflammation and oxidative stress, as *Prunus spinosa* L. fruit extracts are rich in polyphenols and therefore have anti-inflammatory and antioxidant effects on human immune cells (Iglesias-Carres *et al*., 2019b; Magiera *et al*., 2022).

In addition, blackthorn plants are an „interesting tool" in the hands of breeders, as they can easily cross-pollinate with, for instance, cherry plum, plum and even apricot, which results in a range of highly productive genotypes with tasty and aromatic fruits that are resistant to low negative temperatures and moisture deficit in spring and summer. As noted by S. N. Cosmulescu & F. G. Colusaru (2018) and J. A. Brown *et al*. (2022), it is more important to use wild species and forms with different fertility in the selection of ternary species than varieties of a particular fruit crop.

Consequently, the analysis of the available sources of literature indicates a lack of research on the morphology, physiology and ecology of *Prunus spinosa* L. plants, including the use of fruit in the processing and manufacture of healthy food and medicines for the prevention and treatment of many diseases, which determined the topicality of the research.

The objectives of our research were to select and examine new forms of blackthorn by morphological characteristics and physiological properties, evaluate them by quantitative and qualitative characteristics of the fruit. In particular, the study focused on the content of polyphenolic substances in the selection for adaptability and quality and prospects of making products for healthy nutrition.

## MATERIAL AND METHODS

The examination of morphological and biological features of different forms of blackthorn was carried out during field visits to the plots in Chernihiv (Nosivka district), Poltava (Khorol and Shyshaky districts), Lviv (Brody, Zhovkva, Drohobych and Stryi districts), and Volyn (Horokhiv district) regions of Ukraine from 2017 to 2021. The research was conducted using the following methods: observation and description, which contributed

to the detailed study of plant development according to ontogenetic and phylogenetic indicators. It was also mandatory to measure the height of blackthorn plants, in particular the height of the crowns, which is required for the calculation of biometric indicators. During the growing season, the dates of the onset of plant development phases were recorded in a workbook, starting in early spring a week before the start of the growing season and ending in autumn. Then, the state of flowering and abundance of fruiting, field winter and drought resistance were assessed according to the Methodology for examination of varieties (Ministry of Agrarian Policy and Food of Ukraine, 2022). In 2020, the initial material (forms) of blackthorn was taken from each observation site and further introduced to the experimental plots of the Institute of Horticulture of the National Academy of Agrarian Sciences of Ukraine (NAAS) and its research network (Chernihiv and Lviv regions). Fruits were selected for biometrics and biochemical analysis in the laboratory of post-harvest quality of fruit and berry products of the Institute of Horticulture of the NAAS. For example, it was found that the weight and quality of the fruit samples corresponded to the requirements of the Methodology for assessing the quality of fruit and berry by-products (2008) and DSTU ISO 874-2002. The content of oil phenolic compounds was determined according to DSTU 4373:2005. In the laboratory of innovative food technologies of the Institute of Horticulture of the National Academy of Agrarian Sciences of Ukraine under the direction of O. M. Lytovchenko for the production of blended unclarified blackthorn-apple juice were applied: fruits of various forms of fresh blackthorn according to DSTU 4283:2007, fresh apples for industrial processing according to DSTU 7075:2009, white crystalline sugar according to DSTU 4623/GOST 31361 DSTU 623-2006 or natural honey according to DSTU 4497:2005, drinking water according to SanPiN 2. 2.4-171-10 with a hardness of no more than 2.0 mol-eq/dm$^3$ for softened water or up to 7 mol-eq/dm$^3$ for natural unsoftened water. The studies were performed in triplicate and statistically processed in Excel; statistical method ANOVA was used to evaluate the significance of differences. At the same time, the mean values and the variation indicators were calculated to characterize the individual values of a certain characteristic. In particular, the range of variation ($R$), variance ($\sigma^2$), mean square deviation ($\sigma$) and coefficient of variation ($V\sigma$, %) were determined. The standards of the Convention on Trade in Endangered Species of Wild Fauna and Flora (1979) and the Convention on Biological Diversity (1992) were taken into account.

## RESULTS AND DISCUSSION

It was found that the selected plants of the blackthorn species (*Prunus spinosa* L., 1753) belong to the genus *Prunus* L., family *Rosaceae*, order *Rosales*, class *Magnoliopsida* and are deciduous shrubs, 2–3 m high, with blackish or dark brown bark with a bluish bloom, or without it, and dense, strong, slightly to moderately thorny branches. Biometric measurements have demonstrated that the leaves of this species are oval, 2.2–4.9 cm long and 1.2–2 cm wide, with a serrated edge. The flowers are about 1.5 cm in diameter, with five creamy white petals; flowers form long before leaves and bloom in early spring, are entomophilous, and their formula is ♂ $K_{(5)}C_{(5)}A_{20}G_{\underline{1}}$, or O(2)+2Т3П$\underline{1}$. It was noticed that the flowering period of blackthorn occurs in April–May. Fruit ripening occurs in July and August. The fruit of the blackthorn is a drupe, 1.1–1.2 cm long, with a black fruit skin with a bluish, violet-blue waxy bloom or without it. The fruits ripen in autumn and are usually harvested in late September or October after the first frost. The flesh of a ripe fruit is green or yellow-green in colour, with a very astringent flavour. It has been shown

that blackthorn plants grow well both in conditions of sufficient light and in partial shade, and are also characterised by high resistance to drought and low temperatures. When selecting clones at the expedition sites, it was found that the roots of blackthorn plants are located in the ground at a depth of 1 m, and their radius of growth is much wider than the radius of the crown. It was established that plants of the examined forms of blackthorn differ in height. The tallest plants are formed by the Brodovskyi 17-19 blackthorn – over 3.5 m. Nosivskyi 1-17, Nosivskyi 2-17, Horokhivskyi 1-20 and Shishatskyi 1-21 were characterised by a height of 2–2.5 m. Plants of the forms Galytskyi 1-07-21, Galytskyi 2-07-21, Poltavskyi 2-17 (Khorolskyi) and Sopit chornookyi reached up to 2 m in hight, while the lowest plants of the form Galytskyi 1-07-21 were just 1.5 m high, which significantly influenced morphological analysis, fruit harvesting, and crop accounting (**Fig. 1**).

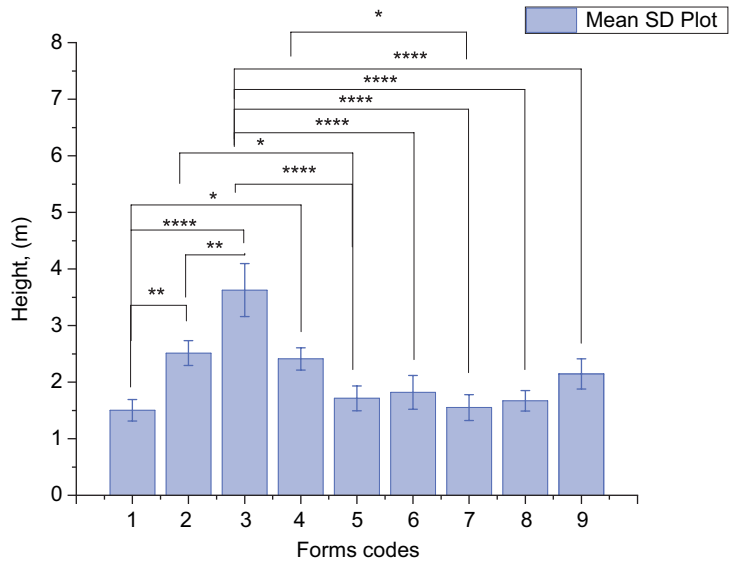


**Fig. 1**. Characteristics of new forms of blackthorn by height (differences between species are significant: * – p <0.05, **– p <0.01, **** – p <0.0001): 1. Galytskiy 1-07-21; 2. Nosivskiy 1-17; 3. Brodovsky 17-19; 4. Horokhivskyi 1-20 (Grafskiy); 5. Galytskyi 2-07-21; 6. Poltavsky 2-17 (Khorolskyi); 7. Mukshanskyi 2-14; 8. Sopit chornookyi; 9. Shishatskiy 1-21

According to the data in **Table 1**, it can be seen that the studied plants of the forms Nosivskyi 1-17 and Horokhivskyi 1-20 (Grafskyi) were of the same type in terms of height (which is evidenced by a high coefficient of variation).

It has been shown that the fruits of blackthorn are formed on short bouquet branches. It has been found that after the first autumn frosts their taste qualities improve, and the inherent astringency disappears to some extent. The fruits of the forms Horokhivskyi 1-20, Shishatskyi 1-21, Sopit Chornookyi, Poltavskyi 2-17 (Khorolskyi) and Mukshanskyi 2-14 have a special range of pleasant tastes. It was found that the forms of thorny thorns differed significantly in morphological characteristics. For instance, Nosivskyi 1-17, Horokhivskyi 1-20 and, in particular, Brodovsky 17-19 were mainly distinguished by the size of their fruits, their weight was 2.4, 2.5 and 3.3 g, respectively (**Fig. 2**).

**Figure 2** presents the average values of fetal weight characteristics. In order to reveal the extent to which the individual values of this characteristic differ from each other and from the average, the variation indicators were calculated. At the same time,

the range of variation of fruit weight indicators by varieties was not significant, which is also reflected by the variation indicators. Weak variability (*Vσ* <10 %) by years of research (2018–2021) is observed for the forms Brodovskyi 17-19 and Galytskyi 2-07-21, for the rest of the studied varieties – average (*Vσ* <11–22 %). This shows that the forms of plants with a stable manifestation of the fruit mass feature were studied.

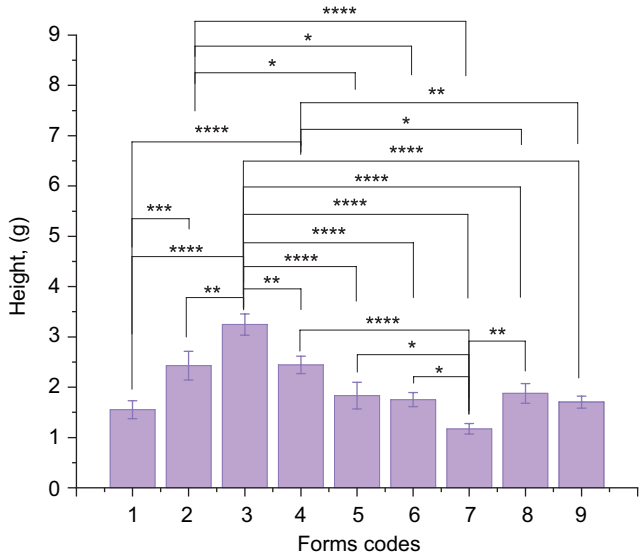


**Fig. 2**. Chaacteristic of new forms of blackthorn by fruit weight (n = 3) (differences between species are significant: * – p <0.05, ** – p <0.01, **** – p <0.0001): 1. Galytskyi 1-07-21; 2. Nosivskyi 1-17; 3. Brodovskyi 17-19; 4. Horokhivskyi 1-20 (Grafskiy); 5. Galytskyi 2-07-21; 6. Poltavskyi 2-17 (Khorolskyi); 7. Mukshanskyi 2-14; 8. Sopit Chornookyi; 9. Shishatskyi 1-21

It should be noted that the fruits of the studied forms of blackthorn differed in the presence and intensity of wax coating of a grey shade. The most intense wax coating was observed on the fruits of Nosivskyi 2-17 and Shishatskyi 1-21, the moderate one – on the fruits of Nosivskyi 1-17, Mukshanskyi and 2-14, Poltavskyi 2-17 (Khorolskyi), and the weak one – on Brodovskyi 17-19 and Horokhivskyi 1-20 (**Fig. 3**).

The absence of wax coating is typical of the fruits of Galytskyi 1-07-21, Galytskyi 2-07-21 and Sopit Chornookyi, collected in Drohobych district, Lviv Region. It is also worth mentioning that fruits of forms Mukshanskyi 2-14 and Shishatskyi 1-21 have a characteristic patch on the exocarp surface, which is more distinct for the latter form.

It was found that the fruits of Galytskyi 1-07-21, Galytskyi 2-07-21 and Sopit Chornookyi are characterized by high transportability (8 points), Shishatskyi 1-21, Horokhivskyi 1-20 and Brodovskyi 17-19 have medium transportability (6 points), and Nosivskyi 1-17, Nosivskyi 2-17, Poltavskyi 2-17 (Khorolskyi) possess below average transportability (>5 points).

It is noteworthy that based on fruit tasting and the results of determining the content of dry matter, total sugars and titratable acids in fruits, fruits of the forms Nosivskyi 1-17, Nosivskyi 2-17, Poltavskyi 2-17 (Khorolskyi) can be recommended for jams, preserves, and dried fruit production. Meanwhile Shishatskyi 1-21, Horokhivskyi 1-20 and Brodovskyi 17-19 are suitable for the production of jams, preserves, dried fruits, whereas Galytskyi 1-07-21, Galytskyi 2-07-21 and Sopit Chornookyi are advisable mainly for syrups, blended juices, and beverages.

**Fig. 3.** Fruits of various forms of blackthorn: 1 – Nosivskyi 1-17; 2 – Nosivskyi 2-17; 3 – Brodovskyi 17-19; 4 – Mukshanskyi 2-14; 5 – Horokhivskyi 1-20; 6 – Shishatskyi 1-21; 7 – Galytskyi 2-07-21; 8 – Poltavskyi 2-17 (Khorolskyi)

The data on the content of polyphenols was collected during the biochemical analysis. The maximum levels of these compounds were found in the fruits of the form Galytskiy 1-07-21 (2019±10 mg/100 g of fresh weight). More than 1000 mg/100 g of polyphenols were accumulated in the fruits of Sopit Chornookyi and Shishatskyi 1-21 (1764±32 and 1717±17 mg/100 g of fresh weight, respectively), Brodovskyi 17-19 (1561±31), Horokhivskyi 1-20 (1443±30) and Galytskyi 2-07-21 (1634±24). The average inter-varietal index was (1422±17 mg/100 g). The content of polyphenols was less than 1000 mg/100 g of fresh weight in the following forms: Nosivskyi 1-17 (803±9), Poltavskyi 2-17 (909±8), and Mukshanskyi 2-14 (949±9) (**Fig. 4**).

**Figure 4** shows that the indicators of the content of polyphenols for the forms Shishatskyi 1-21 and Brodovskyi 17-19 are stable, given the high coefficients of variation – 5.6 and 7.9, respectively.

It is well worth remarking that *Prunus* is a large genus of flowering plants in the *Rosaceae* family, which includes more than 340 species living in various landscapes worldwide. Since time immemorial, people have valued blackthorn for the treatment of many diseases, including stomach ache and flu, due to its biologically active substances.

In the recent years, as the environment and the quality of nutrition have deteriorated, the nutrients in fruit and berry crops have received particular attention as researchers explore their potential applications in various industries. Taking only the *Prunus* genus, more than 500 phytochemicals have been isolated from their fruits, including 212 compounds of importance for health, most of which are flavonoids, phenolic acids, anthocyanins and their derivatives. The results of the study by W. Liu *et al*. (2020) testify that 100 g of dry weight of *Prunus spinosa* L. fruit contains vitamin A (390 μg), C (7.70 mg), E (2.75 mg), B1 (0.31 mg), B2 (0.80 mg), B6 (0.84 mg), neosine (2.10 mg), folate (24.75 μg) and some concentrations of organic acids, including malic (158 mg), lactic (126 mg), sodium (44 mg), fumaric (1.64).

L. Sabatini *et al*. (2020) concluded that *Prunus spinosa* L. is not suitable for direct human consumption, but is appropriate for the production of jams, pastilles, preserves and blended juices and low-alcohol beverages due to its exceptionally dry taste. This

dry taste is caused by the high content of tannins, which, together with the high content of anthocyanins, make these fruits valuable. To be specific, as E. Backes *et al.* (2020) suggest, the high anthocyanin content of blackthorn fruit makes it an excellent food colouring agent.

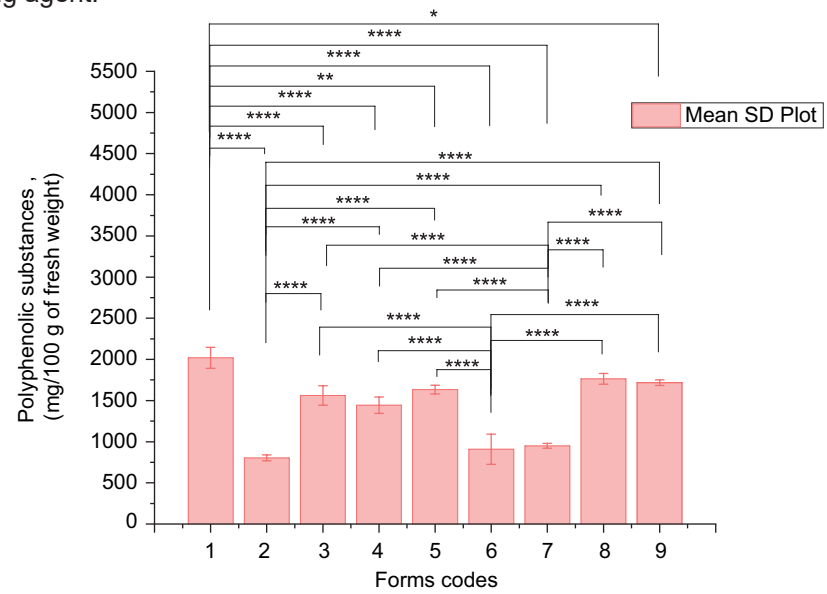


**Fig. 4.** Characteristics of new forms of blackthorn by the content of polyphenolic substances in fruits (n = 3) (differences between species are significant: * – p <0.05, ** – p <0.01, **** – p <0.0001): 1. Galytskyi 1-07-21; 2. Nosivskyi 1-17; 3. Brodovskyi 17-19; 4. Horokhivskyi 1-20 (Grafskiy); 5. Galytskyi 2-07-21; 6. Poltavskyi 2-17 (Khorolskyi); 7. Mukshanskyi 2-14; 8. Sopit Chornookyi; 9.Shishatskiyi 1-21

A scientifically based approach to the storage and processing of blackthorn fruit is crucial to preserve its consumer, preventive and therapeutic value. K. Olesińska *et al.* (2018) proved that freeze-dried or frozen blackthorn fruits preserve the highest content of anthocyanins and flavonoids. M. Marčetić *et al*. (2022) brought into the open the prebiotic effect of blackthorn in terms of a significant effect on the ferment *Saccharomyces boulardii* and the ability of anthocyanins to from its fruit to prevent the proliferation of harmful bacteria by minimizing gene expression. As noted by M. Wang *et al*. (2022), anthocyanins alter metabolic enzymes and affect respiratory metabolism. Their presence can facilitate the expansion of probiotics, which is of great importance for the processing of plant raw materials for the food industry.

N. Yahfoufi *et al*. (2018), provided the data that blackthorn fruits are bioefficiennt for medicinal purposes and have a particular significance for the food industry. The immunomodulatory and anti-inflammatory role of polyphenols in blackthorn fruits has also been proven to play an indispensable role in the prevention and development of chronic inflammation-related diseases, such as diabetes, obesity, neurodegeneration, cancer and cardiovascular diseases. N. Baltas *et al*. (2017) applied high-performance liquid chromatography to figure out the presence of protocatechuic, vanillic, syringic and p-coumaric acids and luteolin in the extract from blackthorn fruits, which enhance the biochemical properties of polyphenol oxidase. K. Takım (2021) testifies that a broth of blackthorn fruit, rich in phenols and minerals, has a strong antihyperglycaemic effect and, accordingly, can serve as a useful antidiabetic herbal medicine.

Scientists (Pozzo *et al*., 2020) have also conducted various research on the antimicrobial effect in vitro and *in vivo* of *Prunus spinosa* L. fruit extracts, showing their value for both the nutraceutical and food industries. The authors M. De Luca *et al*. (2023) emphasised the importance of aqueous-ethanolic extract from blackthorn fruit as a significant source of antioxidant and antibacterial effects, which has a beneficial impact on the condition of red blood and skin cells. I. V. Seniuk and B. J. A. Sahlanee (2019) came to the conclusion that *Prunus* fruit extract is able to moderately suppress the development of edema in animals during the anti-exudative inflammatory phase, and can be used for the treatment of similar conditions in humans in the future. The effectiveness of blackthorn extracts has been shown in a different way, in particular, through their effect on wound healing (Coppari *et al*., 2021).

A. Magiera *et al*. (2022) report that foods from blackthorn have high antioxidant activity, which is also an important means of preventing many illnesses, including tumor study. Blackthorn fruits are characterised by high antioxidant properties. For example, the pectin polysaccharide complex with a yield of 3.8 % due to hot water extraction (Hw) of wild blackthorn fruit after freeze-drying has high antioxidant activity.

M. Condello *et al*. (2019) found out that an extract from *Prunus spinosa* fruit together with a nutraceutical activator complex impedes the growth and formation of colon cancer cells in mice with severe immunodeficiency. M. Sönmez *et al*. (2021) add that the high cytotoxic effect of *Prunus spinosa* L. extracts and their components, including methanol and ethyl acetate derivatives, against cancer cells help to prevent these diseases. Researchers H. Mechchate *et al.* (2021) and O.-R. Negrean *et al.* (2023) found that flavonoids such as catechin, epicatechin and rutin contained in blackthorn fruit have a defensive effect against diabetes.

I. Balta *et al.* (2019) observed that blackthorn fruit (*Prunus spinosa* L.) reduced the adverse effects of the food additive tartrazine (yellow 5 or E102, which is a synthetic food colouring that can alter perception and behaviour, causing agitation, confusion, rhinitis and can trigger hyperactivity disorder in children when combined with benzoates) on the blood and organs of white rats.

The effect of blackthorn on cell viability is also noteworthy. M. C. Albertini *et al*. (2019) proved the effect of the ethanolic extract of *Prunus spinosa* L. fruit on the viability and reproductive activity of Trichoplax adhaerens (a microscopic whitish-grey translucent animal), which points to its bioeffectiveness and potential as a valuable ingredient for nutraceuticals used as food supplements.

As D. McDaniel (2022) notes, due to the high therapeutic effect of blackthorn, it is extensively exploited in the food industry. In the western hemisphere, the juice from the fruit of the blackthorn is widely used in the production of port wine, liqueurs (SpicySloeGin), and vodka (SloeGin). Blackthorn fruit can also be used for fruit pies and other food products (Food Spotlight, 2021).

The authors (Moskalets *et al*., 2022) report that major areas of blackthorn distribution are found in Poltava, Volyn, Rivne, Lviv, Zakarpattia and other regions of Ukraine. That is, the resource of blackthorn fruit is sufficiently available, which intensifies amateur fruit collection, their widespread sale and utilisation by Ukrainian farmers-technologists in the manufacture of various food products.

Recently, under the guidance of O. M. Lytovchenko (Lytovchenko *et al.*, 2022), new technologies for the production of medicinal products from the fruits of the ternivka have been developed. These include the wines Sofiyivs'ka ternivka, Poltavs'ka ternivka,

Ternivka likerna. Particularly, the Sofiyivs'ka ternivka dessert fruit and berry wine is made from apple, thorn, red currant and mulberry wine materials. It is distinguished by a complex aroma with plum and cherry tones. The taste is full, harmonious, with a chocolate-velvet aftertaste. "Sofiyivs'ka ternivka" fruit and berry dessert wine was awarded a gold medal at the International Competition.

Summarising the aforesaid, it can be concluded that an increased attention of farmers to blackthorn, search and selection of economically valuable forms, varieties based on morphological, physiological and biochemical studies, as well as processing of their fruits, production and introduction of valuable consumer products into the domestic market has prospects for further advancement. It is worth noting that the addition to food of even a small amount of blackthorn fruits will meet the human body's need for essential substances, help to avoid the development of nutritionally dependent diseases, prevent the aging process and contribute to the strengthening of the immune system by eliminating the deficiency of vitamins, antioxidants, micro- and microelements.

## CONCLUSION

The first stage of analytical breeding in the fallow ecosystems of Chernihiv, Khmelnytsky, Volyn and Lviv regions of Ukraine resulted in the study of new forms of blackthorn regarding their morphological characteristics, physiological properties, and biochemical parameters of fruits. The best forms were introduced to the stationary plots of the Institute of Horticulture of the NAAS, where a collection of source material was formed for further breeding activities.

It was established that new forms of blackthorn have high winter and drought resistance. In addition, they are highly resistant to low temperatures in spring, and some forms have an increased fruit size, weight, and polyphenolic content.

We highly recommend to use the following breeding forms of blackthorn: Nosivskyi 1-17, Nosivskyi 2-17, Brodovsky 17-19, Mukshanskyi 2-14, Horokhivskyi 1-20, Shishatskyi 1-21, Galytskyi 2-07-21, Poltavskyi 2-17 for the preparation of such high-quality food products as jams, syrups, pastilles, marinades, and sauces. Moreover, fruits of the Sopit Chornookyi form are advisable to be used for the production of blended juices and syrups.

The forms Nosivskyi 1-17 (2.43 g), Brodovskyi 17-19 (3.25 g), and Horokhivskyi 1-20 (2.44 g) are characterized by the largest fruit mass. Low-growing forms, Galytskiy 1-07-21 and Mukshanskyi 2-14, are promising in selection for shortness. In particular, Galytskyi 1-07-21 form has an increased content of polyphenolic substances in the fruits.

The starting material of blackthorn, valuable for a complex of economic traits, was collected for subsequent scientific research. The fruits of new blackthorn forms have a high content of biologically active substances, particularly polyphenolic substances, which gives the fruit raw materials and products a special flavour. Additionally, the high antioxidant number of fruit raw materials allows them to be used for the production of functional products (blended juices, syrups, fruit and berry dried, dessert wines, etc.).

In 2021, the Institute of Horticulture of the National Academy of Agrarian Sciences of Ukraine (Kyiv) elaborated and implemented the relevant documents, namely "Technological Instructions for the Production of Blackthorn Syrup TI 10.244.006-2021" and "Technological Instructions for the Production of Apple-Thorn Syrup TI 10.244.004-2021" for the products (blended juice and syrup) made from the fruit of blackthorn. The studied new forms of blackthorn are recommended for use in the fruit gardening system, including in the selection and development of elements of fruit processing technologies and the manufacture of products for healthy nutrition.

## ACKNOWLEDGEMENTS AND FUNDING SOURCES

The authors received no financial support for the research, authorship, and/or publication of this article.

## COMPLIANCE WITH ETHICAL STANDARDS

**Conflict of Interest**: the authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

**Animal Rights**: this article does not contain any studies with animal subjects performed by any of the authors.

## AUTHORS CONTRIBUTIONS

Conceptualization, [V.M.; B.H.]; methodology, [V.M.; B.H.]; validation, [V.M.; O.K.]; formal analysis, [V.M.; S.M.; B.H.]; investigation, [V.M.; B.H.; O.K.]; resources [V.M.; O.K.]; data curation [V.M.; B.H.; S.M.; O.K.; S.P.]; writing original draft preparation [V.M.]; writing [V.M.]; visualization [S.P.]; supervision [V.M.]; project administration [V.M.].

All authors have read and agreed to the published version of the manuscript.

## REFERENCES

Albertini, M. C., Fraternale, D., Semprucci, F., Cecchini, S., Colomba, M., Rocchi, M. B. L., Sisti, D., Di Giacomo, B., Mari, M., Sabatini, L., Cesaroni, L., Balsamo, M., & Guidi, L. (2019). Bioeffects of *Prunus spinosa* L. fruit ethanol extract on reproduction and phenotypic plasticity of *Trichoplax adhaerens* Schulze, 1883 (Placozoa). *PeerJ*, 7, e6789. doi:10.7717/peerj.6789
Crossref ● PubMed ● PMC ● Google Scholar

Angulo-López, J. E., Flores-Gallegos, A. C., Ascacio-Valdes, J. A., Contreras Esquivel, J. C., Torres-León, C., Rúelas-Chácon, X., & Aguilar, C. N. (2022). Antioxidant dietary fiber sourced from agroindustrial byproducts and its applications. *Foods*, 12(1), 159. doi:10.3390/foods12010159
Crossref ● PubMed ● PMC ● Google Scholar

Araújo-Rodrigues, H., Santos, D., Campos, D. A., Ratinho, M., Rodrigues, I. M., & Pintado, M. E. (2021). Development of frozen pulps and powders from carrot and tomato by-products: impact of processing and storage time on bioactive and biological properties. *Horticulturae*, 7(7), 185. doi:10.3390/horticulturae7070185
Crossref ● Google Scholar

Backes, E., Leichtweis, M. G., Pereira, C., Carocho, M., Barreira, J. C. M., Kamal Genena, A., José Baraldi, I., Filomena Barreiro, M., Barros, L., & C.F.R. Ferreira, I. (2020). *Ficus carica* L. and *Prunus spinosa* L. extracts as new anthocyanin-based food colorants: a thorough study in confectionery products. *Food Chemistry*, 333, 127457. doi:10.1016/j.foodchem.2020.127457
Crossref ● PubMed ● Google Scholar

Balta, I., Sevastre, B., Mireşan, V., Taulescu, M., Raducu, C., Longodor, A. L., Marchiş, Z., Mariş, C. S., & Coroian, A. (2019). Protective effect of blackthorn fruits (*Prunus spinosa*) against tartrazine toxicity development in albino Wistar rats. *BMC Chemistry*, 13(1), 104. doi:10.1186/s13065-019-0610-y
Crossref ● PubMed ● PMC ● Google Scholar

Baltas, N., Pakyildiz, S., Can, Z., Dincer, B., & Kolayli, S. (2017). Biochemical properties of partially purified polyphenol oxidase and phenolic compounds of *Prunus spinosa* L. subsp. *dasyphylla* as measured by HPLC-UV. *International Journal of Food Properties*, 20(2), 1377–1391. doi:10.1080/10942912.2017.1343349
Crossref ● Google Scholar

Beed, F., Taguchi, M., Telemans, B., Kahane, R., Le Bellec, F., Sourisseau, J. M., Malézieux, E., Magalie, L.-J., Deberdt, P., Deguine, J.-P., Faye, E., & Ramsay, G. (2021). *Fruit and*

*vegetables. Opportunities and challenges for small-scale sustainable farming*. Italy, Rome: FAO–CIRAD. doi:10.4060/cb4173en
Crossref ● Google Scholar

Brown, J. A., Montgomery, W. I., & Provan, J. (2022). Strong spatial structuring of clonal genetic diversity within blackthorn (*Prunus spinosa*) hedgerows and woodlands. *Tree Genetics & Genomes*, 18(1). doi:10.1007/s11295-022-01538-x
Crossref ● Google Scholar

Brumfield, R. (2020). Ultra-niche crops series: beach plum enterprise budget. Budgeting and financial management publications. *Rutgers*. Retrieved from https://njaes.rutgers.edu/fs1314

Campos, F., Peixoto, A. F., Fernandes, P. A. R., Coimbra, M. A., Mateus, N., de Freitas, V., Fernandes, I., & Fernandes, A. (2021). The antidiabetic effect of grape pomace polysaccharide–polyphenol complexes. *Nutrients*, 13(12), 4495. doi:10.3390/nu13124495
Crossref ● PubMed ● PMC ● Google Scholar

Capek, P., & Delort, A.-M. (2023). Polysaccharides extracted with hot water from wild *Prunus spinosa* L. berries. *Carbohydrate Research*, 529, 108852. doi:10.1016/j.carres.2023.108852
Crossref ● PubMed ● Google Scholar

Condello, M., Pellegrini, E., Spugnini, E. P., Baldi, A., Amadio, B., Vincenzi, B., Occhionero, G., Delfine, S., Mastrodonato, F., & Meschini, S. (2019). Anticancer activity of "Trigno M", extract of *Prunus spinosa* drupes, against *in vitro* 3D and *in vivo* colon cancer models. *Biomedicine & Pharmacotherapy*, 118, 109281. doi:10.1016/j.biopha.2019.109281
Crossref ● PubMed ● Google Scholar

Coppari, S., Colomba, M., Fraternale, D., Brinkmann, V., Romeo, M., Rocchi, M. B. L., Di Giacomo, B., Mari, M., Guidi, L., Ramakrishna, S., Ventura, N., & Albertini, M. C. (2021). Antioxidant and anti-inflammaging ability of prune (*Prunus spinosa* L.) extract result in improved wound healing efficacy. *Antioxidants*, 10(3), 374. doi:10.3390/antiox10030374
Crossref ● PubMed ● PMC ● Google Scholar

Cosmulescu, S. N., & Calusaru, F. G. (2018). Morphologic characteristics variability in *Prunus spinosa* L. shrubs identified in southern area of Oltenia, Romania. *Notulae Scientia Biologicae*, 10(3), 447–451. doi:10.15835/nsb10310364
Crossref ● Google Scholar

de Araújo, F. F., de Paulo Farias, D., Neri-Numa, I. A., & Pastore, G. M. (2021). Polyphenols and their applications: an approach in food chemistry and innovation potential. *Food Chemistry*, 338, 127535. doi:10.1016/j.foodchem.2020.127535
Crossref ● PubMed ● Google Scholar

De Luca, M., Tuberoso, C. I. G., Pons, R., García, M. T., Morán, M. del C., Ferino, G., Vassallo, A., Martelli, G., & Caddeo, C. (2023). Phenolic fingerprint, bioactivity and nanoformulation of *Prunus spinosa* L. fruit extract for skin delivery. *Pharmaceutics*, 15(4), 1063. doi:10.3390/pharmaceutics15041063
Crossref ● PubMed ● PMC ● Google Scholar

Dias, R., Pereira, C. B., Pérez-Gregorio, R., Mateus, N., & Freitas, V. (2021). Recent advances on dietary polyphenol's potential roles in Celiac Disease. *Trends in Food Science & Technology*, 107, 213–225. doi:10.1016/j.tifs.2020.10.033
Crossref ● Google Scholar

Farag, S., Tsang, C., & Murphy, P. N. (2023). Polyphenol supplementation and executive functioning in overweight and obese adults at risk of cognitive impairment: a systematic review and meta-analysis. *PLoS One*, 18(5), e0286143. doi:10.1371/journal.pone.0286143
Crossref ● PubMed ● PMC ● Google Scholar

Farrag, A., Mohammed E, T., Mohamed El, M., Nour Solim, T., & Mohamed Fa, H. (2018). Microencapsulation of grape phenolic compounds using whey proteins as a carrier vehicle. *Journal of Biological Sciences*, 18(7), 373–380. doi:10.3923/jbs.2018.373.380
Crossref ● Google Scholar

Fernandes, A., Mateus, N., & de Freitas, V. (2023). Polyphenol-dietary fiber conjugates from fruits and vegetables: nature and biological fate in a food and nutrition perspective. *Foods*, 12(5), 1052. doi:10.3390/foods12051052
Crossref ● PubMed ● PMC ● Google Scholar

Food Spotlight. (2021, June 14). Blackthorn: the original sloe food. By fine dining lovers. Retrieved from https://www.finedininglovers.com/article/blackthorn-sloe-berry-fruit

Guo, Q., Xiao, X., Lu, L., Ai, L., Xu, M., Liu, Y., & Goff, H. D. (2022). Polyphenol–polysaccharide complex: preparation, characterization, and potential utilization in food and health. *Annual Review of Food Science and Technology*, 13(1), 59–87. doi:10.1146/annurev-food-052720-010354
Crossref ● PubMed ● Google Scholar

Iglesias-Carres, L., Mas-Capdevila, A., Bravo, F. I., Aragonès, G., Muguerza, B., & Arola-Arnal, A. (2019a). Optimization of a polyphenol extraction method for sweet orange pulp (*Citrus sinensis* L.) to identify phenolic compounds consumed from sweet oranges. *PLoS One*, 14(1), e0211267. doi:10.1371/journal.pone.0211267
Crossref ● PubMed ● PMC ● Google Scholar

Iglesias-Carres, L., Mas-Capdevila, A., Bravo, F. I., Mulero, M., Muguerza, B., & Arola-Arnal, A. (2019b). Optimization and characterization of Royal Dawn cherry (*Prunus avium*) phenolics extraction. *Scientific Reports*, 9(1), 17626. doi:10.1038/s41598-019-54134-w
Crossref ● PubMed ● PMC ● Google Scholar

Janceva, S., Andersone, A., Lauberte, L., Bikovens, O., Nikolajeva, V., Jashina, L., Zaharova, N., Telysheva, G., Senkovs, M., Rieksts, G., Ramata-Stunda, A., & Krasilnikova, J. (2022). Sea buckthorn (*Hippophae rhamnoides*) waste biomass after harvesting as a source of valuable biologically active compounds with nutraceutical and antibacterial potential. *Plants*, 11(5), 642. doi:10.3390/plants11050642
Crossref ● PubMed ● PMC ● Google Scholar

Koch, W. (2019). Dietary polyphenols–important non-nutrients in the prevention of chronic noncommunicable diseases. A systematic review. *Nutrients*, 11(5), 1039. doi:10.3390/nu11051039
Crossref ● PubMed ● PMC ● Google Scholar

Le Bourvellec, C., Bagano Vilas Boas, P., Lepercq, P., Comtet-Marre, S., Auffret, P., Ruiz, P., Bott, R., Renard, C. M. G. C., Dufour, C., Chatel, J.-M., & Mosoni, P. (2019). Procyanidin – cell wall interactions within apple matrices decrease the metabolization of procyanidins by the human gut microbiota and the anti-inflammatory effect of the resulting microbial metabolome *in vitro*. *Nutrients*, 11(3), 664. doi:10.3390/nu11030664
Crossref ● PubMed ● PMC ● Google Scholar

Lee, L. (2022, November 22). Drink in history: sloe gin fizz. Retrieved from https://chilledmagazine.com/drink-in-history-sloe-gin-fizz

Liu, W., Nan, G., Nisar, M. F., & Wan, C. (2020). Chemical constituents and health benefits of four Chinese plum species. *Journal of Food Quality*, 2020, 1–17. doi:10.1155/2020/8842506
Crossref ● Google Scholar

Lytovchenko, O. M., Grynyk, I. V., Moskalets, T. Z., Moskalets, V. V., Kuznetsov, A. V., Klymenko, S. V., & Vovkogon, A. G. (2022). Scientific methodical and practical innovations of the Institute of Horticulture NAAS of Ukraine on making healthy nutritional products from the fruits of viburnum, dewberry, dogwood and wild plum tree. *Horticulture: Interdepartment Subject Scientific Collection*, 77, 146–162. doi:10.35205/0558-1125-2022-77-146-162 (In Ukrainian)
Crossref

Magiera, A., Czerwińska, M. E., Owczarek, A., Marchelak, A., Granica, S., & Olszewska, M. A. (2022). Polyphenol-enriched extracts of *Prunus spinosa* fruits: anti-inflammatory and antioxidant effects in human immune cells *ex vivo* in relation to phytochemical profile. *Molecules*, 27(5), 1691. doi:10.3390/molecules27051691
Crossref ● PubMed ● PMC ● Google Scholar

Marčetić, M., Samardžić, S., Ilić, T., Božić, D. D., & Vidović, B. (2022). Phenolic composition, antioxidant, anti-enzymatic, antimicrobial and prebiotic properties of *Prunus spinosa* L. fruits. *Foods*, 11(20), 3289. doi:10.3390/foods11203289
Crossref ● PubMed ● PMC ● Google Scholar

McDaniel, D. (2022, December 19). Sloe gin – a marriage of prunus and juniperus. *By the herb society of America*. Retrieved from https://herbsocietyblog.wordpress.com/2022/12/19/sloe-gin-a-marriage-of-prunus-and-juniperus

Mechchate, H., Es-safi, I., Haddad, H., Bekkari, H., Grafov, A., & Bousta, D. (2021). Combination of Catechin, Epicatechin, and Rutin: optimization of a novel complete antidiabetic formulation using a mixture design approach. *The Journal of Nutritional Biochemistry*, 88, 108520. doi:10.1016/j.jnutbio.2020.108520
Crossref ● PubMed ● Google Scholar

Ministry of Agrarian Policy and Food of Ukraine. (2022). Metodyka provedennia ekspertyzy sortiv roslyn hrupy plodovykh, yahidnykh, horikhoplidnykh ta vynohradu na vidminnist , odnoridnist i stabilnist [Methodology for examination of varieties of fruit, berry, nut and grape plant varieties for distinction, homogeneity and stability]. Kyiv. Retrieved from https://sops.gov.ua/uploads/page/metodiki/2022-05-13.pdf (In Ukrainian)

Migicovsky, Z., Amyotte, B., Ulrich, J., Smith, T. W., Turner, N. J., Pico, J., Ciotir, C., Sharifi, M., Meldrum, G., Stormes, B., & Moreau, T. (2022). Berries as a case study for crop wild relative conservation, use, and public engagement in Canada. *Plants, People, Planet*, 4(6), 558–578. doi:10.1002/ppp3.10291
Crossref ● Google Scholar

Moskalets, V., Moskalets, T., Shevchuk, L., Frantsishko, V., Barat, Y., & Krasovsky, V. (2022). Genetic resource of the Blackthorn or sloe (*Prunus spinosa* L.) with valuable economic signs for breeding on yield and quality. *Agriculture and Forestry*, 1(24), 76–95. doi. 10.37128/2707-5826-2022-1-6 (In Ukrainian)
Crossref

Negrean, O.-R., Farcas, A. C., Pop, O. L., & Socaci, S. A. (2023). Blackthorn – a valuable source of phenolic antioxidants with potential health benefits. *Molecules*, 28(8), 3456. doi:10.3390/molecules28083456
Crossref ● PubMed ● PMC ● Google Scholar

Olesińska, K., Wilczyński, K., & Kałwa, K. (2018). The effect method of preservation on selected bioactive compounds and antioxidant activity in blackthorn fruits (*Prunus spinosa* L.). *Agronomy Science*, 73(3), 45–54. doi:10.24326/asx.2018.3.5
Crossref ● Google Scholar

Pawlaczyk-Graja, I. (2018). Polyphenolic-polysaccharide conjugates from flowers and fruits of single-seeded hawthorn (*Crataegus monogyna* Jacq.): chemical profiles and mechanisms of anticoagulant activity. *International Journal of Biological Macromolecules*, 116, 869–879. doi:10.1016/j.ijbiomac.2018.05.101
Crossref ● PubMed ● Google Scholar

Polka, D., Podsędek, A., & Koziołkiewicz, M. (2019). Comparison of chemical composition and antioxidant capacity of fruit, flower and bark of *Viburnum opulus. Plant Foods for Human Nutrition*, 74(3), 436–442. doi:10.1007/s11130-019-00759-1
Crossref ● PubMed ● PMC ● Google Scholar

Ribeiro, T. B., Costa, C. M., Bonifácio-Lopes, T., Silva, S., Veiga, M., Monforte, A. R., Nunes, J., Vicente, A. A., & Pintado, M. (2021). Prebiotic effects of olive pomace powders in the gut: *in vitro* evaluation of the inhibition of adhesion of pathogens, prebiotic and antioxidant effects. *Food Hydrocolloids*, 112, 106312. doi:10.1016/j.foodhyd.2020.106312
Crossref ● Google Scholar

Sabatini, L., Fraternale, D., Di Giacomo, B., Mari, M., Albertini, M. C., Gordillo, B., Rocchi, M. B. L., Sisti, D., Coppari, S., Semprucci, F., Guidi, L., & Colomba, M. (2020). Chemical composition, antioxidant, antimicrobial and anti-inflammatory activity of *Prunus spinosa* L. fruit ethanol extract. *Journal of Functional Foods*, 67, 103885. doi:10.1016/j.jff.2020.103885
Crossref ● Google Scholar

Santos, D., Lopes da Silva, J. A., & Pintado, M. (2022). Fruit and vegetable by-products' flours as ingredients: a review on production process, health benefits and technological functionalities. *LWT*, 154, 112707. doi:10.1016/j.lwt.2021.112707
Crossref ● Google Scholar

Seniuk, I. V., & Sahlanee, B. J. A. (2019). Study of the anti-exudative activity of dry extract from *Prunus domestica* fruits. *Ukrainian Biopharmaceutical Journal*, 2(59), 55–59. doi:10.24959/ubphj.19.220 (In Ukrainian)
Crossref ● Google Scholar

Sönmez, M., Cömert Önder, F. C., Tokay, E., Celık, A., Köçkar, F., & Ay, M. (2021). Investigation of antioxidant, enzyme inhibition and antiproliferative activities of blackthorn (*Prunus spinosa* L.) extracts. *International Journal of Life Sciences and Biotechnology*, 4(3), 360–380. doi:10.38001/ijlsb.851220
Crossref ● Google Scholar

Tagliani, C., Perez, C., Curutchet, A., Arcia, P., & Cozzano, S. (2019). Blueberry pomace, valorization of an industry by-product source of fibre with antioxidant capacity. *Food Science and Technology*, 39(3), 644–651. doi:10.1590/fst.00318
Crossref ● Google Scholar

Takım, K. (2021). Bioactive component analysis and investigation of antidiabetic effect of Jerusalem thorn (*Paliurus spina-christi*) fruits in diabetic rats induced by streptozotocin. *Journal of Ethnopharmacology*, 264, 113263. doi:10.1016/j.jep.2020.113263
Crossref ● PubMed ● Google Scholar

Tarko, T., & Duda-Chodak, A. (2020). Influence of food matrix on the bioaccessibility of fruit polyphenolic compounds. *Journal of Agricultural and Food Chemistry*, 68(5), 1315–1325. doi:10.1021/acs.jafc.9b07680
Crossref ● PubMed ● Google Scholar

Wang, M., Zhang, Z., Sun, H., He, S., Liu, S., Zhang, T., Wang, L., & Ma, G. (2022). Research progress of anthocyanin prebiotic activity: a review. *Phytomedicine*, 102, 154145. doi:10.1016/j.phymed.2022.154145
Crossref ● PubMed ● Google Scholar

Yahfoufi, N., Alsadi, N., Jambi, M., & Matar, C. (2018). The immunomodulatory and anti-inflammatory role of polyphenols. *Nutrients*, 10(11), 1618. doi:10.3390/nu10111618
Crossref ● PubMed ● PMC ● Google Scholar

Zhang, Y., Li, Y., Ren, X., Zhang, X., Wu, Z., & Liu, L. (2023). The positive correlation of antioxidant activity and prebiotic effect about oat phenolic compounds. *Food Chemistry*, 402, 134231. doi:10.1016/j.foodchem.2022.134231
Crossref ● PubMed ● Google Scholar

## ТЕРЕН КОЛЮЧИЙ (*PRUNUS SPINOSA* L.): ЕКОЛОГІЧНІ ОСОБЛИВОСТІ ПЕРСПЕКТИВНИХ ФОРМ І ЦІННІСТЬ НУТРІЄНТНОГО СКЛАДУ ЙОГО ПЛОДІВ ДЛЯ ПРІОРИТЕТНИХ НАПРЯМІВ ІЗ ВИГОТОВЛЕННЯ ФУНКЦІОНАЛЬНИХ ПРОДУКТІВ

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**Вступ.** Актуальність досліджень полягає у постійному прагненні збільшити можливості використання малопоширених плодових і ягідних культур, зокрема, терену колючого у селекції рослин, технологіях виготовлення продуктів здорового харчування способами науково обґрунтованого добору, оцінювання за фізіологічними, фітопатологічними показниками та біохімічними параметрами плодів. Мета

роботи – розширити морфологічне різноманіття терену, який поєднує високу продуктивність і якість для подальшої селекції.

**Матеріали і методи.** В умовах *ex-sity* досліджено морфологічні ознаки і біологічні властивості нових форм терену колючого, проведено аналіз якості плодів за біохімічними показниками. Використовували польові, фенологічні, біометричні, фізіологічні, статистичні, лабораторні методи досліджень.

**Результати.** За результатами практичних досліджень представлено оригінальні дані про морфологію й господарську характеристику форм терену колючого (*Prunus spinosa* L.), відібраних у напівперелогових землях північної, центральної і західної частин України. У роботі висвітлено морфобіологічні властивості добірних форм терену, біохімічні параметри плодів, зокрема, акцентовано увагу на вмісті поліфенольних речовин як джерела антиоксидантів. З'ясовано, що відібрані форми терену мають високу посухостійкість і зимостійкість, зокрема, стійкість до низьких температур під час фази цвітіння. Фенологічні спостереження за рослинами різних форм *Prunus spinosa* L. дали змогу з'ясувати час настання фаз онтогенезу: розвитку вегетативних і генеративних бруньок, бутонізації та цвітіння, появи листків, інтенсивності росту пагонів, утворення і розвитку зав'язей, достигання плодів, що є вагомим науковим доробком для перспективних напрямів селекції в системі плодового садівництва.

Диференційовано форми терену за висотою рослин, силою росту, колючковістю, крупністю і масою плодів та їхнім подальшим використанням у технологіях переробки і виготовлення функціональних продуктів. Біохімічний аналіз плодів, зокрема, з визначення поліфенолів, дав змогу встановити їхню придатність до переробки і виготовлення продуктів здорового харчування.

**Висновки.** Отримано відомості про відібрані нові форми терену колючого, який є потенційним вихідним матеріалом для перспективних напрямів селекції; з плодів кращих зразків терену за біохімічними властивостями і технологічними показниками розроблено технології виготовлення купажованих соків і сиропів.

***Ключові слова:*** терен колючий, нові форми, біологічні особливості, якість плодів

Received / Одержано 14 March, 2024 | Revision / Доопрацьовано 01 April, 2024 | Accepted / Прийнято December, 2024 | Published / Опубліковано December, 2024