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JUSTIFICATION OF SELECTION DIFFERENT TYPES AND HYBRIDS OF TOMATOES FOR DRYING

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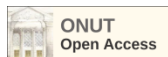
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Introduction. Formulation of the problem

Tomato (*Lycopersicon esculentum*) is one of the most common vegetable crops in Ukraine and the world, an important food product characterized by high

taste, dietary and medicinal properties, nutritional and biological value. The fruits are widely used in food in fresh and processed form. The world production of tomatoes is over 180 tons per year, and the number of registered trademarks involved in their processing

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Abstract. Tomato is one of the most common vegetable crops, the fruits of which are characterized by high organoleptic and taste properties, the content of biologically valuable nutrients and are used for various types of processing. In recent years, in connection with the interest of consumers in a healthy lifestyle, the need for high-quality and useful food products is growing. Such products include sun-dried tomatoes, which contain a significant amount of vitamins and mineral compounds that have powerful antioxidant properties. The article presents the results of research into the quality of fresh fruits and dried tomato products of six hybrids of different types: two hybrids are plum-like and four are cherry-type (*Lycopersicon esculentum* Var. *Cerasiforme*). It has been established that when using cherry tomato hybrids for low-temperature drying (withering), it is possible to obtain 13.0–14.1 % of dry products with a sugar content of 50.8–55.9 % and vitamin C 28–30 mg/100 g, and the plum type – 12.0–12.2, 40.2–41.3 % and 37.8–40.2 mg/100 g, respectively. To produce 1 kg of dried products, 8.1–8.3 kg of fresh plum tomatoes and 7.2–7.4 kg of cherry tomatoes are required. It was found that with an increase in the mass of tomato fruits, the content of dry soluble matter ($r = -0.89$), the sugar-acid ratio ($r = -0.88$), their tasting evaluation ($r = -0.91$) and yield of finished products ($r = -0.82$). A significant inverse relationship was established between the content of dry soluble matter and vitamin C ($r = 0.84$), as well as the content of dry soluble matter and the amount of waste during the preparation of raw materials for drying ($r = -0.89$). The materials of the article are of practical value for vegetable growers, breeders, specialists of processing enterprises when choosing a type and hybrid of a tomato for withering (drying).

Keywords: tomato, hybrid, type, fruit, quality, biological value, processing, drying.

exceeds 8 million. pcs. [1]. They are used for pickling, salting, obtaining tomato puree, juice paste and sauces, etc.

The most widespread way of processing tomato fruits in Ukraine today is preservation with the addition of acetic acid. However, such products have low biological value and are harmful to people with diseases of the gastrointestinal tract. In recent years, the production dried fruits and vegetables by low temperature method, including tomatoes, has become quite popular [2]. They are a trend of their own in the production and processing of food products. The advantages of this method of low temperature of drying, as a method of processing are its low cost, availability, long storage time of storage and transportation of the finished product and high nutritional value [3]. In addition, if the drying technology is used correctly, the finished product retains most of the vitamins and biologically active substances and has useful, since it does not contain any artificial preservatives or chemicals [4].

Today in the 2024, domestic retail chains sell mostly Italian, Greek and Polish dried tomatoes. In Ukraine, most of such products are prepared at home or produced in small private enterprises. Today, drying tomatoes in our country is a new and perspective method of processing them, which became especially relevant during the period of military operations to provide food for the army. The quality of such product and the efficiency of its production depends significantly on the quality of the raw materials [4,5,6].

Analysis of recent research and publications

The nutritional and medicinal value of tomatoes is determined by their chemical composition. Fresh fruits contain about 4.0–5.0 % sugars, 0.5–1.5 % proteins, 0.4–0.6 % organic acids, 0.6% minerals, 0.07–0.5 % starch and also phenolic compounds, fibres and a complex of vitamins. Thus, 1 kg of tomatoes contains (mg): vitamin C – 25–30, β -carotene – 15–17, vitamin B1 (thiamine) – 1.0–1.2, vitamin B₂ – 0.5–0.6, vitamin PP (nicotinic acid) – 4.1–4.5, vitamin B9 (folic acid) – 0.75, vitamin H (biotin) – 0.04 [2,7]. It should be noted that cherry fruits accumulate more valuable elements than the fruits of other types of tomatoes.

The most valuable substance that contained in tomatoes is lycopene, a biologically active pigment from the carotenoid group [2,8]. According to Nikita S. Bhatkar (2021), lycopene is the most widespread carotenoid in tomatoes, accounting for 80–90% of their total amount [9]. In recent years, lycopene has attracted the attention of researchers due to its potential health benefits. Lycopene has the most effective free radical scavenger and its antioxidant capacity is more than twice that of β -carotene [5,9]. Lycopene is a powerful antioxidant that can prevent the development of serious diseases such as cancer of the stomach, oesophagus, intestine, pancreas, breast, lungs and the likelihood of

developing pathologies of the cardiovascular system [8–10].

It is important that lycopene is best absorbed by the human body not from fresh, but from thermally processed fruits [11]. Its concentration in fresh fruits is up to 20 mg/100 g, and in paste – 30–35 mg/100 g [12]. For supplying the human body daily norm of lycopene, it is necessary to consume about 200 g of fresh fruits, 500 ml of juice or one tablespoon of paste [3].

Tomatoes also contain vitamin K, which stabilizes calcium absorption, and thus normalizes the functioning of the kidneys and biliary system [13]. Substances that accumulated in tomato seeds are useful for the circulatory system, dissolve the blood, and reduce the risk of thrombosis [14]. It has been established that people who regularly consume tomatoes have a lower risk of increased cholesterol, blood pressure, blood sugar, heart disease, Parkinson's and Alzheimer's, and cell damage. Thus, the high level of biologically active compounds in tomato fruits are beneficially for human health and makes them desirable functional ingredients in food products [15].

Due to the high content of free moisture and the soft structure of the cell walls, tomatoes are classified as perishable products, which leads to significant losses during storage and environmental pollution [16]. Therefore, the search for alternative ways to extend the storage period is actually. Drying is one of the most effective methods, as it allows you to maximally safe and preservative of the biologically valuable compounds contained in fresh fruits [17,18]. Drying both whole fruits and their processed products allows you to obtain valuable products – raw materials for the manufacture of various innovative, functional products with specified properties. Dried tomatoes, according results of researching of Violeta Nour, Tatiana D. Panaite (2018), contain 176.2 g/kg protein, 21.9 g/kg fat, 524.4 g/kg crude fibre, a significant amount of lycopene (510.6 mg/kg) and β -carotene (95.6 mg/kg) [19]. The other researchers indicated that content of lycopene in dried tomatoes significantly depends on the varietal characteristics, methods of raw material preparation, speed and method of drying and can changing in wide ranges – from 126 to 390 μ g/g dry weight [1,2,9,11,20]. Due to the high sensitivity of lycopene to thermal action, it is important to use optimal drying temperature regimes that will be ensuring high preservation and stability of this compound in dry products [19].

Numerous studies have been conducted in different countries on the possibility of using dried tomatoes and their processing by-products as ingredients in various food products. Dried tomato powder is used as a biologically active additive to improve the organoleptic, taste properties, and biological value of bakery (focaccia), pasta, confectionery (cookies), and meat products [21]. Food products with the addition of tomato peel, pulp, and

seeds (powders and extracts) contain high concentrations of bioactive compounds, including phenolic compounds, natural dietary fibre, and minerals, and can be used to strengthen the immune system [22,23]. Tomato seeds are also a valuable processing product, as they contain a significant amount of crude fat and protein [14]. The positive effect of addition tomato seeds on the volume of bread, amino acid content and rate of its staling has been established [24].

The technology of production of dried products from fruits and vegetables has many similar aspects. The results of our own long-term research and scientists from other countries show that the quality of the finished product is influenced by many factors, namely: varietal characteristics, growing conditions, content and ratio of biochemical indicators in the fruits and the technology of drying [25-27]. The main effect on the maximum preservation of biologically valuable compounds in dried products has drying temperature. According results of Idoya Fernandez-Pan (2023) the higher the drying temperature lowered their content in the finished products [1]. Therefore, drying ensures the production of higher-quality, biologically valuable products, as it prevents protein coagulation, sugar caramelization, destruction of cell structure and burning of raw materials [28].

Air-solar, convective and infrared drying or their combination are used for tomatoes drying. T. J. Gaware (2010) notes that the rehydration capacity of dried tomatoes is highest when using freeze-drying [29]. Studies conducted by R. Kaur (2020) found that when using thermal drying of tomatoes, it is most appropriate to use a temperature of up to 60°C, as this contributes to better preservation of phenolic substances (738.44 ± 0.10 mg/100g), flavonoids (499.56 ± 0.04 mg/100g) and overall antioxidant properties of dried products (42.79 ± 0.11) [15]. R. Mwende (2018) states that the quality of dried products depends significantly not only on drying temperatures, but also on varietal characteristics and preparation of raw materials for drying [30]. Vitamin C is rapidly oxidized, so much more of it remains in dried products obtained by convective, especially infrared and freeze-drying methods [31].

Infrared drying is one of the most effective methods for producing high-quality dried products from fruits and vegetables. The basis of this method is the ability of infrared rays to be absorbed by water, heat and evaporate it, without damaging other substances and cells [32]. This allows to maximally preserve the original quality of raw materials and the content of biologically valuable substances in the finished product. In addition, the high density of infrared radiation actively destroys harmful microflora, making dry products practically sterile, thanks to which they can be stored for a long time without deterioration in quality [33, 34]. Infrared drying is also economically advantageous, since low temperatures do

not heat the drying equipment, air and there is practically no energy loss.

Modern tomato production is clearly segmented by the areas of fruit utilization [35]. Varieties and hybrids of tomato processing must have certain requirements, namely: friendly ripening, high yield, suitability for mechanized harvesting, transportability, high of dry matter and sugar content [2,8,32]. As indicated data from literature sources and the results of our own research, the most suitable for drying (drying) are hybrids of plum-form tomatoes and cherry tomatoes, that have fleshy dense pulp, high dry matter content and lower juice content [2,34].

The decisive factor for obtaining high-quality dried products from tomato fruits is the choice of variety or hybrid. Therefore, the **purpose** of the research was to select cherry and plum-type tomato hybrids suitable for dried. To achieve this purpose, the following **objectives** were set:

- to assess the quality of fresh fruits of different types and hybrids according to a set of biometric, organoleptic and biochemical indicators;
- to establish the amount of waste and the yield of dried products;
- to determine the influence of varietal characteristics on the quality of dry products;
- to identify correlations between the studied quality indicators.

Research materials and methods

The research was conducted during 2018-2021 at the National University of Life and Environmental Science of Ukraine in the conditions of the NNVL of fruit and vegetable processing of the Department of Storage, Processing and Standardization of Plant Products after prof. B.V. Lesik and SFG "Maryna" of the Ternopil region.

Tomatoes hybrids of cherry and plum-type were selected for investigations, since they are most recommended for drying. Control variants were selected separately for each type. The experiment scheme included new hybrids of foreign selection, that have proven themselves best in recent years of cultivation and are widespread in production. The following cherry tomato hybrids were studied: Nectar F₁, Star Gold F₁, Crispina Plum F₁, Rianna F₁. The Italian hybrid Star Gold F₁, that was included to the Register of Plant Varieties Suitable for Distribution in Ukraine in 2019, was chosen as the control. Two hybrids tomatoes of plum-type of French and American selection were studied: Pietra Rosso F₁ (originator French company "Clauze") and Yellow River F₁. The control was the Pietra Rosso F₁ hybrid that was registered in 2015.

Raw material cultivation.

Cherry tomatoes were grown by seedling method in a winter greenhouse. Seeds were sown manually in cassettes of 160 pieces. Sowing was carried out on

February 5–8, picking – March 12–14. Seedlings of cherry tomato hybrids were planted in closed ground on April 19–22. Planting pattern – 100×20×40 (two-row), density – 2.5 pcs/m². Every two weeks were carried out tying and weeding. Harvesting in closed ground was carried out selectively in bunches, starting from July to November. Plum-form tomatoes were grown in open ground according to generally accepted technology.

Determination of quality indicators

Organoleptic, biometric, and biochemical indicators were determined in the conditions of the educational and scientific laboratory of the Department of Storage, Processing and Standardization of Plant Products after prof. B.V. Lesik according to generally accepted methods [36]. To determine biometric indicators, an average sample of fruits of each variant weighing 1 kg was selected in triplicate. The dry matter content was determined by the thermogravimetric method by drying in a drying oven according to the requirements of DSTU ISO 751:2004 Processed fruit and vegetable products. Method for the determination of water-insoluble solids (control method) (ISO 751:1998, IDT); dry soluble matter – using a refractometer according to the requirements of DSTU ISO 2173:2007 Fruit and vegetable products. Determination of soluble solids by refractometric method (ISO 2173:2003, IDT); sugar content (sum) – by Bertrand method according to DSTU 4954:2008 Products of processed vegetables and fruits. Methods for the determination of sugars; vitamin C – by titrimetric method according to the requirements of the standard DSTU 7803:2015 Products of fruit and vegetable processing. Methods for the determination of vitamin C.

Tasting score for fresh and dried fruits were given as the average overall score of organoleptic quality indicators on a 9-point scale. For fresh fruits, the attractiveness of the appearance, color, tenderness of the skin, the character of the pulp, smell, taste and juiciness were assessed. Taste qualities and juiciness were determined on the following scale: 1 – very tasteless, not juicy; 3 – tasteless, not juicy; 5 – medium taste, not very juicy; 7 – tasty, juicy, 9 – very tasty, juicy. Character of the pulp: 1 – very little fleshy; 3 – little fleshy; 5 – medium fleshy; 7 – fleshy; 9 – very fleshy. For dried products, the following were considered: appearance, preservation of color, its correspondence to the color of the starting material, the presence of atypical, stuck particles, density (softness) of the pulp, characteristic odor, and balance of taste properties.

Fruit drying technology

For drying fresh fruits, an infrared dryer was used. 2 kg of calibrated fruits were selected and their cut on the half immediately before drying. They were placed on dryer pallets with a perforated bottom, set on racks with infrared film and loaded into the dryer in one time (Fig. 1). The products were dried at a

temperature of 50–55 °C until completely dry, that was determined organoleptically. For uniform drying and to prevent over drying of fruits during the drying process, samples of the finished product were periodically selected.

Statistical analysis

The obtained research results were processed using Excel with the Microsoft Office 2007 software package. The experiment was carried out in three repetitions. The data are presented as mean values ± standard deviation. The strength of correlation relationships was assessed according to the following gradation: if *r* (correlation coefficient) is 0.66–0.99, such a relationship is strong (significant); if it is within 0.33–0.65 – the relationship is medium; if less than 0.33 – weak, insignificant [36].

Results of the research and their discussion

Fresh fruits of the studied hybrids differed significantly in terms of quality indicators (Table 1). The average weight of plum-shaped marketable fruits was 30.8–33.2 g and exceeded cherry tomatoes by almost three times (9.8– 12.9 g). Among cherry tomatoes, the heaviest and largest fruits were formed by the Crispina Plum F₁ hybrid – 12.9 g, that is 3.1 g more compared to the control (significant difference). Cherry tomato fruits were more aligned in terms of marketable fruit weight compared to plum-shaped ones.

The best raw material for the production of dried tomatoes, as indicated by literature sources and the results of our own research, are fruits with a dry soluble matter content of more than 5.0%. The fruits of all experimental variants according to this indicator were suitable for this method of processing. The highest content of dry soluble matter had in the fruits of the cherry hybrids Star Gold F₁ and Crispina Plum F₁ – 10.2 and 9.8%, respectively. No significant difference was found between the experimental plum-shaped hybrids in terms of the amount of dry soluble matter – its content ranged from 6.1–6.3%.

Sugars, that are the basis of dry and dry soluble matter, accumulated in plum-type tomatoes less than to cherry tomatoes. Their total amount in plum-type fruits reached slightly less than the traditional value for these hybrids 4.0–4.1%, and in cherry-type fruits contained 5.3–6.7% of sugars. The highest amount was found in samples of hybrids Star Gold F₁ and Crispina Plum F₁ – 6.7 and 6.3 %, respectively, and the lowest – in fruits of hybrid Rianna F₁ – 5.3%, which is 1.4% less, compared to the control.

The content of vitamin C in tomatoes depends on the varietal characteristics and growing conditions. The fruits of plum-shaped hybrids grown in open ground contained more of it – 24.4–27.1 mg/100 g. Among the tomatoes, the fruits of the Crispina Plum F₁ hybrid had the highest vitamin content and accumulated 17.2 mg/100 g of ascorbic acid.



Fig. 1. Dryer tray with infrared film and prepared for drying raw materials

Table 1 – Quality indicators of fresh tomato fruits of different hybrids, average for 2018–2020 (n=3, p<0.05)

Hybrid name	Weight of marketable fruit, g	Fruit content			Sugar-acid coefficient	Tasting score, units*
		dry soluble matter, %	sugars (sum), %	vitamin C, mg/100 g		
Plum-shape tomatoes						
Pietra Rossa F ₁ (control)	30.8±2.1	6.1±0.1	4.0±0.2	24.4±2.4	7.2	7.0±0.4
Yellow River F ₁	32.4±1.8	6.3±0.2	4.1±0.1	27.1±3.0	7.8	7.2±0.3
Cherry tomatoes						
Star Gold F ₁ (control)	9.8±0.5	10.2±0.2	6.7±0.3	15.6±1.4	15.2	8.8±0.1
Crispina Plum F ₁	12.9±0.8	9.8±0.3	6.3±0.2	17.2±1.2	14.0	8.8±0.1
Nectar F ₁	11.6±0.7	8.4±0.2	5.5±0.2	16.5±1.6	12.0	8.3±0.2
Rianna F ₁	11.5±0.8	8.2±0.3	5.3±0.1	15.2±1.5	11.1	8.5±0.2

Note: *on a 9-point scale

The richness and harmony of the taste of tomatoes depends not only on the content of sugars and acids in them, but also on their correlation, which is characterized by the sugar-acid coefficient. During the growing season, plum-shaped fruits accumulated more acid, compared to cherry tomatoes – 0.52–0.56% and 0.44–0.48%, respectively. This affected the value of the sugar-acid coefficient and the taste of the fruits. Thus, the sugar-acid coefficient in cherry tomatoes fluctuates within 11.1–15.2 and a plum-type – 7.2–7.8 units.

The overall tasting score of cherry tomato hybrids was 8.3–8.8 points on a 9-point scale, and plum-shaped tomatoes 7.0–7.2 points. The fruits of cherry hybrids had an attractive appearance, bright uniform colour, tender juicy pulp, thin skin and balanced rich taste. The highest tasting scores were received by the fruits of the Crispina Plum F₁ and Star Gold F₁ hybrids – 8.8 points on a 9-point scale (Fig. 2).

The amount of waste in the process of preparing raw materials and the yield of finished products is of great importance to produce dried vegetables, including tomatoes, as this affects the yield of finished products and the economic efficiency of production. As the results of the study show, technological indicators significantly depended on the type and hybrid of tomato (Fig. 3).

The amount of waste formed as a result of preparing raw materials for drying in plum-shaped tomatoes and cherries differed significantly and amounted to 16.0–16.4

and 1.8–3.0%, respectively. This is due to the presence of a core in the middle of plum-shaped tomatoes and its absence in cherry-type fruits.

In terms of dry product yield, cherry hybrid fruits were superior to plum-shaped ones – 13.0–14.1% and 12.0–12.2%, respectively. In general, this indicator, as evidenced by the results of the study, is most affected by the content of dry matter in fresh fruits and the amount of waste. This is confirmed by the results of our own studies and other researchers [2,4,6,17,15,37]. However, the difference between the types of fruits in terms of the yield of finished products was not so significant, as in terms of the amount of waste and was 1.0–2.1%. This is apparently due to the structure of plum-shaped tomato fruits, their consistency and moisture-holding capacity. In general, the highest yield of dried products was established for the use of fruits of the Star Gold F₁ hybrid (14.1%), and the lowest – Yellow River F₁ (12.0%).

As a result of the calculations, it was found that the smallest amount of fresh fruit to produce 1 kg of dried products is required when using the Star Gold F₁ hybrid – 7.2 kg, and the largest – the Yellow River F₁ hybrid – 8.3 kg. It is obvious that this indicator correlates with the yield of dried products.

The nutritional and biological value of dried product was defined by preservation in it of biochemical indicators (Fig. 4).



Fig. 2. Fruits of cherry tomato hybrids during tasting: 1 – Star Gold (control) F₁; 2 – Crispina Plum F₁

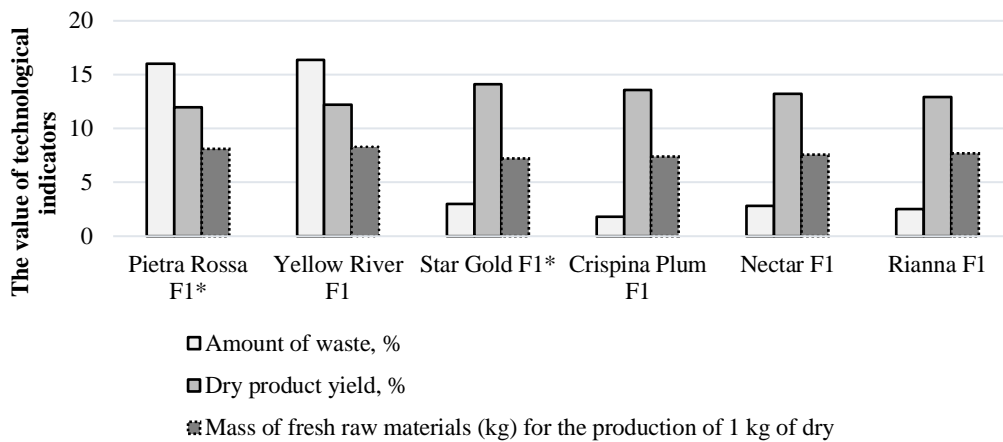


Fig. 3. Amount of waste, yield of dry products and weight of fresh raw materials required to produce 1 kg of dry products from tomato fruits of different species and hybrids, average for 2018–2020. Note: *control

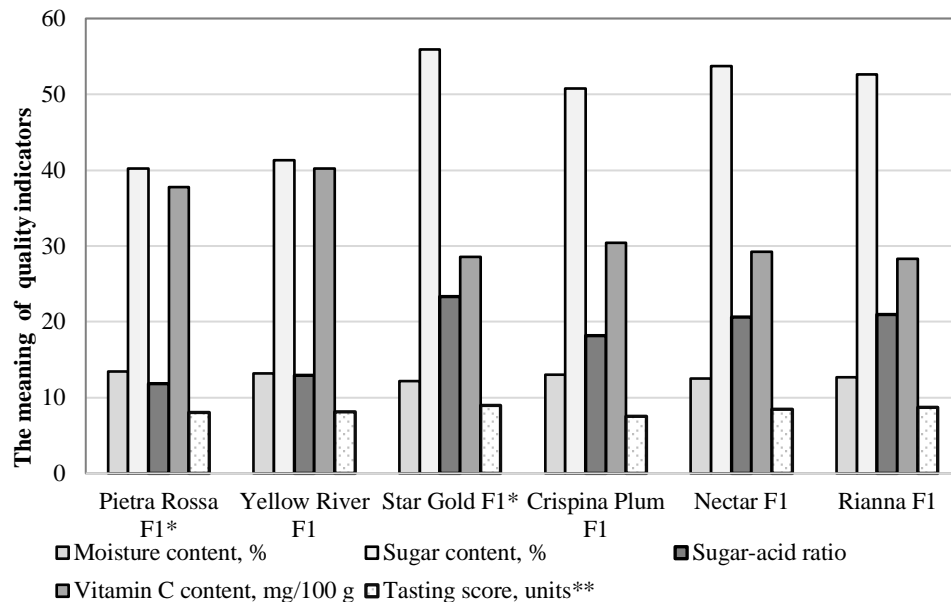


Fig. 4. Content of main biochemical components and tasting evaluation of dried tomato products of different hybrids, average for 2018–2020. Note: **control; **on a 9-point scale

The moisture content in dried tomatoes ranged from 11.8 to 13.4%. At the same time, dried cherry tomatoes of the Star Gold F₁ hybrid contained the least

moisture (10.8%) and the plum-shaped hybrid Pietra Rossa F₁ contained the most (12.8%). It was found that during the drying process the sugar content (sum) was

significantly concentrated (7–8 times) and varied depending on the hybrid. According to this indicator, the dried products of the Star Gold F₁ hybrid dominated, containing 60.0% sugars (sum). The smallest amount of sugars among cherry tomatoes was in the finished products of the Crispina Plum F₁ hybrid – 50.8%. Dried products of plum-shaped hybrids contained significantly less sugars, compared to cherry tomatoes – 40.2–41.3%.

It was found by calculation method that the sugar content in dry products increased by 2.0–5.0% (depending on the hybrid) compared to fresh fruits. Apparently, during the drying process, polysaccharides were converted into mono- and disaccharides, resulting in an increase in the amount of sugars.

The amount of acid in dry products was also significantly higher than fresh vegetables and amounted to 2.5–3.4% (in fresh – 0.4–0.6 %). More of them were contained in dry products made from plum-shaped tomatoes – 3.2–3.4% but among of cherry tomatoes – in products obtained from the fruits of the Crispina Plum F₁ hybrid – 2.9%. This was significant effect on the sugar-acid coefficient. As in fresh fruits, this indicator was higher in dried products obtained from cherry tomatoes – 17.2–23.3 units (in fresh – 11.1–15.2). The maximum value of the sugar-acid coefficient was established in dried products from the Star Gold F₁ hybrid (control) – 23.3 units, that positively affected on its taste properties. The sugar-acid coefficient of dried products produced from plum-shaped tomato fruits was 11.8–12.9 units.

Dried tomatoes contain a significant amount of vitamin C, a substance that directly affects the biological value of food products. In terms of the amount of this element, products made from plum-like hybrids prevailed and contained it within 38–40 mg/100 g. It was found by calculation method, that during infrared drying of tomatoes at a temperature of +50–55 °C, the losses of vitamin C were quite significant and amounted to 55–67 %, which confirms the data of other researchers. However, during convective drying, the losses of this biologically valuable element are even higher. Thus, according to Abdou Bouba Armand (2018), the losses of vitamin C during the use of convective drying of onions amounted to 72.5–78.1 % [31].

It was found that the sugar content in dried products significantly affects not only the taste properties, but also its tasting assessment in general. As a result of the conducted correlation analysis, a significant direct relationship was established between the sugar content and the tasting assessment of dried tomatoes ($r= 0.87\pm 0.18$). In general, as a result of the assessment of dried tomato products according to five main organoleptic indicators, the highest overall score was received by the products of the Star Gold F₁ and Rianna F₁ hybrids – 9.0 and 8.7 points, respectively, according 9-point scale. Samples of dry and reconstituted products of the Star Gold F₁ hybrid, which received the maximum tasting scores, are shown in Fig. 5.

The lowest score among all the presented samples was received by the product made from the fruits of the Crispina Plum F₁ hybrid – 7.5 points on a 9-point scale and it was attributed to the second commercial grade. This result was caused by its non-uniform colour, the presence of dark spots and stickled particle.

Correlation calculations between the studied quality indicators of fresh fruits and dried tomato products were carry out (Table 2).

The correlation calculations revealed a significant inverse relationship between fruit weight and dry soluble matter content ($r= -0.89$), sugar-cid coefficient ($r= -0.88$), tasting score ($r= -0.94$) and yield of dry product ($r= -0.82$). The results obtained show that with increasing fruit weight, the dry soluble matter content, sugars and yield of dry product significantly decrease; smaller fruits accumulate more dry soluble substances and sugars. Fruit weight also significantly affected the vitamin C content and the amount of waste. However, the relationship was direct: with increasing fruit weight, the vitamin C content and the amount of waste significantly increased ($r= 0.91$). A significant direct relationship was found between the content of dry soluble matter and the tasting score ($r= 0.86$) and a significant inverse relationship was found between the content of dry soluble matter and the amount of waste ($r= -0.89$). A significant direct relationship was found between the content of dry soluble matter and the yield of the finished product ($r= 0.97$).



Fig. 5. Dried (1) and rehydrated (2) reconstituted products of the Star Gold F₁ hybrid

Table 2 – Matrix of relationship correlations between the studied indicators of tomato fruits (calculated based on average data)

Indicator	Fruit weight, g	Dry soluble matter content, %	Sugar–acid coefficient	Vitamin C content, mg/100 g	Tasting score, units	Amount of waste %	Yield of dry product, %
Fruit weight, g	1						
Dry soluble solids content, %	-0.89*	1					
Sugar–acid coefficient	-0.88*	0.99*	1				
Vitamin C content, mg/100 g	0.92*	-0.84*	-0.84*	1			
Tasting score, units	-0.94*	0.86*	0.95*	-0.91*	1		
Amount of waste, %	0.91*	-0.89	-0.88*	0.97*	-0.95*	1	
Yield of dry product, %	-0.82*	0.97*	0.98*	-0.75*	0.91*	-0.83*	1

Notes: * there is a strong relationship between the signs

Source: based on own research

Significant relationships were found between biochemical indicators of tomato fruits, namely: increase the content of dry soluble matter significant influences on the increase content of the sugar-acid coefficient ($r = 0.99$) and decrease content of vitamin C ($r = -0.84$). The tasting assessment of dry products significantly increased with an increase in the sugar–acid coefficient ($r = 0.95$) and decreased with an increase in the weight of the fruit ($r = -0.94$). The positive and negative correlations between the studied indicators of tomato quality can be used to select raw materials suitable for drying.

Conclusion

Among the studied assortment of tomatoes according of biometric and commercial indicators was the best the fruits of cherry-type hybrids, that were more even in terms of commercial fruit weight compare to plum-shape. Significant inverse correlations between fruit weight, dry matter and dry soluble matter content, sugar-acid coefficient, tasting score and finished product yield were established.

Cherry-type tomato fruits accumulated more dry matter, dry soluble matter and sugars, but the plum-type tomatoes accumulated more acid and vitamin C, which is explained by varietal characteristics and growing conditions. According to the complex of biochemical indicators that determined the suitability of tomatoes for drying, the fruits of cherry hybrids Star Gold F₁ and Chrispina Plum F₁ were the best. They accumulated 10.8–11.3% dry matter, 6.7–6.3% sugar and the sugar–acid coefficient was 15.2–14.0 units. The highest vitamin C was accumulated in the fruits of the plum–type hybrid Yellow River F₁ – 27.0 mg/100 g. As a result of the conducted correlation analysis, a direct significant relationship between taste and sugar-acid coefficient ($r = 0.95$) was established.

According to the technological indicators, that established suitability of raw materials for processing as also the economic efficiency of its production, the most suitable were cherry tomato hybrids, that are characterized by the minimum amount of waste in the process of preparation for processing (1.8–3.2%) and had yield of dry products at the level of 13.0–14.1%. For produce 1 kg of dry products from cherry hybrids are required 7.2–7.7 kg of fresh fruits and plum-shaped ones – 8.1–8.3.

Dried tomatoes have high nutritional and biological value. As a result of drying, the content of dry matter, sugars, acids is concentrated, so the actual values of these indicators in dried products are much higher, compared to fresh fruits. The larger amount of dry matter (87.0–88.2 %) and sugar (50.8–55.9 %) were contained in dry products made from cherry tomatoes but acids and vitamin C – in plum-shape tomatoes (3.2–3.4 % and 38–40 mg /100 g, respectively). The highest value of the sugar-acid coefficient was found in dry products with the Star Gold F₁ hybrid (23.3 units), which affected its taste properties (tasting score was 9.0 points on a 9-point scale).

Thus, for the complex of studied indicators, the most suitable for drying at a temperature up to 55 °C are the fruits of cherry-type tomato hybrids, which are characterized by a yield of finished products within 13.0–14.1 %, contain more than 50 % sugars, 28–30 mg/100 g of vitamin C and the tasting score is within 8.5–9.0 points according 9-point scale (except for the Chrispina Plum F₁ hybrid). The highest biological value is given to dried products from plum–type fruits of the Pietra Rossa F₁ and Yellow River F₁ hybrids, which contain 38–40 mg/100g of ascorbic acid.

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ОБГРУНТУВАННЯ ВИБОРУ ПОМІДОРА РІЗНИХ ТИПІВ ТА ГІБРИДІВ ДО СУШІННЯ

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Анотація. Помідор – одна з найпоширеніших овочевих культур, плоди якої характеризуються високими органолептичними й смаковими властивостями, вмістом біологічно цінних, поживних речовин й використовуються для різних видів переробки. В останні роки, в зв'язку із зацікавленістю споживачів до здорового способу життя, зростає потреба у якісних та корисних продуктах харчування. До таких продуктів можна віднести в'ялені томати, в яких зберігається значна кількість вітамінів, мінеральних сполук, що мають потужні антиоксидантні властивості. В статті наведено результати дослідження якості свіжих плодів та в'яленої продукції помідора шести гібридів різних типів: два гібриди сливоподібні та чотири – типу чері (*Lycopersicon esculentum* Var. *Cerasiforme*). Встановлено, що при використанні для низькотемпературного сушіння (в'ялення) помідора гібридів типу чері можна отримати 13,0–14,1% сухої продукції з вмістом цукрів 50,8–55,9% та вітаміну С 28–30 мг/ 100 г, а сливоподібного типу – 12,0–12,2, 40,2–41,3% та 37,8–40,2 мг/100 г відповідно. Для виробництва 1 кг в'яленої продукції необхідно затратити 8,1–8,3 кг свіжих плодів сливоподібних помідорів та 7,2–7,4 кг – типу чері. Виявлено, що зі збільшенням маси плодів помідора суттєво зменшується вміст у них сухої розчинної речовини ($r = -0,89$), цукро-кислотний коефіцієнт ($r = -0,88$), їх дегустаційна оцінка ($r = -0,91$) та вихід готової продукції ($r = -0,82$). Встановлено суттєвий обернений зв'язок між вмістом сухої розчинної речовини й вітаміну С ($r = 0,84$), а також вмістом сухої розчинної речовини й кількістю відходів під час підготовки сировини до сушіння ($r = -0,89$). Матеріали статті становлять практичну цінність для овочівників, селекціонерів, фахівців переробних підприємств під час вибору типу й гібриду помідора для в'ялення (сушіння).

Ключові слова: помідор, гібрид, тип, плід, якість, біологічна цінність, переробка, сушіння.