# TESTING SOME PRODUCTION TECHNOLOGIES OF RED GRAPE JUICE IN THE REPUBLIC OF MOLDOVA

## ÎNCERCAREA UNOR TEHNOLOGII DE PRODUCERE A SUCULUI ROȘU DE STRUGURI ÎN REPUBLICA MOLDOVA

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***Abstract.*** *The process of primary processing of black grapes in viticulture and canning branches aims to mechanize the process of extracting the colour from the whole grapes before the fermentation of the must in order to obtain different types of red juice and red wine. To be solved: simplification of the scheme and the creation of the universal technological line for juice - wine with increased hygienic properties and reduced expenses. The whole grapes received in the bunker-press are treated with 0.2% $SO_2$ solution, hot 55$^0$C for 15 minutes, which can be recovered for other batches of raw material. The decontaminated grapes are thermally treated (selectively the skin) for 10-20 minutes with hot must +60-85$^0$C, followed by the first cycle of hydraulic (pneumatic) pressing with the separation of the pigmented dietary red must and storage. The rest of the mass in the bunker-press is dosed with potassium pyrosulfite together, dihydroxyfumaric acid and with hot must +60$^0$C for 10 minutes for the final extraction: anthocyanin - SBA, cooling it to +25$^0$C, pressing the second with the selection of the must fraction and fermentation to make red wine.*
**Key words:** grapes, must, wine, factors, anthocyanins, colour

***Rezumat.*** *Procedeul procesării primare a strugurilor negri în ramura vitivinicolă și cea de conserve are drept scop mecanizarea procesului de extracție a culorii din strugurii întregi până la fermentarea mustului pentru obținerea diferitor tipuri de suc roșu și vin roșu. Se rezolvă: simplificarea schemei și crearea liniei tehnologice universale pentru suc - vin cu însușiri igienice sporite și cheltuieli reduse. Strugurii întregi recepționați în buncher-presă sunt tratați cu soluție de 0,2% $SO_2$, încălzită la 55$^0$C timp de 15 minute, cu recuperarea soluției pentru alte loturi de materie primă. Strugurii decontaminați sunt tratați termic (selectiv pielița) timp de 10-20 minute cu must fierbinte +60-85$^0$C, urmează ciclul unu de presare hidraulică (pneumatică) cu separarea mustului roșu dietetic pigmentat și depozitarea acestuia. În restul masei din buncher-presă se dozează pirosulfît de potasiu în ansamblu cu acid dihidroxifumaric și cu must fierbinte +60$^0$C timp de 10 minute pentru extracția finală: antociani - SBA, răcirea la +25$^0$C, presarea a doua cu selectarea fracțiunii de must și fermentarea pentru prepararea vinului roșu.*
**Cuvinte cheie:** struguri, must, vin, factori, antociani, culoare.

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## INTRODUCTION

On the world market, the expansion of the production of beverages from pink and red grapes is observed, the trend being more valid for wines (Oliveri, 1981; Martiniere *et al.*, 1973; Somers and Evans, 1979). As for the juices, they are predominantly white, sometimes pink. The technology of juice production is continuously improving, a considerable leap has been made in terms of the study of red varieties, their softened processing, the issues regarding the standard colour, the degree of oxidation, the choice of raw material, the technical assurance of juice preservation, the extraction of biologically active substances (SBA); only the award of the PDO or PGI protected designation of origin lags behind for juices (Griza and Vacarciuc, 2022). Producers from different countries, including the Republic of Moldova, offer reduced volumes of natural juice on the beverage market, and red juice is missing, the main obstacle being the choice of an effective method of extracting the natural colouring (pigmented) substances that migrate from the skin of the grape for black varieties (Griza *et al.*, 2022).

Preventive investigations (Griza and Vacarciuc, 2021, 2022; Vacarciuc, 2005) allow improvements such as complex grape processing schemes, application of the mitigating technological process and a rational regime for the manufacture of red juice with special operations, apparatus for the extraction of must, thus, widening the range of drinks. The grapes of the red varieties were tried: Amethyst, Sauvignon, Merlot, Negru de Ialoveni, Plamenii, Izabella and others that ensure the standard colour, and depending on the variety and the quality of the grapes - the reserve of phenolic substances (RSF) (Griza *et al.*, 2022).

From the known methods at the stage of primary processing, we highlight two technological schemes often applied in different variants: 1). crushed grapes, the must goes: to short-term maceration, to special cryo-maceration, enzymatic, carbonic or thermo-maceration; 2). whole red grapes - directed: to heating with steam or must (Dubaquie, Ferre method), to carbonic maceration (Flanzy method). The first scheme is more widespread, but with weak points, characterized by the oxidation of the mustache and the poor diffusion of pigments in the absence of alcoholic fermentation, the second scheme shows the consumption of thermal energy.

Devices for the extraction of the wort and the separation of the must, combined in a single device or devices that combine several operations such as maceration, pumping, stirring, pressing and evacuation of fractions are in the stage of improvement within enterprises. Completing the technological line with such devices ensures the reduction of product losses and aromatic substances. Recently, the attention of specialists is being directed towards thermo-vinification processes (scheme 2). The device for separating the grape must, together with the operation of thermo-plasmolysis was proposed (Vacarciuc, 2015) which allows to intensify the extraction of the solid phase - the skin processing with heat ($+50^0$C), the enrichment with the pigments of red grape varieties. Extracting the must in the rotating perforated basket with a vibrating element ensures the increase in productivity, the amount of must and its quality.

The bunker-press installation proposed for the blanching of whole grapes with steam, studied by us to replace the thermal maceration of the must, allowed the selective treatment of the berries, the increase of the colour quality, the improvement of the pressing and the increase of the amount of must by 30%, the simplification of the line, the reduction of electrical energy consumption, compared to its crushing and maceration (Vacarciuc, 2005; Vacarciuc *et al.*, 2021).

With the widening of the range of new selection red grape varieties, it becomes necessary to investigate their use, the innovation of more productive processing schemes, SBA extraction and standard quality assurance. The experiences corresponding to the listed schemes ensure the colour, aroma, gustatory harmony, the guaranteed extract and the chemical composition necessary for a red juice. The diffusion process at the contact of the liquid phase with the solid phase and the factors on which the colour indices and the quality of the drinks depend (Vacarciuc and Rusu, 1989; Vacarciuc, 2015) were previously studied: the degree of crushing of the raw material, temperature, and the duration of the process and the intensity of agitation. The purpose of this study is to choose the rational technological regime based on attempts to prepare red juice according to the method of direct processing of whole grapes with black berries (scheme 2), which is a progressive technology - selective thermal processing (PTS) and focused on several factors, according to the variants described.

## MATERIAL AND METHOD

The experiments according to scheme 2, on the selective thermal processing - PTS, were carried out in micro-vinification conditions of the Center area, both with vapours and with hot juice. From 8 variants from the same batch of grapes (Negru de Ialoveni) and maintaining the other factors at a similar level, the preventive tests proved that the first variants at $40^0$C and $50^0$C do not give tangible results in colour and were further excluded (4 variants). In another 4 variants, whole grapes, harvested at 19-21% sugar content, were heat-treated, first for decontamination, with 0.2% $SO_2$ solution, hot $50^0$C for 10 minutes, which was recovered for other batches of raw material. The Selective Effect Index ($S_{ef}$) was calculated, based on the initial temperature ($t_i$), the temperature of the skin (tp) and the core (tm), according to the formula [9; 10]: $S_{ef} = 100 – (t_m – t_i) \times 100 / t_p$,%.

Next, the grapes were treated with hot juice, according to the following 2 variants - with hot juice at temperatures: 1). $60^0$C and 2). $80^0$C, cooled to $35^0$C and pressed directly (whole), according to the scheme. The must was clarified with bentonite (0.5 g/l), sterilized and preserved in 0.9 l jars, and the remaining fraction was directed to additional must treatment, $+50^0$C, final pressing and fermentation to dry raw wine.

The obtained juice samples were analysed, and ordinary juice samples were used for control. The colour palette was analysed by photo colorimeter and spectrophotometer according to confirmed methods: sum of phenolic compounds - F (Seider-Datunaşvili), content of anthocyanins - A (G. Valuico), leucoanthocyanins - L (Boiarski-Ivaniutin), colour intensity - I (Glories) and the tonality - T (OIV), the leucoanthocyanins / anthocyanins ratio – L/A (Ribereau-Gayon) and the anthocyanins / phenolic compounds ratio – A/F (Şolţ). The polymerization index was calculated: $I.P.= [(D_{520} - D_{420})/D_{420}]x100\%$.

## RESULTS AND DISCUSSIONS

The treatment of whole grapes by thermal shock with vapours at constant pressure manifests itself specifically: the temperature rises suddenly at the level of the skin (tp) and delays (hysteresis) - in the core (tm), a fact that is technologically convenient since the native product is preserved and energy saving priorities are identified because of the reduction of the selectively heated mass (skin). Thus, the index decreases between 6-12 minutes, but is on average 65%. During this time, good selective dissolution for anthocyanins 220-290 mg/dm$^3$ with a selective diffusion of over 40% is attested. The results obtained at PTS agree with the data from the specialized literature: G. Olivieri, 1981; M. Castino, 1988; G. Masson, 2001; C. Flanzy, 2004 and others who processed red grapes (Oliveri, 1981; Martiniere *et al.*, 1973; Somers and Evans, 1979). Such experiences (table 1), were carried out with various varieties of grapes, treated in the year 2021 with hot juice obtained from white varieties at temperatures of 60$^0$C and 80$^0$C, according to the above methodology, for 10 and 20 minutes each. The data presented in table 1 regarding the treatment regime at the temperature of 80$^0$C for 20 minutes demonstrates that the extraction of phenolic compounds is close to the standards (table 2). In the 4$^{th}$ variant of 20 min, even if there is the phenomenon of hysteresis, time confronts it and the intensity of the colour, the content of leucoanthocyanins and phenolic substances of the must in the 80/20 regime are clearly superior compared to the first 2 variants and the control.

*Table 1*

**The technological regime for heat treatment of grapes, red and white varieties with grape juice**

| Variety regime | Saperavi | Ametist | BC 508 | Feteasca Neagră | Alexand-rina | Augustina | Malena | Bega |
|---|---|---|---|---|---|---|---|---|
| T. of treatment,$^0$C | 60/80 | 60/80 | 60/80 | 60/80 | 60/80 | 60/80 | 60/80 | 60/80 |
| T. in the skin, $^0$C | 50 | 55 | 50 | 55 | 50 | 50 | 50 | 50 |
| T. in bac, $^0$C | 30 | 45 | 30 | 35 | 33 | 33 | 32 | 33 |
| Treatment time, min | 10/20 | 10/20 | 10/20 | 10/20 | 10/20 | 10/20 | 10/20 | 10/20 |
| Yield, % | 40 | 38.9 | 42.2 | 50 | 42.2 | 44.4 | 44.4 | 53.3 |
| Conc. of sugars, g/dm$^3$ | 180 | 207 | 127 | 234 | 119 | 138 | 164 | 204 |

From table 1 we notice that the PTS of whole grapes with black berries proceeds with increasing skin temperature, where up to 85% of colouring and aromatic substances are concentrated, at the level of 60-70$^0$C, protecting the flesh of the solid phase from high temperatures (not above of +50$^0$C), with its complex of vitamins, amino acids and enzymes necessary in the subsequent processes of juice preparation or wine maturation. The thermo plasmolysis of the skin ensures the dissolution of the pigments, the intensification of the diffusion and the improvement of the pressing, and a certain increase in the must yield.

The experimental variants were analysed physical-chemically, the indices of which are included in table 2, for the Negru de Ialoveni variety. The extract, titratable acidity, total phenolic compounds and their components leucoanthocyanins, anthocyanins were determined in the untreated red juice. The same cultivar without treatment and directly pressed served as a control. In addition, the ratio of yellow / red pigments (L/A) and the ratio of anthocyanins / sum of phenols (A/F) were calculated, which are increasing at the harsher regime, but which provide the necessary colour.

*Table 2*

**Chemical composition and quality of red (rose) juice, prepared according to the scheme PTS (2)**

| Clues physical - chemical | Negru de Ialoveni: V a r i a n t e s: 1; 2; 3; 4; | | | | |
|---|---|---|---|---|---|
| | direct press, witness | T = 60$^0$C | | T = 80$^0$C | |
| | | 10 minutes | 20 minutes | 10 minutes | 20 minutes |
| Non-reducing extract, g/dm$^3$ | 19.1 | 24.3 | 25 | 26 | 27 |
| Mass concentration of: | | | | | |
| - titratable acids, g/dm$^3$ | 8.4 | 8.7 | 8.8 | 8.8 | 8.9 |
| - phenolic substances (F), g/dm$^3$ | 0.45 | 1.0 | 1.3 | 1.3 | 1.4 |
| - leucoanthocyanins (L), mg/dm$^3$ | 85 | 160 | 180 | 180 | 210 |
| - anthocyanins (A), mg/dm$^3$ | 15 | 90 | 110 | 220 | 290 |
| L/A ratio | 5.66 | 1.77 | 1.64 | 0.82 | 0.72 |
| A/F ratio x 100, % | 3.33 | 9.0 | 8.46 | 16.9 | 19.3 |
| Colour intensity (I), 1mm | 0.33 | 0.63 | 0.7 | 0.8 | 0.86 |
| Key (T) | 0.32 | 0.52 | 0.6 | 0.9 | 0.9 |
| I.P.=[(D520D420)/D420]x100% | 150 | 84.2 | 81 | 74.2 | 70.2 |
| Tasting score, points, 10 | 7.8 | 8 | 8.3 | 8.3 | 8.4 |

It should be noted that variants 1-2 have a lower anthocyanin content, therefore, the L/A ratio and the polymerization index (I.P.) are excessive, and the tasting note - modest. Obviously, the A/F index in percentages turned out to be lower. The results of the analysis of the control juice and the first variants indicate that these, according to the content of leucoanthocyanins, phenolic substances and colourings, do not correspond to the typicality of a red juice and this regime did not accept them. So, options 3-4 with heat treatment at 80$^0$C of grapes and selection of must for red juice, followed by must for red wine in the described regime, give the possibility to calculate the following colour indices: D - optical density, I- intensity, T -tonality, Jd – wavelength, Pe – colour purity.

As a result of the experiences described, the installation for PTS, a device for heat treatment with hot must (Ferre method), tried in this experiment was proposed (Vacarciuc *et al.*, 2021). We pursued the goal of preparing a red wine-juice with indices: $d_{420}$ = 33%, $d_{520}$ = 62%, I = 0.8, T = 0.9 and Jd = 625. It is important not to allow co-pigmentation or the association of dimers with other components, the extraction of yellow carotenes from the skin and the accumulation of leucoanthocyanins and quinones through oxidation, which can decrease the amount of red cations.

The fact that phenolic substances tend to polymerize, bind with ions (metals, bisulphite, organic fractions), forming salts depending on the pH level, the presence of

oxygen and o-polyphenoloxidase, and in the semi-finished product, quinones and intermediate products accumulate that will determine the shades and tonality colour of the product. The concrete colour (yellow-red-blue fractions), are in constant change, depending on: technology, the presence of $O_2$, pH, metals, reductones, and other active organic components, in tangent with the influence of factors: variety, degree of ripening, temperature, time and the reserve of coloured substances in grapes.

## CONCLUSIONS

1. Heat treatment of whole grapes selectively acts on approximately 80% of the skin cells in the first 10-20 minutes, which ensures the diffusion of anthocyanins in proportion to 50% of the initial content.

2. The must obtained by the proposed method contains less burr, is sterile and has a higher yield;

3. The installation proposed for the treatment is mechanized, it replaces several technical units in the traditional crushing line, and it is less expensive to procure and operate.

4. In the presence of red grape varieties with a moderate reserve of phenolic substances (RSF up to 2400 mg/dm$^3$), we recommend the technological regime of PTS for whole grapes at parameters 80$^0$C/20 min as an effective method for the production of red juice.

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