Iraqi Journal of Agricultural Sciences –2026:57(4):1298-1307
P-ISSN: 0075- 0530 /E-ISSN: 2410-0862
DOI: https://doi.org/10.36103/zbr3w439

CONCENTRATION OF ORANGE JUICE BY USING ROTARY VACUUM EVAPORATOR TO PROTECT FLAVOR COMPOUNDS

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ABSTRACT

This paper is an attempt to protect the main flavor compounds in concentrated orange juice by using vacuum evaporator technique, instead of the traditional method which causes a remarkable degradation in these compounds. The physiochemical and microbial properties of juice were monitored throughout the concentration processes. Rotary evaporator technique was used at different conditions to concentrate orange juice and comparing with traditionally heat treatment. Total soluble solid (TSS), ascorbic acid, acidity, pH, viscosity and tannins have been affected by various levels according to concentration technique and period of storage. The microbial content had never developed even throughout the storage for six months, because we have added 100 ppm sodium benzoate to the fresh juice immediately after squeezing. The main flavor compounds in fresh orange juice have been monitored throughout the various concentration processes to judge their abilities for maintaining the flavor compounds of concentrated juice.

Key words: **flavor retaining, proposal technique, physiochemical properties, Total soluble solid**

Received: 11/2/2024, Accepted: 15/5/2024, Published: 30/4/2026

INTRODUCTION

Citrus fruits are the most economically relevant and extensively grown fruits in the world and are important source of secondary metabolites for nutrition, health, and industrial applications (O'Neale *et al*, 2011 Maqbool *et al*, 2023). Orange juice is the most popular juice because it has aroma, attractive flavor and color, as well as health benefits (O'Neale *et al*, 2011). Orange flavor is perhaps widely recognized and accepted in the food and beverage industry around the world (Machado *et al*, 2022). The flavor of fresh orange juice is due to complex combination of a large number of volatile compounds such as, esters, aldehydes, alcohols, ketones, and terpenes (Sadecka *et al*, 2014). Odors and flavors are the major determinants of fruit quality, but these traits are often genetically complex and difficult to score (Galili *et al*, 2002). Storage time, temperature and microbial contamination had a significant effect on the flavor of fruit juice (Perez-Cacho *et al*, 2008). It is difficult to preserve fresh orange juice due to fluctuations in temperature, exposure to light and other storage environment. At present, the quality of orange juice is mainly judged according to appearance, color, acidity and microbial detection. The aroma index is an important characteristic of citrus juice, which indicates that quality can be judged by changes in these compounds (Lubinska-Szczygieł *et al*, 2018). New concentration technologies which are currently used in the fruit juice industry have gained importance in recent years. Many of the technologies used globally come into play in improving the quality of juices. These technologies include the rotary evaporator, osmotic pressure concentration, reverse osmosis, freezing, Steam distillation (SD) and

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microwave-assisted steam distillation (MASD) and use of ultrafiltration (Assawarachan, and Noomhorm, 2011; Patil *et al*, 2025). Citrus juice's fresh and attractive aroma comes from perceptual interaction of multiple aroma compounds. Those aroma compounds of fresh citrus juice are easily changed during processing or storage. Aroma change is one of the most critical issues in citrus juice during processing and storage, which implies that the disappearance of most aroma-active compounds and the formation of off-flavor compounds in citrus juice eventually led to the formation of citrus juice off-flavor including cooked, grease, earthy, musty, plastic, pungent, medical odor. In comparison, off-flavor has a sizeable negative impact on the pleasant aroma quality of citrus juice. Therefore, molecular sensory science has raised great interest in unravelling the off-flavor compounds and their formation pathway in citrus juice. A better understanding of the off-flavor compounds in orange, mandarin, and grapefruit juice, will control the production of off-flavor compounds in the processing and storage of citrus juice. Off-flavor compounds were found in thermal, storage, light, oxygen, and other factors-induced (fruit maturity, package, diseases, centrifugal pretreatment for cloudy orange juice debittering process) citrus juices (Jia *et al*, 2022; Rodríguez, *et al*, 2017). In this study, proposal concentration processes have been suggested to retain the main flavor compounds in concentrated orange juice and their changes during storage.

MATERIALS AND METHODS

Preparation of fresh orange juice: 10 kg of local ripe orange fruits were washed, dried and squeezed by laboratory juicer. The juice was sieved to get rid of pulp and seeds, the yield is about 58.51%. 100 ppm sodium benzoate was added as preservative. The fresh juice was stored at freezing conditions.

Determination of some orange juice properties: Total Soluble solids (TSS) were determined using a manual refractometer. Ascorbic acid was estimated using 2,6-dichlorophenol indophenol as described in (Pegg, and Eitenmiller, 2017). Total acidity was determined as citric acid in fresh juice as described in (AOAC. 2016). The pH was monitored using a portable pH meter, a Chinese pH device (5231 Crison, Model GLP22, Crison Instruments S.A.) with an accuracy of ±0.05 units (Sadler, and Murphy, 2010). Viscosity was determined using a viscometer (FUNGILAB instrument model ALPHA series 101034). Tannins was determined by titration method against permanganate solution by using indigo carmine as indicator (AOAC. 2016).

Identification the main flavor compounds by GC/MS: The flavor compounds in orange juice were measured by Agilent (7820A) USA GC MASS Spectrometer at certain conditions after been extracted by dichloromethane CH_2Cl_2 (Solís-Solís *et al*, 2007).

Liquid-Liquid Extraction (LLE): Di chloromethane, was the most suitable solvent for isolating of volatile compounds in fruits and vegetables (Kelebek and Selli, 2011). The extraction method was performed by a method modified from a previously published procedure (Aubert *et al*, 2005). In a bottle, 10 mL of fruits juice and 20 µl of n-octan as surrogate standard (IS) with 1.5 mL of CH_2Cl_2 were vigorously shaken for 5 min using a Vortex mixer in order to extract the free volatile fraction. The mixture was centrifuged at 4000 rpm for 5 min (this extraction was done twice). With some modifications regarding concentrated juices. Watery phase was removed and the organic phase (CH_2Cl_2 + volatile compounds) was adjusted from 1 ml to 0.1 ml in a dry flow of nitrogen and then injected (1 µl of extract) in a GC/MS system (Solís-Solís *et al*, 2007).

GC/ MS Conditions: Analytical column: Agilent HP-5ms Ultra lenite.
injection volume 1µl, pressure 11.933 psi
GC inlet temperature: 250C°
Aux heaters temperature 300C°
Injector temperature: 250C°
Temperature ramp 160C° to 180C° 7C°/ min ramp 4 280C° hold to 3 min.

RESULTS AND DISCUSSION

Determination of Physical and Chemical Indexes: Some physicochemical properties of fresh and concentrated orange juice utilizing conventional temperature and rotary vacuum evaporator technique are shown in Table 1.

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The physicochemical properties, pH, total acidity, vitamin C, viscosity, and tannin, all showed significant variations. The degradation of vitamin C was taken as indicator to the efficiency of rotary evaporator comparing with traditional one. In general, the traditional method to concentrate orange juice (using high temperature degree) was worse than rotary evaporator method. These results are consistent with what Sarvarian found in the concentration of orange juice, as he found an increase in all physicochemical parameters proportional to the degree of concentration of the juice (Sarvarian *et al*, 2022).

Table 1. Physical and chemical parameters of fresh and concentrated orange juice using rotary vacuum evaporator and conventional heat treatment techniques

Orange Juice	TSS	pH	TA	Vit C mg\100ml	Viscosity	%Tannins mg\100g	%destroying Vit C
Fresh	11.5	3.701	0.743	56.055	0.213	280.37	------
Rotary 40C°	57	2.866	3.669	271.59	6.482	1392	10.44
Rotary 50C°	57	2.841	3.688	245.49	7.731	1397.2	28.03
Rotary 60C°	58	2.822	3.734	135.15	9.832	1413.2	57.89
Temp 60 C°	56	2.873	3.605	73.329	11.031	1365.3	77.81
Temp 80 C°	57	2.854	3.649	38.023	11.74	1424	91.94
Temp 100 C°	57	2.833	3.673	10.864	12.48	1436.4	96.23

The Effect of juice concentration method on flavor compounds: The flavor compounds were grouped into seven main chemical classes; including, terpenes, alcohols, aldehydes, esters, ketone and two types of heterocyclic aromatic compounds. Other derivatives included hydrocarbons, alkyl halides, carboxylic acids, and their derivatives. Fifty flavor compounds were detected in fresh orange juice. According to the peak areas the main flavor compounds are show in Table 2. Maccarone *et al*, (1998) found 23 volatile compounds in Italian oranges, most of these were found in Egyptian navel oranges (our sample). Perestrelo *et al*, (2019) identified 98 flavor compounds in fresh orange juice, including terpenoids, esters, alcohols, carbonyl compounds, carboxylic acids, phenols and furanic compound. Yu *et al*, (2018) identified 84 volatile compounds in blood orange. Table 2, shows that, the terpenes represent the major constituent of flavor compounds in orange juice especially, limonene, eremophylene and β-myrcene respectively. The table shows, there was a direct relationship between the temperature and the degradation percent in flavour compounds. Comparing with the conventional method to concentrate orange juice (high temperature at atmospheric conditions), the degradation by using rotary evaporation was less. The results illustrate that the rotary evaporator method maintain the major flavor compounds, these results were agreed what was found by (Elss *et al*, 2007). The limonene may convert during the heat treatment to α-terpinol and α-pinene, while the eremophylene may change to nootkatone depending on oxygen content and this was a negative contribution in orange juice quality (Rodríguez *et al*, 2017; Selli *et al*, 2004). In this study, beside limonene and α-terpinol other monoterpenes such as, α-pinene, β-myrcene, isocitral and citral were also detected in orange juice during high temperature conventional method comparing with rotary evaporation. Table 2, also illustrate disappearing of some terpenes by using high temperature treatments throughout the presence of monoterpenes isomers and hydrocarbon terpenes which was agreed with (Sadecka *et al*, 2014). The study also refers to disappearing of citral and iso citral when high temperature was used. When oxygen and high temperature were available the oxidation of terpens was taken a place, so the concentration of orange juice under vacuum conditions to some extent safer at flavor compounds as (Kumar *et al*, 2023) were mentioned.

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Table 2. Showing the percentages of flavor compounds (terpenes) in fresh orange juice and Concentrate reconstituted using rotary evaporator techniques

The flavour compounds	Fresh % of total	R40 C°	R50 C°	R60 C°	Temp 60 C°	Temp 80 C°	Temp 100 C°
Limonene	63.955	21.50	20.43	16.51	15.10	8.49	2.98
Eremophylene Naphthalene, 1,2,3,5,6,7,8,8a-octahydro-1,8a-dimethyl-7-(1-methylethenyl)-, [1S-(1α,7α,8aα)]-	9.152	7.90	5.18	4.88	4.83	3.87	2.65
Beta-Myrcene	1.434	0.56	0.50	0.43	0.38	ND	ND
4,11-selinadiene 2-Isopropenyl-4a,8-dimethyl-1,2,3,4,4a,5,6,7-octahydro naphthalene. Cubenene naphthalene, 1,2,4a,5,8,8a-hexahydro-4,7-dimethyl-1-(1-methylethyl)-.	0.793	0.50	0.42	0.37	0.34	0.25	0.22
(E)-Iso citral. Citral.	0.604	0.56	0.61	0.65	ND	ND	ND
α – pinene	0.488	0.49	0.55	0.62	0.67	0.70	0.81
(-)-beta-ElemeneCyclohexane, 1 ethenyl-1-methyl-2,4-bis(1-methylethenyl)-, [1S (1alpha.,2 beta.,4beta.)] .	0.413	0.22	0.20	0.18	0.17	0.11	ND
7-epi-alpha-selinene (2S,4aR,8aR)-4a,8-dimethyl-2-(prop-1-en-2-yl)-1,2,3,4,4a,5,6,8a-octahydronaphthalene. (-)- alpha -Panasinsen 2,2,4a,8-tetramethyl-1,2a,3,4,5,6-hexahydrocyclobuta[i]indene. Aromadendrene	0.395	0.37	0.34	0.32	0.30	0.28	0.25
(−)-Allo-Aromadendrene. 4αH-EudesmaneNaphthalene, decahydro-1,4a-dimethyl-7-(1-methylethyl)-, [1S-(1α,4aα,7α,8aβ)]-. Cedrene-V6 .	0.329	0.27	0.18	0.17	0.19	0.14	0.11

The previous papers refer to the effect of high temperature degree on flavor compounds, that it caused a series of chemical alterations, which in turn, lead to lose many aromatic compounds (such as terpenes, aldehydes and esters) and production a new abnormal flavour compounds which was affected negatively on the acceptance of the consumers (Jiménez-Sánchez *et al*, 2017; Yi *et al*, 2016). Although, the sesquiterpenes (such as cubenene and selinadiene) were more sensitive to light and temperature, but it gave low degradation percentages by using rotary evaporation method comparing with the traditional method (high temperature open system). The study shows that the degradation of such compounds like (-)-β-elemene, epi-α-selinene, (-)-α-panasinsen and aromadendrene were less affected by using rotary evaporator comparing with traditional method. The degradation percentages of (-)-allo-aromadendrene, 4αH-eudesmane and cedrene-V6 was less when rotary evaporator was used comparing with high temperature open system (conventional method).Table 3, illustrate, that the degradation percentages of some alkane compounds such as, hexadecane, heptadecan and Heneicosane, were closed to each other, whether using rotary evaporation or conventional method to concentrate orange juice, which in turn indicates that these compounds are relatively more stable. The reducing in these compounds as comparing with fresh orange juice due to convert some of them to alkyl halides or other derivatives through binding with some organic compounds

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Table 3. Showing the percentages of flavor compounds (Alkane and Halide alkyl) in fresh orange juice and concentrate reconstituted using rotary evaporator techniques

The flavour compounds	Fresh % of total	R40 C°	R50 C°	R60 C°	Temp 60 C°	Temp 80 C°	Temp 100 C°
Heneicosane, Heptadecane, Hexadecane	2.050	0.44	0.43	0.44	0.44	0.44	0.41
Heneicosane, Tetracosane, Pentacosane	1.355	0.44	0.44	0.43	0.42	0.39	0.32
Octadecane.	1.121	0.19	0.17	ND	ND	ND	ND
10-Methylnonadecane	0.745	0.23	ND	ND	ND	ND	ND
Nonadecane.	0.714	0.32	ND	ND	ND	ND	ND
3-Ethyl-3-methylheptane	0.596	0.51	ND	ND	ND	ND	ND
5-methyl-5-propylnonan	0.571	ND	ND	ND	ND	ND	ND
Nonan, 1-iodo	0.427	0.22	ND	ND	ND	ND	ND
Tetradecane, 4-methyl- Pentacosane 2-methyloctacosane	0.410	0.31	0.24	0.19	0.19	0.17	0.12
Octadecane, 3-ethyl-5-(2-ethylbutyl)	0.369	0.28	0.19	0.15	ND	ND	ND
Tritetracontane Hexacosane Heneicosane, 11-(1-ethylpropyl)-	0.362	0.31	0.27	0.26	ND	ND	ND
Hentriacontane	0.300	ND	ND	ND	ND	ND	ND
Eicosane Heneicosane 2-Bromotetradecane	0.293	0.27	0.25	0.21	0.28	0.25	0.16
Tetradecane Hexadecane	0.260	0.24	0.21	0.14	0.095	0.055	0.043
Octacosane Hentriacontane	0.259	ND	ND	ND	ND	ND	ND
Decane, 4-ethyl	0.241	0.23	0.21	0.21	0.20	0.17	0.13

Heneicosane, tetracosane and pentacosane were records high degradation percentages at high temperature treatment which was associated what was found by (Perez-Cacho, and Rouseff, 2008). In general, the effect of rotary evaporator technique to concentrate orange juice has less damage at flavor compounds comparing with the traditional one. The reducing in flavor compounds when rotary evaporator has been used may due to the vacuum effect which may exhausted the most volatile compounds in fresh orange juice (Perestrelo *et al*, 2019). Table 4, shows the percentages of some carboxylic acids and esters in fresh orange juice and concentrated after reconstituted by using both rotary evaporator and traditional methods. As shown the degradation percentages of n-hexadecanoic acid pentadecanoic acid were 3.96, 16.16 and 18.42% by using rotary evaporator at 40, 50 and 60°C respectively. The degradation percentages of both compounds were more, 19.19 and 16.44% at 60 and 80°C, but a rebuilding was shown at 100°C for these two compounds. At high temperature degree, such as 100°C, an increase was observed in carboxylic acid percentage, this may due to the hydrolysis or oxidation of some compounds (such as esters and aldehydes) under the conditions of the experiment (Jiménez-Sánchez *et al*, 2017; Perez-Cacho *et al*, 2008; Yi *et al*, 2016).

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Table 4. Showing the percentages of flavor compounds (Carboxylic acid and esters) in fresh orange juice and concentrate reconstituted using rotary evaporator techniques

The flavour compounds	Fresh % of total	R40 C°	R50 C°	R60 C°	Temp 60 C°	Temp 80 C°	Temp 100 C°
n-Hexadecanoic acid, Pentadecanoic acid	1.819	1.747	1.525	1.484	1.47	1.52	1.88
1,2-Dipalmitine: Hexadecanoic acid, 1-(hydroxymethyl)-1,2-ethanediyl ester.							
Hexa decanoic acid, 2-hydroxy-1-(hydroxymethyl) ethyl ester.	1.256	0.28	0.18	0.15	ND	ND	ND
Phthalic acid, 3-methylbutyl Nona decyl ester.	0.579	ND	ND	ND	ND	ND	ND
Phthalic acid, 4,4-dimethylpent-2-yl octadecyl ester							
Phthalic acid, hexyl tridecyl ester.							
9-Hexadecenoic acid, methyl ester, (Z)	0.569	0.28	0.21	0.18	ND	ND	ND
Methyl palmitate Hexadecenoic acid, methyl ester	0.453	0.28	0.19	0.13	ND	ND	ND
Hexanoic acid, 3-hydroxy-, ethyl ester.	0.439	0.19	0.14	ND	ND	ND	ND
Butane dioic acid, hydroxy-, diethyl ester.							
Sulfurous acid, hexyl octyl ester.	0.427	0.22	ND	ND	ND	ND	ND
Methyl petroselinate 6-Octadecenoic acid, methyl ester, (Z)-.	0.318	0.30	0.24	0.21	ND	ND	ND

Previous research has confirmed that these thermal treatments easily induced a series of chemical changes, which leads to the loss of many characteristic aroma-active compounds (mainly terpenes, aldehydes, and esters) and the production of new off-flavor compounds (mainly terpenes degradants, sulfur-containing compounds, phenols, acids, and others) (Table 4), subsequently, reducing the consumer acceptability (Jiménez-Sánchez *et al*, 2017; Perez-Cacho *et al*, 2008; Yi *et al*, 2016). As shown in Table 4, the rotary evaporator technique was maintaining the content of many flavour compounds comparing with the traditional method (high temperature) such as, Hexadecanoic acid, 1-(hydroxymethyl)-1,2-ethanediyl ester, 2-hydroxy-1-(hydroxymethyl) ethyl ester, 9-Hexadecenoic acid, methyl ester, Methyl palmitate hexadecenoic acid, methyl ester, methyl petroselinate 6-Octadecenoic acid methyl ester. Table 5, show the percentages of aldehydes, alcohols, ketones and some amines and amides. Some of these compounds were disappear or interact with other organic compounds, especially, at high temperature degrees, which in turn, illustrate the highly sensitive of these compounds. The rotary evaporator technique gave less degradation due to low temperature and to some extent the absence of oxygen. The percentages of 2-piperidinone, N- [4-bromo- n- butyl] degradation by using rotary evaporator were less comparing with conventional method, which explain the ability of rotary evaporator to maintain flavor compounds. The vacuum condition which reduces the oxygen availability inhibits the oxidation reaction. Similar results were shown with 12-Methyl-E, E-2,13-octadecadien-1-ol compounds, the degradation effect was more by using high temperature degrees (traditional method) and free oxygen. The heat treatment easily leads to chemical degradation and building up new adopted flavor compounds, which may badly affect the original flavor (Mastello *et al*, 2015; Vervoort *et al*, 2012). Many previous papers referred to the presence of d-carvone and α-terpinol which derived from limonene dissociation throughout heat treatment under acidic conditions (Bi *et al*, 2020; Wibowo *et al*, 2015; Cheng *et al*, 2022).

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Table 5. Showing the percentages of flavor compounds (alcohol, ketone, aldehyde and others) in fresh orange juice and concentrate reconstituted using rotary evaporator technology

Compound	Fresh % of total	R40 C°	R50 C°	R60 C°	Temp 60 C°	Temp 80 C°	Temp 100 C°
N-Methyl-3-piperdinecarboxamide. Octanal	1.464	ND	ND	ND	ND	ND	ND
2-pyridinemethanamine	1.434	0.56	0.50	0.33	0.23	ND	ND
2-Piperidinone, N-[4-bromo-n-butyl]	1.429	0.96	0.72	0.41	0.38	0.36	0.23
1,3,2-Dioxaborolane, 4,4-dimetyl-5-oxo-,2-ethyl.	1.256	0.28	0.18	0.15	ND	ND	ND
1,2-15,16-Diepoxyhexadecane.	0.793	0.14	ND	ND	ND	ND	ND
12-Methyl-E, E-2,13-octadecadien-1-ol	0.760	0.30	0.25	0.25	0.23	0.20	0.17
1H-Tetrazole-1-ethanol, 5-amino- 1-Dodecanol, 2-octyl-	0.555	ND	ND	ND	ND	ND	ND
2-Hexyl-1-decanol.	0.389	0.22	0.19	0.12	ND	ND	ND
Anethole	0.337	ND	ND	ND	ND	ND	ND
2-Dodecen-1-yl (-) succinic anhydride. Octa decanal	0.318	0.28	0.23	0.21	ND	ND	ND
3,5-di-terButyl-4-hydroxybenzaldehyde	0.280	ND	ND	ND	ND	ND	ND
1-Cyclohexene, 1,3,3-trimethyl-2-(1-methylbut-1-en-3-on-1-yl). Pyrido(4,3-d) pyrimidine-2,4(1H,3H)-dione, 1,3-dimethyl-.	0.261	ND	ND	ND	ND	ND	ND

CONCLUSION

GC-MS has identified about 50 taste constituents in fresh orange juice. The main flavor components of concentrated and fresh orange juice include esters, monoterpenes, sesquiterpenes, and limonene. According to the study, there were notable variations in the flavor components between the concentrated orange juice made with a rotary vacuum evaporator and the fresh orange juice. In concentrated orange juice, new taste molecules have been found, particularly when high temperatures are applied. The paper also discusses how difficult it is to protect taste molecules against degrading factors.

ACKNOWLEDGEMENT

We extend our sincere thanks to the Department of Food Science and the Faculty of Agricultural Sciences Engineering for their valuable contributions to the advancement of scientific research and academic excellence.

CONFLICT OF INTEREST

The authors declare that they have no conflicts of interest.

AUTHOR/S DECLARATION

We confirm that all Figures and Tables in the manuscript are original to us. Additionally, any Figures and images that do not belong to us have been incorporated with the required permissions for re-publication, which are included with the manuscript.

Author/s signature on Ethical Approval Statement.

Ethical Clearance and Animal welfare

Funds:

AUTHOR'S CONTRIBUTION STATEMENT

Mohamed Subhi Khattab and Tariq Nasser Musa were responsible for designing the study. All experiments under study were conducted by Mohamed. S. Khattab. The simulation and discussion were conducted by Mohamed. S. Khattab and Tariq N. Musa. They were responsible for expressing all the flavor compounds mentioned in the research. The data analysis was conducted by Mohamed S. Khattab using Agilent GC-MS analysis in the Ministry of Science and Technology with the assistance of BSc Hatem Al-Shuhail. All manuscripts and data were discussed with some specialists.

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P-ISSN: 0075- 0530 /E-ISSN: 2410-0862
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Iraqi Journal of Agricultural Sciences –2026:57(4):1298-1307
P-ISSN: 0075- 0530 /E-ISSN: 2410-0862
DOI: https://doi.org/10.36103/zbr3w439

تركيز عصير البرتقال باستعمال تقنية المبخر الدوار المفرغ لحماية مركبات النكهة

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المستخلص

إن البحث الحالي هو محاولة لحماية مركبات النكهة الرئيسية في عصير البرتقال المركز باستعمال تقنية المبخر الدوار بدلا من الطريقة التقليدية التي تسبب تحطم ملحوظ بتلك المركبات. تمت مراقبة الخواص الكيمياوية والميكروبية للعصير خلال عمليات التركيز. تم استعمال تقنية المبخر الدوار تحت ظروف مختلفة لتركيز العصير ومقارنة ذلك بالطريقة التقليدية التي تستعمل فيها حرارة عالية. تمت مراقبة المواد الصلبة الكلية، حامض السكوربك، الحموضة، الرقم الهيدروجيني، اللزوجة والتانينات إذ أنها تأثرت بمستويات مختلفة بحسب تقنية التركيز المستعملة. لم يتطور المحتوى الميكروبي خلال عمليات الخزن لمدة ستة أشهر بسبب إضافة 100 جزء بالمليون من مادة بنزوات الصوديوم كمادة حافظة بعد عملية العصر مباشرة. تمت مراقبة مركبات النكهة الرئيسية في عصير البرتقال الطازج خلال عمليات التركيز المختلفة للحكم على قابليتها في الحفاظ على مركبات النكهة في العصير المركز.

الكلمات المفتاحية: الكلمات المفتاحية: المواد الصلبة الكلية، التقنية المقترحة، الخواص الفيزيوكيميائية، استرجاع النكهة.