OPEN ACCESS
Potravinarstvo® Scientific Journal for Food Industry
Crossref Similarity Check Powered by iThenticate

potravinárstvo®

Potravinarstvo, vol. 10, 2016, no. 1, p. 469-474
doi:10.5219/575
Received: 14 December 2015. Accepted: 6 April 2016.
Available online: 16 October 2016 at www.potravinarstvo.com

ISSN 1337-0960 (online)
License: CC BY 3.0

SCIENTIFIC BASIS OF USE OF FRUITS *CORIANDRUM SATIVUM* L. IN FOOD TECHNOLOGIES

Natalia Frolova, Olga Korablova

ABSTRACT

Today in the world recognized the need for environmentally friendly products for a healthy food and quality life. Products with natural ingredients, including flavoring become very popular. Coriander is one of herbs that functions as both, spice as well as herbal medicine. *Coriandrum sativum* L. is a major aromatic crop in Ukraine. The plants of Coriandrum sativum contain the essential oils and other compounds in the seeds and leaves and have an important role as flavorings. The main objective was to investigate possibility effective utilization of coriander essential oil in national economy of Ukraine. It was necessary to study the chemical compounds of coriander fruits by instrumental analysis and odor by sensory analysis with following creating new aroma compositions. Search had been carried out throughout 2009 – 2014 years. The aerial parts of aromatic plants were harvested at the plots of National Botanical Garden of National Academy of the Sciences of Ukraine. Essential oil was obtained by hydro distillation procedure in National University of food technology. Main and specific components of essential oils from seeds coriander were characterized. Qualitative structure of essential oils was determined by the gas-liquid chromatography method on the chromatograph Agilent Technologies 6890 with mass-spectrometric detector 5973. The run of components was done using Device of Fractional Distillation. Linalool, limonene, geranyl acetate, d-camphor, myrcene and geraniol were found as the major components. In the composition of essential oils each component has its own flavor, the combination of which determines the flavor of the oil. We investigated the possibility of target separation of essential oils of coriander fruits into fractions of different flavor. The article presents the results of research sequential processing fruits *Coriandrum sativum* to obtain a series of natural flavors. Principles and laws of the vacuum distillation were used for directional control of the process distillation of complex mixtures of hydrocarbons on the distillation column. Mode of selection process the fractionation of essential oils allowed changing the component composition of the fractions and to provide more variety of flavors. Monitoring of the fractioning process allows concentrating the key aromatic components and receiving highly concentrated flavors of original pure notes. Combinations of the individual fractions with a specific weight have been created. We obtained some fractions which can be used as flavorings in food industries. Highly concentrated flavor "Coriander fragrance" was developed with fraction № 3 of essential oil coriander. "Coriander fragrance" can be used instead of the aromatic spirits of coriander seeds in liquors and spirits production for producing bitters, liquors and other drinks, e.g. vodkas "Gorilka", "Chernihivska", "Starokyivska". The flavors "Coriander fragrance" was used in processing for "Lollipop" candies, vodka special "Captain", dessert drink "Married couple".

Keywords: *Coriandrum sativum*; distillation; essential oil; fraction; flavor

INTRODUCTION

Today in the whole world there is an urge for a healthy and quality life. Due to this fact, products with natural components, including aromatic ones, are becoming more popular. As a result, the demand for the products with natural flavors is constantly increasing. Coriander (*Coriandrum sativum* L.), a member of the *Apiaceae* family, is among most widely used plant, possessing nutritional as well as medicinal properties. Many species of this genus can be used by medical practitioners and like as flavour of the food products.

The sources for natural flavor substances are aromaticand essential oil crops. The main essential oil crop in Ukraine is *Coriandrum sativum L.*, it occupies up to 80% of space for essential-oil plants, extensively cultivated in India, Russia, Central Europe, in some countries of Asia and Africa. So as essential oils and others flavors in food stuffs are used in small dozes, very important is exact to know their chemical compound at drawing up of compounding. From fruits of *Coriandrum sativum* 1,2% of essential oil, 17% of fatty oil and 65% of oilseed meal, which is a valuable source of secondary raw materials, are obtained. The leaves and fruits are highly fragrant and contain nutrients like fat, proteins, vitamins, minerals etc. Essential oil of *Coriandrum sativum* contains basic "key" components with floral geraniol and herbal linaloolflavors. Oil contains a significant quantity of these components, and they have a wide interval of boiling points. Wide physiological properties of oil should be noted **(Matasyoh et al., 2009)**.

In Ukraine coriander is among most widely used medicinal and food plant. The leaves, seeds Coriandrum sativum and essential oils from them used as a spice for food industry. The dried fruits are extensively employed in Ukraine as a condiment, especially for flavouring of sauces and marinades, meat and fish products, bakery and confectionery items **(Korablova and Rakhmetov, 2012)**.

Research of **Peter (2004)** supports that some of these foods, as part of an overall healthful diet, have the potential to delay the onset of many age-related diseases, so there is urgent need to explore the role of these compounds. Coriander leaves are used as parsley like garnish with a fresh fragrance that is vital in, soups, and meat dishes because these are rich in vitamin A, B2 (riboflavin), C and dietary fiber. Salads are incredibly beneficial for weight conscious persons due to their lofty vitamins and fiber contents. The dried seeds contribute to pleasantly aromatic spice that is much used in stews, cuisine, sweet breads, sausages and cakes**.**

There is experience of using of seeds and essential oil *Coriandrum sativum* in different areas of industry **(Khan and Abourashed, 2011)** and medicine **(Garnik et al., 2003)**. An essential oil from leaves and fruits *C. sativum* L. showed biological, antifungal and antimicrobial activity **(Soares et al., 2012; Delaquis et al., 2002; Mandal and Mandal, 2015; Petrová et al., 2015)**, anti-hyperglycemic and diuretic activity **(Bhat, 2014)**.

We took into consideration the experience of medicine, perfume and cosmetic industry regarding fractional distillation of complex organoleptic blends, including those of natural origins **(Patent no. 20100197801, 2013)**.

Such actions are directed to purposefully single out one or several components as a source of flavor, or derivative valuable biologically active components of medicaments, or prophylactic remedies **(Krichkovskaya et al., 2008; Roshina, 2010; Brindza et al., 2013)**. In food productions, this technological method has not been used before.

Fruit and vegetable processing industry is very important for Ukraine regarding both the internal and the external market. The main objective was to investigate possibility effective utilisation of coriander essential oil in national economy of Ukraine. It was necessary to study the chemical compounds of coriander fruits by instrumental analysis and odor by sensory analysis with following creating new aroma compositions.

MATERIAL AND METHODOLOGY

In the researches, there was used tree samples of the aromatic raw material collected in Kyiv region in 2008 – 2012 on the plots of National Botanical Garden named after N. N. Gryshko. The samples of *Coriandrum sativum* were examined according to the branch standards methods **(DSTU 4654: 2006)** upon the organoleptic and physical-chemical indications.

Essential oil from freshly ground coriander was allocated by distillation method **(Bondarenko, 2010)**.

The ground materials (200 g) were placed in a 1000 mL round bottom flask containing 250 mL distilled water to which two drops of antifoam were added.

The device also consisted a fridge, an essential oil catcher, and a bain-marie with saturated solution of calcium chloride. The contents were subjected to distillation for 2 h. The collected essential oil was dried over anhydrous Na_2SO_4.

Qualitative structure of essential oils was determined by the gas-liquid chromatography method on the chromatograph Agilent Technologies 6890 with mass-spectrometric detector 5973. The chromatographic column is capillary INNOWAX with an internal diameter of 0.25 mm and length of 30 m. The gas-carrier's speed (helium) is 1.2 $mL.min^{-1}$. Temperature of the thermostat was linearly programmed from 50 to 250 ºC with speed 4 $ºC.min^{-1}$. For identification of components there was used a library of mass-specters NIST 05 and WILEY 2007 with a general quantity of specters more than 470000 combined with the programs for identification AMDIS and NIST **(NIST/EPA/NIH 1994)**. The identification of the components under study was made at the mass-specters and component's retention times.

Fractioning of essential oil *Coriandrum sativum* was performed on a pilot universal automatic facility – DFD (Device of Fractional Distillation). This chromatographic method of investigation was developed in the research laboratory of the National University of Food Technologies **(Frolova et al., 2004)**. Short technical description: column type – three-section; number of real plates, pcs – 20; number of side-bars, pcs – 3; diameter of refractive part, mm – 30; head type – full condensation; regulation of the reflux ratio and temperature in a cube - from the control unit; control of temperature – automatic. Facility elements are made of inert material – heat-resistant glass produced by Simex.

RESULTS AND DISCUSSION

In the laboratory conditions, using water distillation on granulated fruitage of *Coriandrum sativum* there were received samples of essential oil. The research results of the quality indicators of essential oil *Coriandrum sativum* were compared with the basic norms (Table 1).

Obviously, the quality indicators of essential oil of Coriandrum sativum not exceed base values. Number of substandard and cracked fruit and mericarps was less permissible on the 24% and 22%. The dynamics of process distillation of essential oil was studied using the method of fractional distilled.

There was conducted fixing of the essential oil and by-products outflow during certain periods of time. Further, the outflow of essential oil on every distillation stage was calculated compared to its total output in each experiment (Table 2). After completion of the distillation 13.49% of the essential oil left in distilled water and 0.73% was irretrievably lost. Quality indicators of the received samples were checked for conformity with normative documents of Ukraine and are presented in Table 3.

The investigated qualitative composition and the mass

Table 1 Quality indicators of *Coriandrum sativum* fruits (%).

Quality indicator	Norms of quality indicators	Investigation results
Humidity	13.0	10.8 ±0.05
Waste	2.0	1.5 ±0.01
Substandard fruits and mericarps	10.0	7.6 ±0.05
Cracked mericarps	15.0	11.7 ±0.05
Admixtures of other aromatic plants	Is not acceptable	Not detected

Table 2 Material balance of receiving the *Coriandrum sativum* essential oil in the laboratory experiment.

Loaded			
Name of the raw material	**Mass (g)**	**Essential oil**	
		Content (%)	**Mass in the raw material (g)**
Ripe fruits of Coriandrum sativum	200	0.52	1.04

Received				
Name of the product	**Volume (mL)**	**Essential oil**		
		Content (%)	**Mass (g)**	**Outflow (%)**
Essential oil of *Coriandrum sativum*	-	-	0.890	85.78
Distilled water	1815.00	0.005	0.097	9.36
Depleted material	385.00	0.011	0.043	4.13
Irretrievable losses	-	-	0.008	0.73

Table 3 Physical-chemical index of quality of essential oil *Coriandrum sativum*.

External appearance	**Thickness at 20 °C ($g.cm^{-3}$)**	**Deflection indicator at 20 °C**	**Acid index (mg KOH) not more**	**Scent**
Yellow easily moveable liquid	0.870	1.460	1.35	Savory, fragrant with a floral tone

Table 4 Composition of essential oil *Coriandrum sativum.*

Reference compound	**Contents in essential oil (%)**	**Reference compound**	**Contents in essential oil (%)**
β- pinene	7.04 ±0.05	linalool	67.30 ±005
camphen	1.30 ±0.02	d- camphor	2.90 ±0.02
myrcene	2.49 ±0.03	linalylacetate	0.22 ±0.01
limonene	3.13 ±0.05	l-borneol	0.13 ±0.01
1,8-cineole	10.56 ±0.05	δ-terpineol	0.32 ±0.02
β-phellandrene	0.25 ±0.01	geraniol	1.42 ±0.05
n-cymene	0.17 ±0.05	geranilacetate	2.90 ±0.05

Table 5 Modes of fractionation of essential oil *Coriandrum sativum.*

No of fraction	**Temperature (°C)**			**Reflux ratio**	**Pressure (kPa)**
	In the cube	**In the column**	**Distillation waters**		
First	85…91	57…59	29…32	1:7	1.97
Second	90…94	57…66	33…49	1:8	1.32
Third	94…97	66…79	54…58	1:10	1.32
Fourth	97–114	79–94	60–76	1:10	1.32
Distillation residue	122				0.92

ratio of the components of the samples of essential oil *Coriandrum sativum* are shown in Table 4.

Modes of fractional distillation were based upon theoretical calculations, according to which the essential oil was considered as a sum of binary mixtures **(Ukrainec' and Frolova, 2009)**. Model calculations were adequately coordinated with the results of real distillations. The optimized operating modes of distillation of essential oil Coriandrum sativum are listed in Table 5.

On the results of distillations 4 fractions and a distillation residue were received. Alternately, as the accumulation process is going on, all fractions are collected in sealed glass capacities. In Table 6 the material balance of the essential oil distillation in DFD (Device of Fractional Distillation) is shown (calculated as 3.5 kg per 1 charge).

Changing thecontent of essential oil components in the different fractions has a significant effect on the sensory characteristics of odor, because each component has its original flavor and odor. The major descriptors of *Coriandrum sativum* odor were pleasant, herbal, green, cooling, earthy, rose-like, sweet and floral aroma with turpentine note.

Table 6 Material balance distillation of coriander essential oil with DFD.

Loaded		Received		
Name	**Weight (kg)**	**Name of the received product**	**Product weight**	
			kg	**% from initial.**
Essential oil Coriandrum sativum	3.5	Fraction 1	0.184	5.30
		Fraction 2	0.252	7.20
		Fraction 3	0.400	11.40
		Fraction 4	2.118	61.20
		Distillation residue	0.441	12.50
		Losses	0.105	2.40

Table 7 The composition of fractions essential oil of *Coriandrum sativum*.

No of fractions	Blend composition of fractions	Aromatic properties
Essential oil of *Coriandrum sativum*		Yellow liquid with a savory floral note
1	α -pinene, camphene, myrcene	Liquid of intense yellow color with a pine note
2	β –phellandrene, n–cimol, d-limonene	Liquid of intense yellow color with a well scented lemon note
3	borneol, camphor	Liquid of yellow color with a sharp camphoraceous scent
4	l-linalool, linalyl acetate	Liquid of slightly yellow color with a specific note of lily of the valley
Distillation residue	terpineol, geraniol, geranylacetat	Liquid of slightly yellow color with a rose fragrance

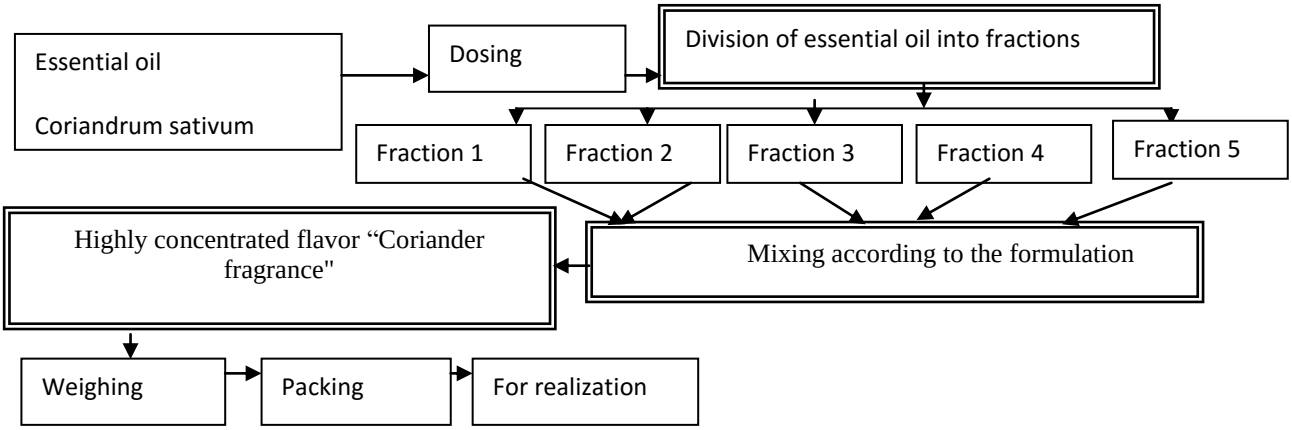

Figure 1 The scheme of receiving a highly concentrated flavor "Coriander fragrance".

Table 8 Organoleptic indicators of special vodka "Captain".

Indicator	Value
External appearance	Transparent liquid
Color	Colorless
Taste	Warm, a bit savory, typical of vodka
Scent	Harmonious accord of honey with field flowers

The given data show that the outflow of the fractions constitutes 97.6% from the initial raw material. Losses are estimated at 2.4% (incomplete capture of essential low-boiling components, losses occurring during column flooding). From each fraction, after thorough mixing, the average sample of the product was selected. A qualitative composition was defined in it by means of gas chromatography, and aromatic properties – by generally accepted and standardized methods (State standard 2729-94) (Table 7).

Descriptors and reference compounds were used for sensory profiling of essential oil.

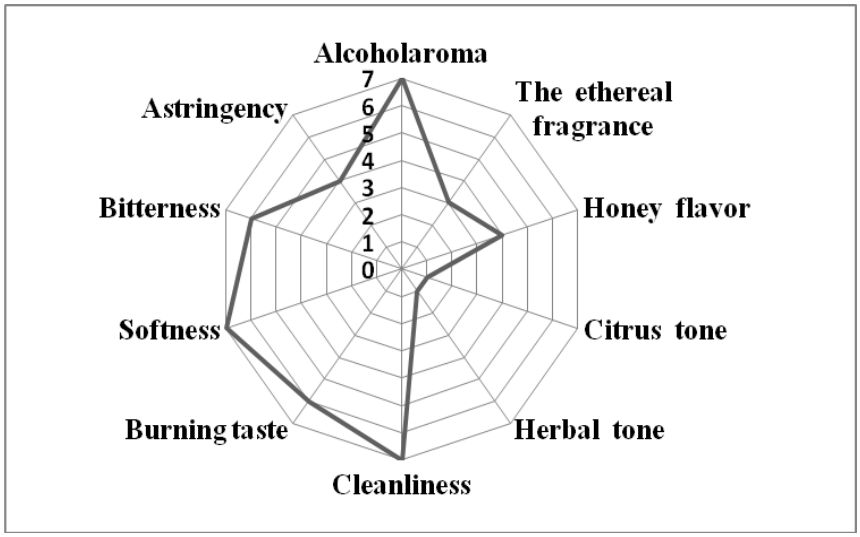

Figure 2 Sensory profilogram of flavor vodka special "Captain".

Every received fraction of *Coriandrum* essential oil is an independent highly concentrated natural flavor agent with stable physicochemical characteristics. It should be noted that changing the process modes leads to changes in the fraction structure.

Besides that, fractioning allows to exclude from fraction constitution those components that worsen organoleptic, physical, chemical and functional properties of a flavor including solubility in liquid mediums, and the expiration date. It is harder to single out such components using other methods **(Sarker et al., 2005)**.

It is advised to use fraction 3 of essential oil *Coriandrum sativum* for "Lollipop" candies with original savory scent. Besides a nice taste and scent, lollipops are advised to be used for prophylaxis of bronchial diseases. The formulation of aromatic component of "Lollipop" candies consists of 10% alcohol solvent: 3 fractions of coriander essential oil – 59%; 3 fractions of fennel essential oil – 29%; 4 fractions of cat mint essential oil – 6%; 2 fractions of clary sage essential oil – 6%.

During the development of flavor for non-alcoholic drinks of immunostimulatory action with a harmonious flavor of lemon floral tone, 10% alcohol solution components were used: 4 fractions of coriander essential oil – 62%; 3 fractions of fennel essential oil – 31%; 5 fractions of cat mint essential oil – 6%.

Apart from receiving flavored products that have formulations which involve fractions of various essential oils, model combining of fractions of essential oil *Coriandrum sativum* was used, and as a result there was developed a formulation of a highly concentrated flavor – "Coriander fragrance".

The scheme of receiving the flavoring is shown in Figure 1.

To receive flavor "Coriander fragrance" fractions of essential oil Coriandrum sativum were mixed in the following quantities, g: the first fraction – 0.81 g, the second one – 1.7 g, the third fraction – 4.37 g, the fourth fraction – 36.61 g, the fifth fraction – 1.70 g, which corresponds to the mass ratio 1:2:3:4=1.0 : 2.1 : 5.4 : 44.4 : 2.1.

The flavor "Coriander fragrance" is a slightly yellow liquid with a specific pure scent of coriander. Floral, rose-like, pleasant, green, herbal, cooling, earthy, spicy, sweet and were the major descriptors of coriander aroma.

The developed flavor can be advised for usage in the production of vodka, brandy, whisky, rum, and other strong alcoholic as well as low alcoholic and non-alcoholic drinks. "Coriander fragrance" can be used instead of the aromatic spirits of coriander seeds in liquors and spirits production for producing bitters, liquors, and other drinks, e.g. "Gorilka", "Chernihivska", "Starokyivska".

Together with a team of authors there was developed a formulation of special vodka "Captain" **(Patent Ukrainy. *Gorilka osoblyva «Kapitan*, 2011)** which by its aromatic palette has a harmonious combination of a honey citrus scent with the fragrance of field flowers.

In table 8 the quality characteristics of vodka "Captain" are shown.

In the formulation, a composition of flavors "Coriander fragrance" and "Fennel - elite fragrance" are used (1.6 : 0.9).

Adding of orange and star-anise essential oils creates a taste impression of an exotic citrus (1.63 : 0.10). Orange oil can be substituted with aromatic spirit, and star-anise essential oil - with the anise one. The expiration date of the drink is 6 months.

Figure 2 shows the sensory profilogram of flavor vodka special "Captain".

Dessert drink "Married couple" is made by mixing rectified ethyl spirit of the highest cleaning, drinking water, citric acid, sugar in the form of 65,8% sugar syrup, apple fortified juice, flavors, lemon essential oil **(**State Intellectual Property Service of Ukraine **Patent of Ukraine. *Napii desertnii «Podruzhzhya»*)**.

CONCLUSION

Coriandrum sativum fruits are the main industrial essential-oil raw material in Ukraine.Its consecutive processing by means of physical procedures into the essential oil, aromatic fractions extenda natural flavors assortment of a savory floral note.Monitoring of the fractioning process allows concentrating the key aromatic components and receiving highly concentrated flavors of original pure notes.Results of the study indicate the possibility to combine the components of the fractions for use in the product to provide the desired flavor notes.The flavors not only give products a special scent, but also are

characterized by the orientation of the physiological action; saturation, and improved stability.Application flavour enables to expand assortment of developed products to improve them tasting properties.

REFERENCES

Bedi, S., Tanuja, Vyas, S. P. 2010. *A handbook of aromatic and essential oil plants (Cultivation, chemistry, processing and uses)*. Jodhpur : Agrobios, 598 p. ISBN 8177543415 / ISBN 13: 9788177543414.

Bhat, S., Kaushal, P., Kaur, M., Sharma, H. K. 2014. Coriander (*Coriandrum sativum* L.): Processing, nutritional and functional aspects. *African Journal of Plant Science*, vol. 8, no. 1, p. 25-33. http://dx.doi.org/10.5897/AJPS2013.1118

Bondarenko, E. Y. 2010. *Improving the technology of processing fruits coriander by steam distillation method using physicochemical methods* : dissertation theses. Krasnodar, Russia: Kuban State University of Technology. 26 p.

Brindza, J., Kucelová, L., Sinica, A., Stehlíková, B., Brindza, J., Kucelová, L., Sinica, A., Stehlíková, B., Čuláková, M. 2013. Morphological, biochemical and sensory characteristics of black mulberry fruits (*Morus nigra* L.), *Potravinarstvo*, vol. 7, no. 1, p. 36-44. http://dx.doi.org/10.5219/234

Chernogorod, L. B., Vinogradov, B. A. 2006. Essential oils of some species of the genus *Achillea* L., containing fragranol. *Plant resources*, vol. 42, no. 2, p. 61-68.

Delaquis, P. J., Stanish, K., Girard, B., Mazza, G. 2002. Antimicrobial activity of individual and mixed fractions of dill, cilantro, coriander and eucalyptus essential oils. *International Journal of Food Microbiology*, vol. 74, no. 1-2, p. 101-109. http://dx.doi.org/10.1016/S0168-1605(01)00734-6

DSTU 4654: 2006. *Oliya efirna koriandrova – Requirements.*

DSTU 2729-1994. *Essential oils and products of essential oil production – Requirements.*

Frolova, N. E., Usenko, V. O., Chepel', N. V., Kubrak, T. V. 2004. Development of method of chromatographic analysis of essential oils with using capillary columns. *Harchova promislovist'*, vol. 3, p. 80-82.

Garnik, T. P., Dudchenko, L. G., Shuraeva, T. K., Barsukov, A. V. 2003. Medical-biological aspects using of essential oils. *Fitoterapiya. Chasopis*, vol. 1-2, p. 52-55.

Khan, I. A., Abourashed, E. A. 2010. *Leung's encyclopedia of common natural ingredients: used in food, drugs and cosmetics*. 3rd ed. Hoboken, New Jersey : John Wiley and Sons, 845 p. ISBN 978-0-471-46743-46744.

Korablova, O. A., Rahmetov, D. B. 2012. *Useful plants in Ukraine. From the introduction to using.* Kyiv : Fitosociocentr. 171 p. ISBN 978-966-306-160-2.

Krichkovskaya, L. V., Chernyshov, S. I., Donchenko, G. V., Zhukov, V. I., Staroverov, V. N., Naumenko, E. N. 2008. The biologically active oils and products based on them (essential oils, carotenoids, and others.). Biology. Biochemistry. Application. Methods for determination. Harkov : Model' Vselennoi. 267 p. ISBN 978-966-7875-26-8.

Mandal, S., Mandal, M. 2015. Coriander (*Coriandrum sativum* L.) essential oil: Chemistry and biological activity. *Asian Pacific Journal of Tropical Biomedicine*, vol. 5, no. 6, p. 421-428. http://dx.doi.org/10.1016/j.apjtb.2015.04.001

Matasyoh, J. C., Maiyo, Z. C., Ngure, R. M., Chepkorir, R. 2009. Chemical composition and antimicrobial activity of the essential oil of *Coriandrum sativum*. *Food Chemistry*, vol. 113, no. 2, p. 526-529. http://dx.doi.org/10.1016/j.foodchem.2008.07.097

Nadeem, M, Anjum, F. M., Khan, M. I., Tehseen, S., El-Ghorab, A., Sultan, J. I. 2013. Nutritional and medicinal aspects of coriander (*Coriandrum sativum* L.). *British Food Journal*, vol. 115, no. 5, p. 743-755. http://dx.doi.org/10.1108/00070701311331526

NIST/EPA/NIH Mass Spectral Data Base. 1994. PC Version 4.5, U.S. Gaithersburg, MD. *Natural Products Isolation, Methods in Biotechnology*. 2006. vol. 20, 2 nd ed. Edited by: S. D. Sarker, Z. Latif, and A. I. Gray. Totowa, NJ : Humana Press Inc., p. 529. ISBN-1-59259-955-9.

Peter, K. V. 2004. *Hand Book of Herbs and Spices.* Cambridge : CRC Press,Woodhead Publishing Ltd. vol. 2, 360 p. ISBN: 978-0-85709-039-3.

Petrová, J., Terentjeva, M., Puchalski, C., Hutková, J., Kántor, A., Mellen, M., Čuboň, J., Haščík, P., Kluz, M., Kordiaka, R., Kunová, S., Kačániová, M. 2015. Application of Lavender and Rosemary essential oils improvement of the microbiological quality of chicken quarters. *Potravinarstvo*, vol. 9, no. 1, p. 530-537. http://dx.doi.org/10.5219/550

Roschina, N. N. 2010. Applied aspects of using of essential oils and terpenes in food. *Vestnik Altaiskogo gos. tehn. un-ta*, vol. 38, p. 387.

Soares, B. V., Morais, S. M., Fontenelle, R. O. S., Queiroz, V. A., Vila-Nova, N. S., Pereira, C. M. C., Brito, E. S., Neto, M. A. S., Brito, E. H. S., Cavalcante, C. S. P., Castelo-Branco, D. S. C. M., Rocha, M. F. G. 2012. Antifungal activity, toxicity and chemical composition of the essential oil of *Coriandrum sativum* L. fruits. *Molecules*, vol. 17, no. 7, p. 8439-8448. http://dx.doi.org/10.3390/molecules17078439 PMid:22785271

State Intellectual Property Service of Ukraine. *Gorilka osoblyva «Kapitan»*. Patent owner: National university of food technology. MPK C12 G3/06. Ukraine. Patent no. 93835. 2011-03-10.

State Intellectual Property Service of Ukraine. *Napii desertnii «Podruzhzhya».* Patent owner: National university of food technology. MPK C12 G3/00. Ukraine. Patent no. 56195. 2011-01-10.

McLafferty, F. W., Stauffer, D. B. 1989. *The Wiley/NBS Registry of mass spectral data.* New York: John Wiley & Sons.

Ukrainec', A. I., Frolova, N. E. 2009. The theoretical justification settings fractional distillation of essential oils. *Harchova Nauka i Tehnologiya*, vol. 2, no. 7, p. 54-58.

US Patent and Trademark Office. Volatile distillate by-product of mint oil that promotes absorption and/or bioavailability of compounds of bio-medical and nutritional interest. Patent owner: Finley, J. W., Finley, J. W., Mezine, I., Kehrer, J. M., Justice, R. J., Int. Cl. A61K31/122. US. Patent no. 20100197801, 2009-10-28.

Contact address:

doc. Natalia Frolova, PhD., National University of food technology, department technology of a food production for a healthy diet, Volodymyrska 68, 01601 Kyiv, Ukraine, Tel.: +38 044 2879333, E-mail: nef1956@mail.ru.

doc. Olga Korablova, PhD., M. M. Grishko National Botanical Gardens of Ukraine National Academy of Sciences, department of a new cultures, Timiryazevska 1, 01014 Kyiv, Ukraine, Tel.: +38 067 913 78 60, E-mail: okorableva@mail.ru.