ТЕХНОЛОГІЯ ВИРОБНИЦТВА І ПЕРЕРОБКИ ПРОДУКЦІЇ ТВАРИННИЦТВА

UDC 638.178.2-138

PAPAVER RHOEAS L. BEE POLLEN

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Abstract. *The aim of our research was to establish morphological and spectrometric characteristics, the content of phenolic compounds and the antioxidant activity of P. rhoeas bee pollen. Samples of monofloral and polyfloral bee pollen were collected in districts of the Kiev region (Ukraine) in the summer period of 2016 with the help of hinged pollen traps. Botanical origin, monoflorality, level formation and morphological parameters of pollen lumps were determined in the laboratory of the Department Horse Breeding and Beekeeping of the National University of Life and Environmental Sciences of Ukraine. Spectrometric parameters and antioxidant activity of P. rhoeas bee pollen were investigated in the laboratory of the Institute of Biodiversity Conservation and Biosafety of the Slovak University of Agriculture in Nitra. Biochemical analyzes were carried out in the laboratory of the Department of Storing and Processing of Plant Products of the Slovak University of Agriculture in Nitra. P. rhoeas bee pollen morphological parameters were established: length – 3,31 ± 0,033 mm; width – 2,97 ± 0,044 mm; weight – 9,87 ± 0,25 mg. Purity P. rhoeas monofloral bee pollen are in the range from 85 to 91 %. Polyfloral bee pollen always less than 80 % P. rhoeas pollen loads, and on average, in polyfloral collection pollen gets 38 %. P. rhoeas bee pollen of the color parameters were determined for its botanical identification. Specular Component Excluded method with illuminants D65/10° and A/10° respectively: L* –33,88 ± 0,25 and 33,91 ± 0,25; a* – 0,04 ± 0,07 and 0,14 ± 0,12; b* – 4,42 ± 0,13 and 4,45 ± 0,12; C* – 4,43 ± 0,13 and 4,47 ± 0,11; h° – 89,34 ± 0,87 and 88,01 ± 1,68. Specular Component Included method with illuminants D65/10° and A/10° respectively: L* – 41,09 ± 0,13 and 41,11 ± 0,13; a* – -0,04 ± 0,03 and 0,03 ± 0,08; b* – 3,28 ± 0,07 and 3,31 ± 0,07; C* – 3,29 ± 0,07 and 3,32 ± 0,07; h° – 90,76 ± 0,56 and*

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89,4 ±1,39. Heterogeneous pollen grains in bee pollen are confirmed by the results of each measurement of P. rhoeas monofloral bee pollens, which show one over one lines on Spectral Plot. The antioxidant activity of P. rhoeas bee pollen in aqueous and alcoholic solutions were 68,61 ± 6,712 % and 55,80 ± 1,492 %, respectively. The content of phenolic compounds is 419,16 ± 9,356 mg TEAC/g; phenolic acids – 2,40 ± 0,052 mg CAE/g; polyphenols – 16,47 ± 0,339 mg GAE/g; flavonoids – 13,34 ± 1.533 mg QE/g.

Keywords: bee pollen, Papaver rhoeas, monoflorality, spectrometry, antioxidants, phenolic compounds

Introduction. Use of bee pollen in the food, pharmaceutical and medicine industries causes the need for in-depth research of morphological and spectrometric parameters for interspecific product identification and further determination of its biochemical and microbiological characteristics. The popularization of functional nutrition forces manufacturers to review the requirements for quality and safety of products, improve technologies, environmentally friendly production and processing.

Analysis of recent researches and publications. The most scientific information and study of the species *Papaver rhoeas* L. its characteristics as a harmful weed in the crops of agricultural plants [11, 12, 14]. However, due to the considerable distribution of this species on meadows, forests and animal wings, *P. rhoeas* is gaining importance as polliniferous plant. Scientists also convinced of the effectiveness of using *P. rhoeas* as a drug substance. It has been established that seed of the species contains readine, protopin, papaver rubin, A, B, C, D, E, regenine, isoregenin, isoradin, allocriptopin, coridine, stylopine, isocoridine, berberine and other alkaloids; sitosterol, higher aliphatic alcohols and fatty acids, anthocyanins, pectin, iron salts and magnesium [10, 18].

P. rhoeas anatomical and morphological features of peduncle and self-incompatibility pollen of plant were studied [17, 19, 20]. Detailed studies were of pollen grains of this species. Thus, M. Cresti, C. Milanesi, P., Salvatici и A. C. Aelst, (1990) point to such features of mature pollen grains – «The mature pollen grain of Papaver rhoeas is bicellular. The vegetative cell contains numerous mitochondria; endoplasmic reticulum is not very extensive and there are few ribosomes and plastids. Golgi bodies are in a very active state. The generative cell is lobed and spindle-shaped. The cytoplasm contains many, generally longitudinally arranged, bundles of microtubules. Other organelles are few in number, and include mitochondria, Golgi bodies and short cisternae of endoplasmic reticulum» [8]. P. rhoeas pollen grains morphological features had been studied earlierly. Shape was defined elliptic in the polar view and circular in the equatorial view (Al-Quaran, 2010). According to others, shape is circular in the polar view, lobate in the dry pollen (PalDat). Exine sculpture was scabrate, verrucate, psilate, perforate. Length of polar axis – 39,7 μm, length of equatorial axis – 28,4 μm [5, 15]. Given that the P. rhoeas vegetable raw material is valuable for the pharmaceutical industry, so it will be relevant to investigate bee pollen. It is known [6, 7, 9], that bee pollen has a high content of biologically active substances depending on its botanical origin. Recently,

researchers have established the morphological structure of pollen lumps: weight – 10,11 mg, height – 2,86 mm, width – 2,45 mm [5].

Scientists have presented a lot of results on biologically active compounds in polyfloral bee pollen [5, 6], however, monofloral pollen informations is very few. Comparing monofloral bee pollen from other plant species met the following data. Determined [21], 75 wt. % ethanol/water extracts of *Schisandra chinensis* (Turcz.) Baill., *Brassica napus* L., *Phellodendron amurense* Rupr., *Prunus armeniaca* L. and *Taraxacum officinale* L. monofloral bee pollen had stronger antioxidant activities. And *Prunus armeniaca* L., Camellia spp. and *Helianthus annuus* L. monofloral bee pollen presented excellent tyrosinase inhibitory activities. *Prunus armeniaca* L. pollen exhibits both powerful antioxidant and strong tyrosinase inhibitory activities.

Other scientists have established the antioxidant properties of examined plant species were different and decreasing in the following order: *Brassica napus* subsp. *napus* L. > *Papaver somniferum* L. > *Helianthus annuus* L. Before that we were identified specific features of bee pollen with *Corylus avellana* L., *Salix* spp., *Acer* spp., *Brassica napus* L. [3, 4, 13, 16]. However, questions remain insufficiently studied morphological and biochemical characteristics of *P. rhoeas* monofloral bee pollen.

The purpose of research was to establish morphological and spectrometric characteristics, the content of phenolic compounds and the antioxidant activity of *P. rhoeas* bee pollen.

Materials and methods. *P. rhoeas* bee pollen was taken from locations in Kiev region in the summer period 2016. Bee pollen is selected by outer pollen traps of bee colonies from local populations. Monoflorality ratio of total bee pollen collection was determined by using percentage of *P. rhoeas* pollen lumps to all other [2].

Botanical origin of bee pollen was installed by using pollen analysis [2].

Morphological features of bee pollen were defined in the laboratory of Institute Biodiversity Conservation and Biosafety, Slovak University of Agriculture in Nitra. Weight of individual pollen lumps was determined by using analytical scales ANG 100C (Axis). Length and width of bee pollen were measured with software Ascension Waves Vision on photos of pollen lumps from electron microscope Zeiss SteREO Discovery V20. Color of bee pollen was determined by construct CIEL*a*b* color space model by using spectrometry devices at Nicolet 6700 FT-IR Spectrometer and Lovibond SP62 S/N 044929. Used SCE (Specular Component Excluded) and SCI (Specular Component Included) methods. Bee pollen shaping level was determined by method, which was developed at the Department of beekeeping NULES of Ukraine [1].

The content of phenolic compounds and antioxidant activity of bee pollen were determined using standardized methods on the equipment laboratory of Institute Biodiversity Conservation and Biosafety, Slovak University of Agriculture in Nitra. Obtained numeric data were subjected to the statistical analysis.

Results and discussion. Dimensions of the length and width of pollen lumps were determined from the average sample of *P. rhoeas* bee pollen (n = 30). The length was in the range from 2,9 to 3,77 mm and averaged 3,31 ± 0,033 mm. The correlation coefficient of 7,15 % indicated a low degree of variability of this feature ($C_v \leq 10$ %). The width of the pollen lobes was in the range from 2,26 to 3,47 mm, averaged 2,97 ± 0,044 mm. The correlation coefficient of 10,6 %, indicates the average degree of variability of this feature ($C_v \geq 10$ %). Can be assumed that of the pollen load width depends on the level of formation bee pollen and may vary depending on filling capacity of pollen collection basket on bee`s leg. In contrast, the length is stable and depends on the length of pollen collection basket on bee`s leg.

In general, we can state that for *P. rhoeas* bee pollen the average size of pollen loads is 3,31 mm in length and 2,97 mm in width (fig. 1).

Determine the weight of one pollen load from the average sample of *P. rhoeas* bee pollen (n = 50). This indicator was in the range from 6,7 to 13,7 mg, average it was 9,87 ± 0,25 mg. The coefficient of variation was 18,3 %, which indicates a high degree of variability ($C_v \geq 10$ %). The scope of the data average weight means different density of formation of pollen loads by bees. And consequently, it affects the different concentrations of nutrients in bee pollen, influencing the biochemical characteristics of the product. As a result of the visual assessment, it was found that the color of *P. rhoeas* monofloral bee pollen from was different depending on the collection period. Probably this was due to falling into pollen lumps of pollen of other plant species. The percentage of monoflority were determined in bee pollen collected samples using pollen analysis (fig. 2).

Purity *P. rhoeas* monofloral bee pollen are in the range from 85 to 91 %. Polyfloral bee pollen always less than 80 % *P. rhoeas* pollen loads, and on average, in polyfloral collection pollen gets 38 %.

Color of bee pollen was determined the means of color perception by using the parameters: lightness (L*); the ratio from green to red color (a*); the ratio from blue color to yellow (b*); relative saturation (C*); hue angle (h°) (tab. 1).

According to research results of color model parameters with different methods (Specular Component Excluded and Specular Component Included) using the standard illuminant (D65/10°) and typical illuminant (A/10°), the averaged data were received spectrometric parameters, which later can be used for identification of *P. rhoeas* bee pollen. The difference in monoflority of the studied samples of bee pollen shows Report Color Plot and Report Spectral Plot (fig. 3–4).

Fig. 1. The shape level and morphological parameters bee pollen lumps of Papaver rhoeas L. (a – morphometric measurements and scale of pollen shape level; b – diversity of bee pollen; c – width of pollen lump; d – length of pollen lump, 1-5 – levels of shaping)

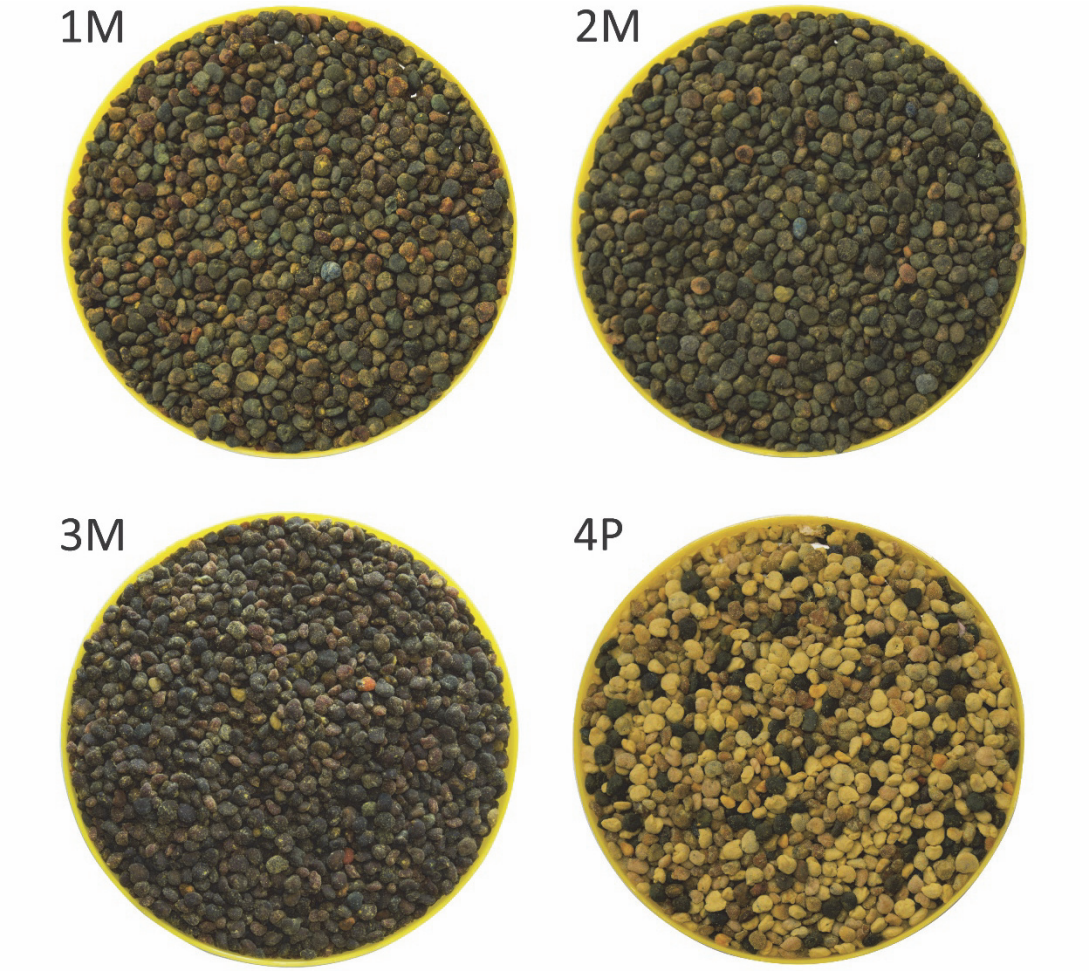

Fig. 2. Samples bee pollen: 1M – monofloral (sample № 2, 18–12 June, 87 % – P. rhoeas, 13 % – others spices); 2M – monofloral (sample № 10, 19–25 June, 85 % – P. rhoeas, 15 % – others spices); 3M – monofloral (sample № 58, 7–10 July, 91 % – P. rhoeas, 9 % – others spices); 4P – polyfloral (sample № 15, 19–25 June, 38 % – P. rhoeas, 62 % – others spices)

Going one by one lines by *P. rhoeas* monofloral bee pollen Spectral Plot, which show the results of each measurement there is evidence heterogeneous pollen grains in bee pollen. That, pollen loads of bee pollen contain only *P. rhoeas* pollen grains. On Color Plot reflected square identification of the color of bee pollen in the color model CIEL*a*b* color space.

After confirmation of monoflority *P. rhoeas* bee pollen, determined the content of biologically active substances. Namely, antioxidant activity of water and methanol solution (%); phenolic acids (mg CAE/g) and phenolic compounds with phosphomolybdenic method (mg TEAC/g); polyphenols (mg GAE/g) and flavonoids (mg QE/g) (tab. 2).

It was found that in the water solution, the antioxidant activity of *P. rhoeas* bee pollen was higher by 12,81 % compared to methanol. Total content of phenolic compounds using phosphomolybdenic method was on average 419,16 ± 9,356 mg TEAC/g. Of these, phenolic acids were 2,40 ± 0,052 mg CAE/g and polyphenols 16,47 ± 0,339 mg GAE/g. Contents flavonoids was 13,34 ± 1,533 mg QE/g.

1. *P. rhoeas* bee pollen spectrometric parameters (*n* = 10)

Indicator	Spectrometric parameter				
	L*	a*	b*	C*	h°
Primary Illuminant D65/10°, SCI method					
Min	40,41	-0,19	2,95	2,95	87,73
Max	41,75	0,12	3,65	3,65	93,19
$X \pm Sx$	41,09 ± 0,13	-0,04 ± 0,03	3,28 ± 0,07	3,29 ± 0,07	90,76 ± 0,56
δ	0,42	0,103	0,23	0,23	1,76
C_v (%)	1,03	-232,003	6,99	7,01	1,95
Primary Illuminant D65/10°, SCE method					
Min	32,49	-0,26	3,64	3,65	85,11
Max	35,11	0,36	4,96	4,97	93,14
$X \pm Sx$	33,88 ± 0,25	0,04 ± 0,07	4,42 ± 0,13	4,43 ± 0,13	89,34 ± 0,87
δ	0,79	0,22	0,42	0,42	2,76
C_v (%)	2,33	515,79	9,51	9,503	3,09
Primary Illuminant A/10°, SCI method					
Min	40,41	-0,19	2,95	2,95	77,84
Max	41,75	0,71	3,65	3,65	93,19
$X \pm Sx$	41,11 ± 0,13	0,03 ± 0,08	3,31 ± 0,07	3,32 ± 0,07	89,4 ±1,39
δ	0,41	0,26	0,22	0,22	4,43
C_v (%)	1,005	763,99	6,57	6,58	4,95
Primary Illuminant A/10°, SCE method					
Min	32,49	-0,26	3,95	4,02	75,0055
Max	35,11	1,06	4,96	4,97	93,14
$X \pm Sx$	33,91 ± 0,25	0,14 ± 0,12	4,45 ± 0,12	4,47 ± 0,11	88,01 ± 1,68
δ	0,78	0,39	0,37	0,35	5,33
C_v (%)	2,29	284,45	8,22	7,75	6,05

Notation. X – arithmetic mean; Sx – error of a measurement; Max, Min – maximum, minimum value sample; Cv – coefficient of variation; δ – standard deviation; L – lightness; a – the ratio from green to red color; b – the ratio from blue color to yellow; C – relative saturation; h° – hue angle; Primary Illuminant D65/10° – is a commonly used standard illuminant defined by the International Commission on Illumination; Primary Illuminant A/10° - is intended to represent typical, domestic, tungsten-filament lighting; SCE – Specular Component Excluded method; SCI – Specular Component Included method

2. *P. rhoeas* bee pollen biologically active substances (*n* = 3)

№	Indicator	Value, $X \pm Sx$
1	Antioxidant activity of water solution, %	68,61 ± 6,712
2	Antioxidant activity of methanol solution,%	55,80 ± 1,492
3	Phenolic compounds with phosphomolybdenic method, mg TEAC/g	419,16 ± 9,356
4	Polyphenols, mg GAE/g	16,47 ± 0,339
5	Flavonoids, mg QE/g	13,34 ± 1,533
6	Phenolic acids, mg CAE/g	2,40 ± 0,052

Notation. TEAC – trolox equivalent antioxidant capacity; GAE – gallic acid equivalent; CAE – caffeic acid equivalent.

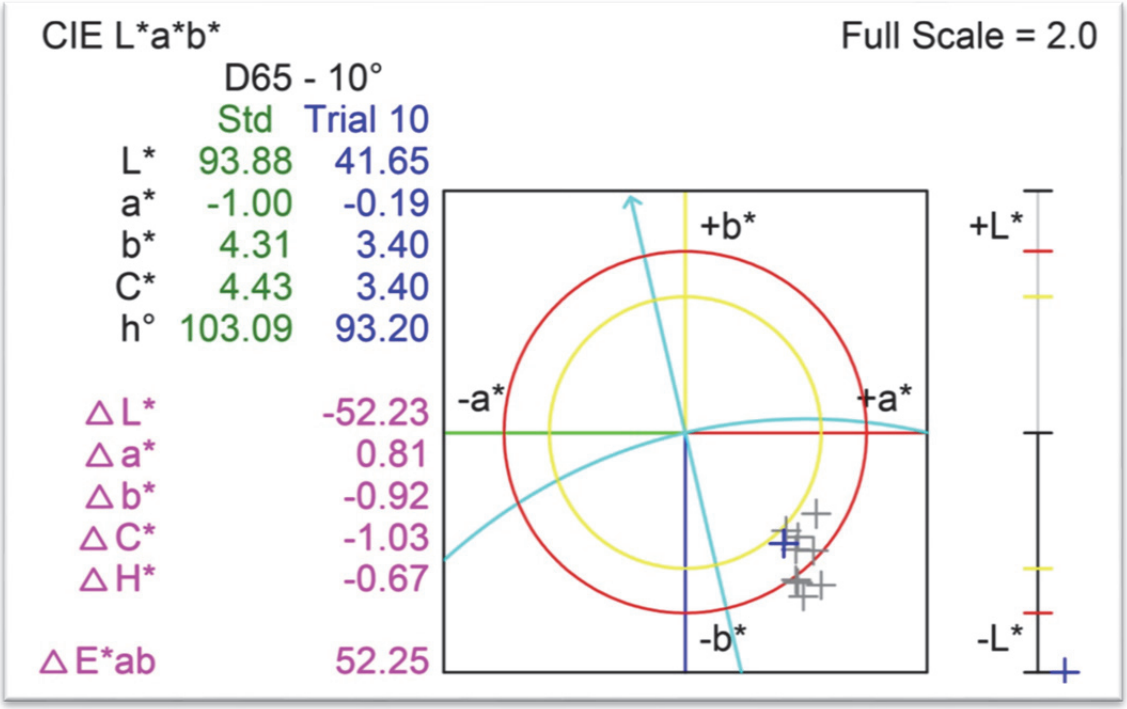

Fig. 3. *P. hoeas* monofloral bee pollen Report Color Plot (*n* = 10)

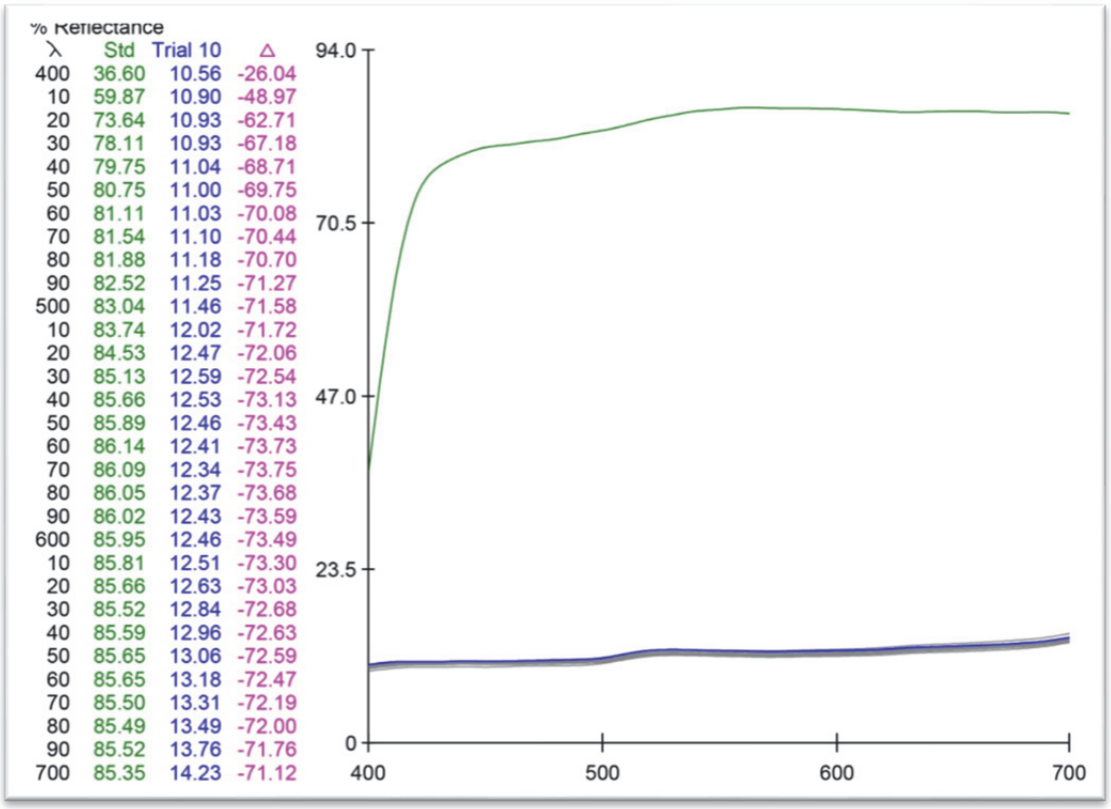

Fig. 4. *P. rhoeas* monofloral bee pollen Report Spectral Plot (*n* = 10)

Conclusions. *P. rhoeas.* bee pollen loads morphometric parameter are length 3,31 ± 0,033 mm, width 2,97 ± 0,044 mm and weight 9,87 ± 0,25 mg. Purity *P. rhoeas* monofloral bee pollen are in the range from 85 to 91 %. Polyfloral bee pollen always less than 80 % *P. rhoeas* pollen loads, and on average, in polyfloral collection pollen gets 38 %.

The color parameters of *P. rhoeas* bee pollen for its botanical identification have been investigated. Specular Component Excluded method with illuminants D65/10° and A/10° respectively: L* –33,88 ± 0,25 and 33,91 ± 0,25; a* – 0,04 ± 0,07 and 0,14 ± 0,12; b* – 4,42 ± 0,13 and 4,45 ± 0,12; C* – 4,43 ± 0,13 and 4,47 ± 0,11; h° – 89,34 ± 0,87 and 88,01 ± 1,68. Specular Component Included method with illuminants D65/10° and A/10° respectively: L* – 41,09 ± 0,13 and 41,11 ± 0,13; a* – -0,04 ± 0,03 and 0,03 ± 0,08; b* – 3,28 ± 0,07 and 3,31 ± 0,07; C* – 3,29 ± 0,07 and 3,32 ± 0,07; h° – 90,76 ± 0,56 and 89,4 ±1,39.

Heterogeneous pollen grains in bee pollen are confirmed by the results of each measurement of *P. rhoeas* monofloral bee pollens, which show one over one lines on Spectral Plot.

Antioxidant activity of *P. rhoeas* bee pollen in water and methanol solution were 68,61 ± 6,712 and 55,80 ± 1,492 % respectively. The content of phenolic compounds is 419,16 ± 9,356 mg TEAC/g; phenolic acids – 2,40 ± 0,052 mg CAE/g; polyphenols – 16,47 ± 0,339 mg GAE/g; flavonoids – 13,34 ± 1.533 mg QE/g.

Acknowledgement. The publication was prepared with the active participation of researchers involved in the International network AgroBioNet of the Institutions and researchers for realization of research, education and development program «Agrobiodiversity for improving nutrition, health and life quality», TRIVE (ITMS 26110230085) and within the project ITEBIO (ITMS 26220220115). Co-author Leonora Adamchuk thanks the Ministry of Education, Science, Research and Sport of the Slovak Republic and Slovak Academic Information Agency for scholarship and research internships, during which were got the results and knowledge presented in this paper.

References

1. Adamchuk, L. A. (2013). Sformirovannost – pokazatel kachestva obnozhki [Level of formation as an indicator of the quality of bee pollen]. Beekeeping, 6, 56–57.

2. Adamchuk, L. O. (2013). Klasyfikatsiini oznaky bdzholynoho obnizhzhia [Classifications bee pollen]. Livestock Ukraine, 5, 16–21.

3. Adamchuk, L. O., Akulonok, O. I. (2016). Morfolohichni osoblyvosti bdzholynoho obnizhzhia z Salix L. [Morphological features bee pollen Salix L.] Scientific Herald of NULES of Ukraine. Series: Technology of Production and Processing of Products of Stock-Raising, 2, 105–113.

4. Adamchuk, L., Samoilenko, V., Nikolaieva, N. (2016). Morphological characteristics of *Corylus avellana* L. bee pollen. Scientific Herald of NULES of Ukraine. Series: Technology of Production and Processing of Products of Stock-Raising, 2, 47–51.

5. Brindza, J. Brovarskyi, V. ed. (2013). Pollen and bee pollen of some plant species. Korsunskiyvidavnichiy dim «Vsesvit», 137.

6. Brovarskij, V., Brindza, J. ed. (2010). Včelí obnôžkový peľ [Bee pollen]. Kyiv–Nitra, FOP I. S. Maidachenko, 290.

7. Brovarskyi, V. D, Holovetskyi, I. I., Losiev, O. M., Velychko, S. M., Adamchuk, L. O., Stepaniuk, M. M. (2009). Bdzholyne obnizhzhia, vyrobnytstvo ta zberihanni [Bee Pollen: Production and Storage]. Kyiv, FOP I. S. Madanchenko, 76.

8. Cresti, M., Milanesi, C., Salvatici, P., Aelst, A. (1990). Ultrastructural observations of *Papaver rhoeas* mature pollen grains. Plant Biology, 103(4),349–354.

9. Fatrcová-Šramková, K., Nôžková, J., Kačániová, M., Máriássyová, M., Rovná K., Stričík M. (2013). Antioxidant and antimicrobial properties of monofloral bee pollen. Journal of Environmental Science and Health, 48, 2, 133–138. doi.org/10.1080/03601234.2013.727664

10. Konoplya, N. I., Perepechay, A. A., Zherdeva, E. A. (2016). Vozmozhnyie perspektivyi ispolzovaniya vidov adventivnogo komponenta floryi [Possible prospects for using the advective species of the flora of Lugansk]. New and non-traditional plants and prospects for their use, 12, 424–426.

11. Kyryliuk, V. P. (2009). Vplyv system osnovnoho obrobitku gruntu na zabur'ianenist posiviv horokhu [Influence of systems of basic cultivation of soil on the obliquity of pea crops]. Collection of scientific works of NSC "Institute of Agriculture of UAAS", 3, 28–36.

12. Makukh, Ia. P., Zemlin, M. I., Marushak, O. V. (2000). Bur'iany u zerno-buriakovykh sivozminakh Lisostepu [Weeds in crop grain and beet rotation of Forest-Steppe]. Collection of scientific works of the Institute of Sugar beet UAAS, 3, 207–211.

13. Novytska, A., Adamchuk, L., Nikolaieva, N. (2016). Acer L. bee pollen morphological features. Scientific Herald of NULES of Ukraine. Series: Technology of Production and Processing of Products of Stock-Raising, 2, 147–157.

14. Okazova, Z. P. (2015). Vredonosnost sornyih rasteniy posevov ozimoy pshenitsyi v lesostepnoy zone Severnogo Kavkaza [Harmfulness of weed plants of winter wheat crops in the forest-steppe zone of the North Caucasus]. Modern problems of science and education, 2–2, 829–835.

15. PalDat – Palynological Database an online publication on recent pollen. Available at: https://www.paldat.org/pub/Papaver_rhoeas/301710

16. Redina, N. M., Adamchuk, L. O., Nikolaieva, N. V., Brindza, J. (2016). Morphological characteristics of bee pollen obtained from *Brassica napus* L. Scientific herald of Lviv National University of Veterinary Medicine and Biotechnology named after SZ Gzhytsky, 18, 2 (68), 73–79.

17. Semenova, E. F., Cheburaeva, A. N., Vilkova, I. A., Morozkina, N. A., Presnyakova, E. V. (2011). Anatomo-morfologicheskie osobennosti tsvetonosov maka snotvornogo *Papaver somniferumx* i maka-samoseyki *P. rhoeasy* [Anatomico-morphological features of peduncles poppy sedative *Papaver somniferumx* and wild poppy *P. rhoeasy*]. Scientific bulletins of the Belgorod State University, 9 (104), 15(2), 152–158.

18. Semenova, E. F., Melnikov, V. L., Presnyakova, E. V., Zhukova, N. G., Osadcha, G. A., Fadeeva, T. M., Vilkova, I. A., Morozkina, N. A., Mitrofanova, N. N, Pravosudova, N. A., Mitina, E. E. (2008). Mikrobiologicheskie issledovaniya semyan i plodov nekotoryih lekarstvennyih kultur [Microbiological studies of seeds and fruits of certain medicinal crops]. News of higher educational institutions. The Volga region. Medical sciences, 2, 26–37.

19. Straatman, K. R., Dove, S. K., Holdaway-Clarke, T., Hepler, P. K., Kunkel, J. G., Franklin-Tong, V. E. (2001). Calcium signalling in pollen of *Papaver rhoeas* undergoing the self-incompatibility (SI) response. Sexual Plant Reproduction, 14, 1–2, 105–110.

20. Thomas, S. G. Franklin-Tong, V. E. (2004). Self-incompatibility triggers programmed cell death in Papaver pollen. Nature, London, 429, 6989, 305–314.

21. Zhang, H., Wang, X., Wang, K., Li, C. (2015). Antioxidant and tyrosinase inhibitory properties of aqueous ethanol extracts from monofloral bee pollen, Journal of Apicultural Science, 59, 1, 119–128.

БДЖОЛИНЕ ОБНІЖЖЯ З *PAPAVER RHOEAS* L.

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Анотація. *Метою наших досліджень було встановити морфологічні і спектрометричні характеристики, вміст фенольних сполук та антиоксидантну активність бджолиного обніжжя з P. rhoeas. Зразки монофлорного і поліфлорного бджолиного обніжжя були зібрані в районах Київської області (Україна) в літній період 2016 року за допомогою навісних пилковловлювачів. Ботанічне походження, монофлорность, сформованість і морфологічні параметри пилкових грудочок визначали в лабораторії кафедри конярства і бджільництва Національного університету біоресурсів і природокористування України. Спектрометричні параметри і антиоксидантну активність бджолиного обніжжя з P. rhoeas досліджували в лабораторії Інституту охорони біорізноманіття і біологічної безпеки Словацького аграрного університету в Нітрі. Біохімічні аналізи проводили в лабораторії кафедри зберігання та переробки рослинних продуктів Словацького аграрного університету в Нітрі. Встановили морфологічні параметри пилкової грудочки бджолиного обніжжя з P. rhoeas: довжина – 3,31 ± 0,033 мм, ширина – 2,97 ± 0,044 мм; маса – 9,87 ± 0,25 мг. Чистота монофлорного бджолиного обніжжя з P. rhoeas знаходилася в межах від 85 до 91 %. Поліфлорне бджолине обніжжя завжди містило менше 80 % пилкових грудочок з P. rhoeas; в середньому у поліфлорному зборі обніжжя, пилкові грудочки з P. rhoeas траплялись у кількості 38 %. Визначили параметри кольору P. rhoeas бджолиного обніжжя для його ботанічної ідентифікації. Методом вимірювань з виключенням дзеркальної складової з освітлювачами D65/10° і A/10° відповідно: L* –33,88 ± 0,25 і 33,91 ± 0,25; a* – 0,04 ± 0,07 і 0,14 ± 0,12; b* – 4,42 ± 0,13 і 4,45 ± 0,12; C* – 4,43 ± 0,13 і 4,47 ± 0,11; h° – 89,34 ± 0,87 і 88,01 ± 1,68. Методом вимірювань із врахуванням дзеркальної складової з освітлювачами D65/10° і A/10° відповідно: L* – 41,09 ± 0,13і 41,11 ± 0,13; a* – -0,04 ± 0,03 і 0,03 ± 0,08; b* – 3,28 ± 0,07 і 3,31 ± 0,07; C* – 3,29 ± 0,07 і 3,32 ± 0,07; h° – 90,76 ± 0,56 і 89,4 ±1,39. Накладання одна на одну ліній, які показують результати кожного вимірювання монофлорного бджолиного обніжжя з P. rhoeas на спектральному графіку свідчить про гетерогенність пилкових грудочок. Антиоксидантна активність бджолиного обніжжя з P. rhoeas у водному і*

спиртовому розчинах становить 68,61 ± 6,712 % і 55,80 ± 1,492 % відповідно. Вміст фенольних сполук – 419,16 ± 9,356 мг TEAC / г; фенольних кислот – 2,40 ± 0,052 мг CAE / г; поліфенолів – 16,47 ± 0,339 мг GAE / г; флавоноїдів – 13,34 ± 1,533 мг QE / г.

Ключові слова: бджолине обніжжя, Papaver rhoeas, монофлорність, спектрометрія, антиоксиданти, фенольні сполуки

ПЧЕЛИНАЯ ОБНОЖКА С *PAPAVER RHOEAS* L.

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Аннотация. *Целью наших исследований было установить морфологические и спектрометрические характеристики, содержание фенольных соединений и антиоксидантной активностью пчелиной обножки с P. rhoeas. Образцы монофлорной и полифлорной пчелиной обножки были собраны в районах Киевской области (Украина) в летний период 2016 года с помощью навесных пыльцеулавливателей. Ботаническое происхождение, монофлорность, сформированность и морфологические параметры пыльцевых комочков определяли в лаборатории кафедры коневодства и пчеловодства Национального университета биоресурсов и природопользования Украины. Спектрометрические параметры и антиоксидантную активность пчелиной обножки с P. rhoeas исследовали в лаборатории Института охраны биоразнообразия и биологической безопасности Словацкого аграрного университета в Нитре. Биохимические анализы проводили в лаборатории кафедры хранения и переработки растительных продуктов Словацкого аграрного университета в Нитре. Установили морфологические параметры пыльцевых комочков пчелиной обножки с P. rhoeas: длина – 3,31 ± 0,033 мм, ширина – 2,97 ± 0,044 мм; масса – 9,87 ± 0,25 мг. Чистота монофлорного пчелиной обножки с P. rhoeas находилась в пределах от 85 до 91 %. Полифлорная пчелиная обножка всегда содержала менее 80 % пыльцевых комочков с P. rhoeas; в среднем в полифлорном сборе обножки пыльцевые комочки с P. rhoeas встречались в количестве 38 %. Определили параметры цвета P. rhoeas пчелиной обножки для его ботанической идентификации. Методом измерений с исключением зеркальной составляющей с осветителями D65/10° и A/10°, соответственно: L* – 33,88 ± 0,25 и 33,91 ± 0,25; a* – 0,04 ± 0,07 и 0,14 ± 0,12; b* – 4,42 ± 0,13 и 4,45 ± 0,12; C* – 4,43 ± 0,13 и 4,47 ± 0,11; h° – 89,34 ± 0,87 и 88,01 ± 1,68. Методом измерений с учетом зеркальной составляющей с осветителями D65/10° и A/10°, соответственно: L * – 41,09 ± 0,13 и 41,11 ± 0,13; a* – - 0,04 ± 0,03 и 0,03 ± 0,08; b* – 3,28 ± 0,07 и 3,31 ± 0,07; C* – 3,29 ± 0,07 и 3,32 ± 0,07; h° – 90,76 ± 0,56 и 89,4 ± 1,39. Наложение друг на друга линий, которые показывают результаты каждого измерения монофлорной пчелиной обножки с P. rhoeas на*

спектральном графике свидетельствует о гетерогенности пыльцевых комочков. Антиоксидантная активность пчелиной обножки с P. rhoeas в водном и спиртовом растворах составляет 68,61 ± 6,712 % и 55,80 ± 1,492 % соответственно. Содержание фенольных соединений – 419,16 ± 9,356 мг TEAC / г; фенольных кислот – 2,40 ± 0,052 мг CAE / г; полифенолов – 16,47 ± 0,339 мг GAE / г; флавоноидов – 13,34 ± 1,533 мг QE / г.

Ключевые слова: пчелиная обножка, Papaver rhoeas, монофлорность, спектрометрия, антиоксиданты, фенольные соединения

UDC 632.2.09:618.4-036.3

CHEWING ACTIVITY OF COWS AND ACIDITY OF RUMEN CONTENTS

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Abstract. *Studying the relationship between the size of the food particles and the acidity of the rumen contents, found that the size of the particle feed has an effect on the pH of the rumen. Analyzing the results, it should be noted that the level of acidity of the rumen content in cows with low chewing activity indicated a more acidic environment, pH ranged from 6.94 to 6.03. At the same time, animals with a higher level of chewing activity were characterized mainly by a neutral or slightly alkaline rumen contents with a pH of 6.91 to 7.75. As we see, cows, which are characterized by elevated chewing activity, were distinguished by higher values of pH of a rumen in comparison with animals, which had a lower duration of chewing. Ruminating activity of cows fed the same ration has been studied. Time of rumination was different that influenced rumen acidity (pH). Strong correlation (r = 0,57; 0,53) between rumination time and rumen pH has been discovered. It nas been proved that 24–h monitoring of rumination can serve as effective instrument of control of microbial processes in the rumen.*

Keywords: chewing monitoring, dairy cows, rumination, rumen contents, acidity

Introduction. Milk production under the conditions of industrial technologies and high level of concentration of livestock is possible only with the maximum use of the most advanced technological solutions and analysis of the basic parameters of the physiological processes of animals. One of the

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