ОПРЕДЕЛЕНИЕ ПРОИСХОЖДЕНИЯ ПЫЛЬЦЕВЫХ КОМОЧКОВ С ПОМОЩЬЮ ВИБРАЦИИ СПЕКТРОСКОПИЧЕСКИХ МАРКЕРОВ

Р. Блега, М. Воточкова, А. Синица, Я. Бриндза

Аннотация. *Работа посвящена определению разнообразия и распределения пыльцевых комочков в обножке четырех ботанических видов растений: Trifolium repens, Papaver somniferum, Brassica napus и Phacelia tanacetifolia. С помощью ИК-Фурье-спектроскопии в ближней (NIR) и средний (MIR) инфракрасных областях, а также FT-Raman-спектроскопии комбинационного рассеяния света, проводили анализ комочков пыльцы и устанавливали их классификацию в соответствии с ботаническим происхождением.*

Полученные спектроскопические данные статистически обработаны с использованием метода главных компонентов (PCA). Установлено, что каждый из методов спектроскопии оказался пригоден для классификации пчелиной обножки на основе спектральных различий. FT спектры комбинационного рассеяния подтвердили, что наличие каротина существенно влияет на цвет пчелиной обножки из мака.

Ключевые слова: ***спектроскопический анализ, пчелиная пыльца, Trifolium repens, Papaver somniferum, Brassica napus, Phacelia tanacetifolia.***

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MORPHOLOGICAL CHARACTERISTICS OF COMMON BUCKWHEAT (*FAGOPYRUM ESCULENTUM* MOENCH) POLLEN GRAINS AND BEE POLLEN

J. Brindza, DSc., Prof.,
Z. Schubertová, PhD
Slovak University of Agriculture in Nitra, Institute of Biodiversity and Biological Safety, Nitra, Slovak Republic
V. Brovarskyi, DSc., Prof.
National University of Life and Environmental Sciences of Ukraine
S. Motyleva, M. Mertvischeva
FSBSI All-Russian Horticultural Institute Breeding, Agrotechnology & Nursery, Moscow, Russia
O. Grygorieva, PhD, Senior Research Fellow
M. M. Gryshko, National Botanical Garden of Ukraine National Academy of Sciences, Kyiv, Ukraine

Annotation. *The aim of this study was to document the morphological characteristics of pollen grains and bee pollen of common buckwheat. Pollen*

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grains were collected for the experiments from plants of common buckwheat harvested in Poltava region. Bee pollen was obtained from beekeepers in Poltava region. With scanning electron microscope the length of polar and equatorial axis of pollen grains were evaluated in range 27.60–36.64 μm and 13.07–18.99 μm respectively. For the bee pollen the average weight in the range 5.47–10.04 mg, height in the range 2.62–3.05 mm and width in the range 2.62–3.05 mm were determined.

Statistically significant medium-strong dependence (r=0.479) between the weight and height of bee pollen was found. Antioxidant activity of bee pollen was determined with DPPH method. Antioxidant activity of aqueous / methanolic extracts of samples dried to 40 °C was 12.9 34.8 % and dried to 80 °C – 5.0/24.9 %.

Key words: ***Fagopyrum esculentum Moench, bee pollen, morphological traits, antioxidant activity.***

Introduction. Common buckwheat (*Fagopyrum esculentum* Moench) belongs to the *Polygonaceae* family, to the genus *Fagopyrum*. From the photosynthetic point of view it is a plant with C_3 – photorespiration (Moudrý et al., 2005). All plant parts contain the alkaloid rutine. Leaves that contain glycosides, rutin and quercetin are the most used in pharmaceutical industry (Poluninová et al., 1994). For flower heterostylism is known. One type of flower has long pistils and short stamens (pin type). The other type has long stamens and short pistils (thru type).

There are also plants with equal length of pistils and stamens in flowers (Vančurová et al., 1966; Janovská et al., 2008). Samborova at al. (1989) determined the length of pollen grains in a flower pin type in the range from 17.58 to 58.05 μm, and in a flower thru type in the range 19.35–63.86 μm. The flowers of common buckwheat are an important source of nectar and pollen for bees. It can be obtained 100–200 kg honey from one hectare (Sághi, 2002). Honey is reddish brown or deep-brown colour with a distinctive scent (Ember, 1955; Szilva, 1968). Many people use it as a natural product for the treatment of many diseases (Sághi, 2002).

Besides seeds, leaves and other plant parts bee pollen is also important for using in various purposes. Weight of bee pollen was studied by many authors in different species. Brindza et al. (2010) determined the weight of bee pollen from different samples of oilseed rape in the range 10.09–14.07 mg, for common sunflower 7.57–10.70 mg. Nôžková et al. (2010) found out the average height of bee pollen from different species in the range 1.81–4.26 mm and the width in the range from 2.13 to 4.56 mm. Brovarskyi and Brindza, (2010) found out height of bee pollen in the range 3.16–3.56 mm and the width in the range 3.60–3.97 mm.

Materials and Methods. Pollen grains of common buckwheat, harvested in Poltava region, were used for the experiments. They were removed from the flowers of common buckwheat mechanically. Bee pollen was obtained from beekeepers in Poltava region during the flowering season. With scanning electron microscope the length of polar and equatorial axis and

shape index of pollen grains were defined. Software AxioVs40 V 4.8.2.0 (Carl Zeiss, Jena, Germany) was used for measurements. Antioxidant activity of bee pollen samples in aqueous and methanolic extracts was estimated with DPPH method (Sánchéz-Moreno et al., 1998). Samples of bee pollen were dried at 40 °C, 60 °C and 80 °C for the analysis of antioxidant activity. For statistical evaluation of experimental data the SAS program was used.

Results and discussion. Table 1 presented morphological characteristics of pollen grains. The results show that the average length of the polar axis was determined in the range 27.60–36.64 μm and the variability of the length of the equatorial axis is 13.07–18.99 μm. The shape index (ratio of polar length to equatorial length) has been determined within 1.54–2.67. Halbritter and Svojtka, (2011) characterize the pollen grains of common buckwheat as medium size. Their size varies from 26–50 μm. The shape of pollen grains of common buckwheat is presented in Figures 1 and 2.

1. The morphological characteristics of common buckwheat (*Fagopyrum esculentum* Moench) pollen grains

Length of the axis	n	min	max	$\bar{x}$	v%
Length of the polar axis (μm)	105	27.60	36.64	32.53	6.09
Length of the equatorial axis (μm)	105	13.07	18.99	16.13	7.83
Shape index (P/E)	105	1.54	2.67	2.03	10.10

Note. n – number of measurements; min – the minimum value; max – the maximum value; x – arithmetic mean; v – coefficient of variation in %

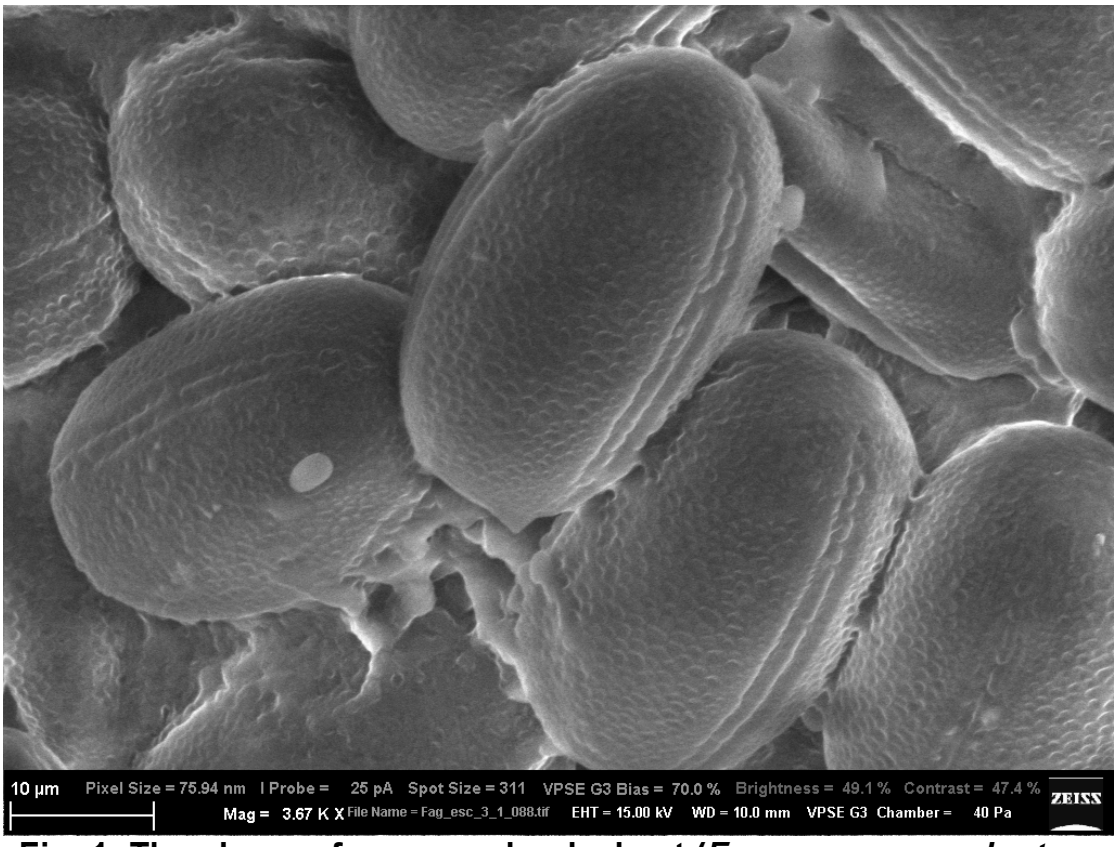

Fig. 1. The shape of common buckwheat (*Fagopyrum esculentum* Moench) pollen grain. Photo: Motyleva, S. (2014)

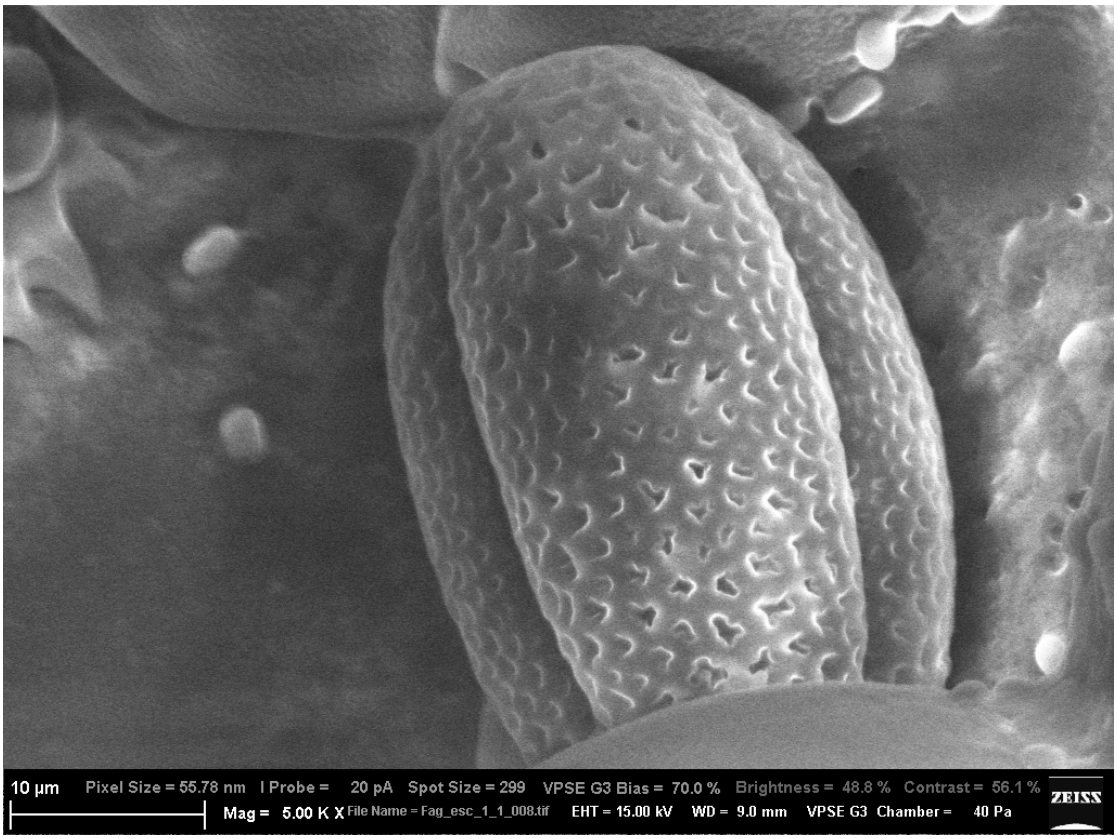

Fig. 2. The shape and surface of common buckwheat pollen grain (*Fagopyrum esculentum* Moench). Photo: Motyleva, S (2014)

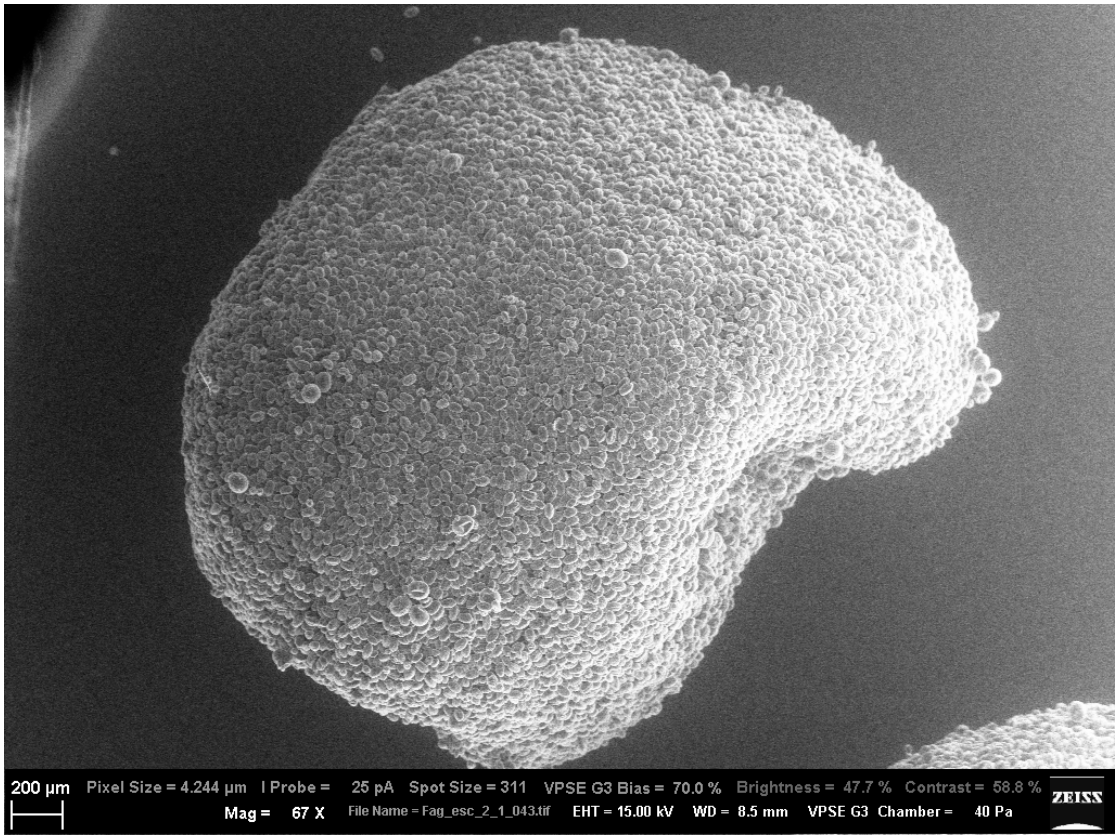

Fig. 3. The common buckwheat (*Fagopyrum esculentum* Moench) bee pollen. Photo: Ostrovský, R. (2014)

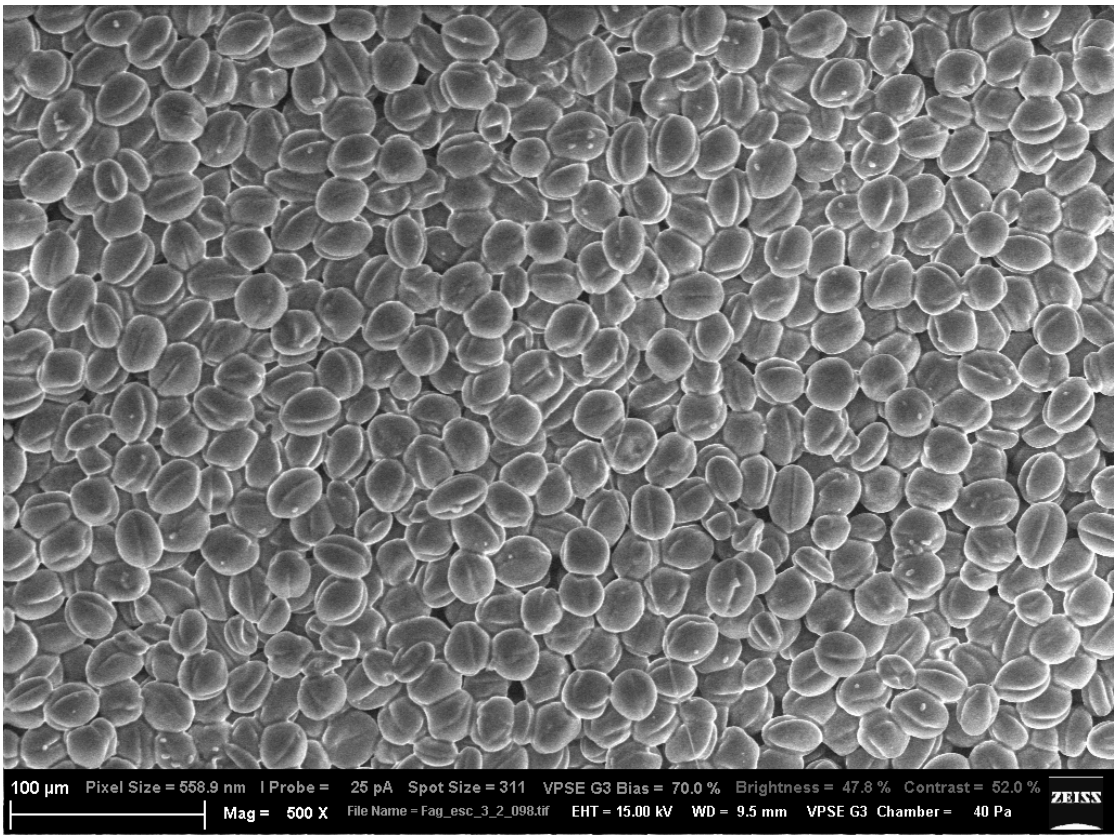

Fig. 4. Homogeneity of common buckwheat (*Fagopyrum esculentum* Moench) pollen grains in bee pollen. Photo: Ostrovský, R. (2014)

2. Variability of morphological traits of common buckwheat (*Fagopyrum esculentum* Moench) bee pollen

Genotypes	n	min	max	$\bar{x}$	V%	Test homogenity
Weight (mg)						
Sample 2	100	6.90	14.40	10.04	17.36	a
Sample 1	100	1.22	11.80	6.38	26.20	b
Sample 3	100	3.30	8.50	5.47	21.13	bc
Height (mm)						
Sample 2	100	2.48	3.72	3.05	8.52	a
Sample 1	100	2.12	3.57	2.83	9.54	b
Sample 3	100	1.85	3.81	2.62	13.36	bc
Width (mm)						
Sample 2	100	2.48	3.72	3.05	8.52	a
Sample 1	100	2.12	3.57	2.83	9.54	b
Sample 3	100	1.85	3.81	2.62	13.36	bc

Note. n – number of measurements; min – the minimum value; max – the maximum value; x – arithmetic mean; v – coefficient of variation in %; a,b – the same letters within a column are not significantly different according to Tukey's multiple range test (P≤0.05)

The results of measurements of morphological traits of three bee pollen samples of common buckwheat are given in Table 2. The average weight of bee pollen samples was determined within 5.47–10.04 mg, the height in the range 2.62–3.05 mm and the width in the range 2.62–3.05 mm. The shape of

bee pollen is different, that is documented in Figures 3 and 5. Figure 4 confirms the high level of monofloral of pollen grains in the bee pollen formed by honeybee from common buckwheat.

Statistically significant medium-strong dependence (r=0.479) between the weight and height of bee pollen was determined. A stronger degree of dependence was determined between the weight and width of bee pollen (r=0.599), as documented by data in Table 3. Antioxidant activity of bee pollen was defined by DPPH method. These results are shown in Table 4. Antioxidant activity of aqueous / methanolic extracts of samples dried to 40 °C is 12.9/34.8 %, dried to 80 °C – 5.0/24.9 %.

3. Relationship between evaluated traits of bee pollen of *Fagopyrum esculentum* Moench (according to Pearson)

Correlated traits	Height (mm)	Width (mm)
Weight of bee pollen (g)	0.479***	0.599***
Height of bee pollen (mm)		0.394***

Note. ***P ≤ 0.001

4. Influence of temperature drying on the antioxidant activity (DPPH method) of bee pollen of common buckwheat (*Fagopyrum esculentum* Moench)

Temperature	n	40 °C		60 °C		80 °C	
		$\bar{x}$	V%	$\bar{x}$	V%	$\bar{x}$	V%
Aqueous extract	5	12.9	4.3	9.6	4.6	5.0	8.0
Methanolic extract	5	34.8	2.1	28.6	2.7	24.9	3.4

Note. n – number of measurements; x – arithmetic mean; v – coefficient of variation in %

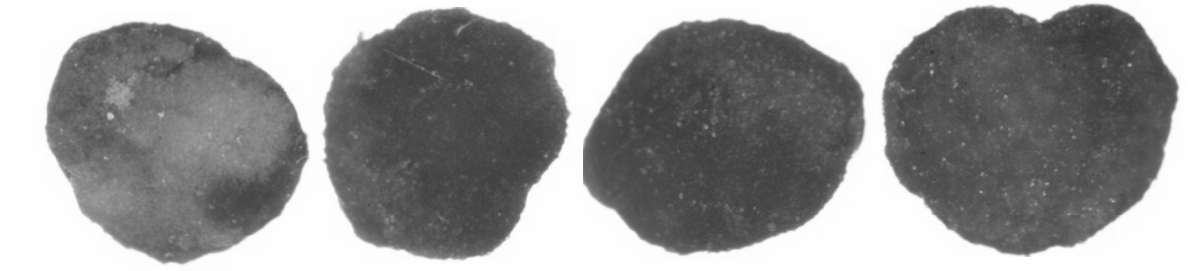

Fig. 5. Variability in the shape of common buckwheat bee pollen documented using fully automatic macro lens Zeiss Discovery V12
Oravec, A. (2015)

Conclusions

The results of this study suggest that bee pollen from common buckwheat is important product that increases the economy growth and also efficiency of using the pollen grains for various practical uses.

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МОРФОЛОГІЧНА ХАРАКТЕРИСТИКА ПИЛКОВИХ ЗЕРЕН ТА БДЖОЛИНОГО ОБНІЖЖЯ ГРЕЧКИ ПОСІВНОЇ (*FAGOPYRUM ESCULENTUM* MOENCH)

Я. Бріндза, З. Шубертова, В. Броварський, С. Мотильова, М. Мертвішева, О. Григор'єва

Анотація. *Визначено морфологічні характеристики пилкових зерен і бджолиного обніжжя гречки посівної. Пилкові зерна для експериментів було зібрано з рослин гречки посівної, вирощених у Полтавській області. Пилок бджолиний був отриманий від бджолярів Полтавської області. За допомогою скануючого електронного мікроскопа було встановлено довжину полярної осі пилкових зерен в межах 27,60–36,64 мкм та довжину екваторіального діаметра – 13,07–18,99 мкм. Для бджолиного обніжжя було визначено середню вагу в інтервалі 5,47–10,04 мг, висоту в діапазоні 2,62–3,05 мм та ширину розміром 2,62–3,05 мм.*

Було знайдено статистично достовірну середньо-сильну залежність (r=0.479) між вагою і висотою бджолиних гранул. Антиоксидантну активність бджолиного обніжжя вимірювали з використанням стабільного радикала ДФПГ. Антиоксидантна активність водних / метанолових екстрактів зразків висушених до 40 °С дорівнює 12,9/34,8 %, а висушених до 80 °С – 5,0/24,9 %.

Ключові слова: ***Fagopyrum esculentum Moench, бджолине обніжжя, морфологічні ознаки, антиоксидантна активність.***

МОРФОЛОГИЧЕСКАЯ ХАРАКТЕРИСТИКА ПЫЛЬЦЕВЫХ ЗЕРЕН И ПЧЕЛИНОЙ ОБНОЖКИ ГРЕЧИХИ ПОСЕВНОЙ (*FAGOPYRUM ESCULENTUM* MOENCH)

Я. Бриндза, З. Шубертова, В. Броварский, С. Мотылёва, М. Мертвишева, О. Григорьева

Аннотация. *Определены морфологические характеристики пыльцевых зерен и пчелиной обножки гречихи посевной. Пыльцевые зерна для экспериментов были собраны с растений гречихи посевной, выращенных в Полтавской области. Пыльца пчелиная была получена от пчеловодов Полтавской области. С помощью сканирующего электронного микроскопа была установлена длина полярной оси пыльцевых зерен в пределах 27,60–36,64 мкм и длина экваториального диаметра – 13,07–18,99 мкм. Для пчелиной обножки был определен средний вес в интервале 5,47–10,04 мг, высота в диапазоне 2,62–3,05 мм и ширина в размере 2,62–3,05 мм.*

Была найдена статистически достоверная средне-сильная зависимость (r = 0.479) между весом и высотой пчелиных гранул. Антиоксидантную активность пчелиной обножки измеряли с использованием стабильного радикала ДФПГ. Антиоксидантная активность водных / метаноловых экстрактов образцов, высушенных до 40 °С, равна 12,9 / 34,8%, а высушенных до 80 °С – 5,0 / 24,9%.

Ключевые слова: ***Fagopyrum esculentum Moench, пчелиная обножка, морфологические признаки, антиоксидантная активность.***