

Proposal of evaluation system for quantitative and qualitative parameters of bee pollen

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OBJECT OF THE STUDY

The aim of our study was to propose and compose the evaluation systems (descriptors) for measurement and evaluation of quantitative and qualitative parameters of bee pollen pellets. The main purpose of these systems is in determination of pellets species origin.

MATERIAL AND METHODS

The experimental set consisted from pellet samples of 114 different plant species. Development of descriptors for quantitative and qualitative traits was realized on the basis of variability study in selected traits. The descriptors were proposed according to methodology of international institute Bioversity International (Bioversity International 2007).

EVALUATION SYSTEMS - DESCRIPTORS

Proposed evaluation systems for bee pollen pellets are determined by selected quantitative and qualitative parameters (Tab. 1, 2). For each trait we proposed the evaluation system – descriptor, which consists from classification states. The maximally there are 9 and minimally 2 states. Using the known variability of trait we composed the classification scales. The trait variability was recognized by literature sources or by our experimental activities.

Table 1. Descriptor for quantitative trait – Bee pollen pellet – area (mm²)

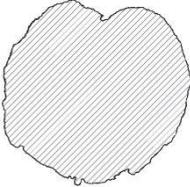
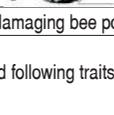
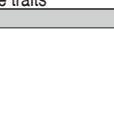
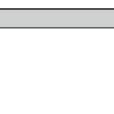
Numeric code	Descriptors state	Scale	Figure
1	veľmi malá	< 5.00	
3	malá	5.00 – 7.00	
5	stredne veľká	7.01 – 9.01	
7	veľká	9.02 – 11.01	
9	veľmi veľká	11.02 a viac	
Method: Evaluate less than 50 undamaging bee pollen pellets.			

Table 2. Descriptor for qualitative trait – Bee pollen pellet – shape

Numeric code	Descriptors state	Figures
1	irregular	
2	globular	
		
3	elliptical	
4	heart-shaped	
		
Method: Evaluate less than 50 undamaging bee pollen pellets.		

For list of descriptors were proposed following traits (tab. 3 – 5).

Table 3. List of selected quantitative traits

Quantitative traits
pellet weight (mg)
pellet area (mm ²)
feret minimum (mm)
feret maximum (mm)
pellet height (mm)
pellet width (mm)
shape index (width/height)
symmetry (feret min/feret max)

Table 4. List of selected qualitative traits

Qualitative traits
pellet compactness
surface structure
shape
shape of heart shaped pellets
depth of recess on heart shaped pellets
colors homogeneity
color hue

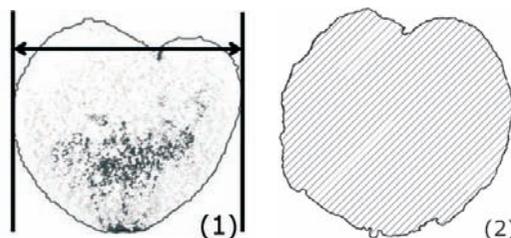
Table 5. List of traits for main substances content

Substances content in dry matter
total proteins (%)
total lipids (%)
total carbohydrates (%)
ash (%)

EVALUATION PROCESS

By tools of image analyses (software AxioVision) were obtained data for quantitative traits (Fig. 1).

Figure 1. Way of pollen loads measuring in selected quantitative traits – (1) pellet weight (mm), (2) pellet area (mm²).



The number of descriptor states and the their scales were determined according to learned variability of respective trait which was measured in experimental set, and also according to knowledge obtained from literature sources (Bogdanov 2004; Human, Nicolson 2006; Almeida-Muradian et al. 2005; Szczesna 2006; 2007a; 2007b; Stanley R.G., Linskens H.F. 1974). The mainly the data for main chemical components in bee pollen pellets were achieved from different literature sources (Tab. 6).

Table 6. Main components contents in bee pollen loads obtained from our experimental work and literature sources

Component	Content in dry matter (%)	Literature source
Proteins	10 - 40	Bogdanov 2004
	27 – 28	Our experiment
	28.1 ±1.6	Human, Nicolson 2006
	21 ±4	Almeida-Muradian et al. 2005
	13.06 – 24.54	Szczesna 2006
Lipids	1 - 10	Bogdanov, 2004
	7 ±2	Almeida-Muradian et al. 2005
	7.6 ±0.2	Human, Nicolson 2006
	6.5 – 14.1	Our experiment
Total carbohydrates	60.7±1.5	Human, Nicolson 2006
	13 - 55	Bogdanov 2004
	37	Almeida-Muradian
	26.87 – 48.44	Szczesna 2007b
Ash	3.6±0.2	Human, Nicolson 2006
	2.4±0.8	Almeida-Muradian et al. 2005
	2 - 6	Bogdanov 2004
	2.08 – 3.19	Szczesna 2007a
	2.2 – 2.7	Our experiment

Individual descriptor scales for quantitative traits were determined by function of fuzzy sets (Stehliková, 2002; Nůžková et al., 2006).

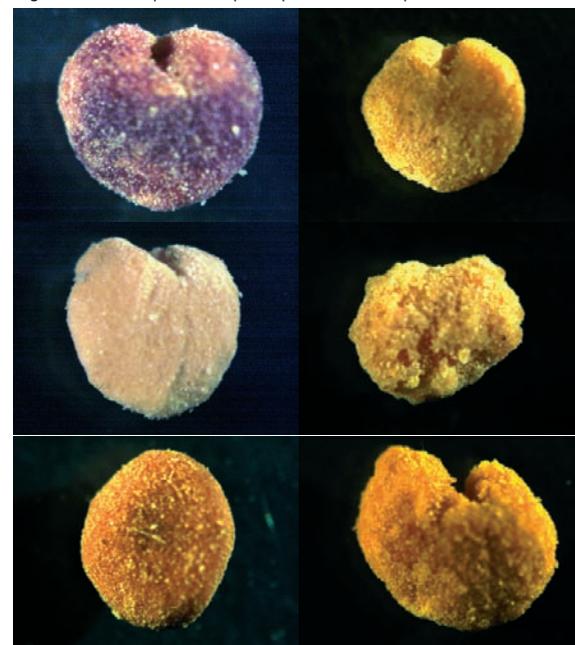
Through two points is unambiguously determined line $y = y_1 + \frac{y_2 - y_1}{x_2 - x_1}(x - x_1)$. In our case were $x_1 = \min$ and $x_2 = \max$, $y_1 = 0$ and $y_2 = 1$. Then the equation

of line is $y = \frac{1}{\max - \min}(x - \min)$. From presented equation were expressed variable 'x', which is needed for calculation of border points for individual intervals - $x = \min + (\max - \min)y$.

The following values were bounded to variable 'y': 0.2; 0.4; 0.5; 0.6; 0.8. The variable 'x' calculated from mentioned equation was identified as searches border value of particular interval of trait.

In the case of qualitative traits the bee pollen pellets were evaluated visually. We had available approximately 2000 detailed pictures of 114 pellets samples (Fig. 2). Picture records were made on fully functional microscope Zeiss Discovery V12 with digital equipment AxioCam 3.1.

Figure 2. Detailed pictures of pollen pellets used for qualitative traits



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