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EVALUATION OF LONG FIBRE QUALITY OF FIBRE FLAX VARIETIES AND BREEDING LINES BY DIFFERENT METHODS

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Abstract

Over the period 2001–2003 long fibre quality parameters of various fibre flax varieties and breeding lines were investigated at the LIA's Upytė Research Station. The aim of the study was to establish quality parameters of flax fibre, to compare them with the same parameters of the standard fibre flax varieties, to determine the superiority of the new varieties, and to compare the data of fibre quality parameters determined by different methods and equipment (including modern methods).

The tenacity of flax fibre at the Upytė RS was evaluated by a dynamometer DKV-60, fibre flexibility by an implement G-2, fineness following special methodology (counting separated fibres). During 2001–2002 at the Institute of Natural Fibres (INF, Poznan, Poland) fibre tenacity was evaluated by an Automatic Tensile Tester STATIMAT ME [Textechno], fineness by Air Flow Electronic Fibre Fineness Meter WIRA, fibre cell measurements by FIBRE IMAGE ANALYSIS Computer Professional System.

The data of fibre quality of the tested varieties and new breeding lines are presented.

A reliable correlation was determined between the fibre quality data assessed using different methods. The strongest fibre was identified for the breeding lines No. 01057-12 and No. 1864-24. The finest was fibre obtained from varieties 'Belinka' and 'Baltučiai' and breeding line No. 1963-3.

Key words: breeding lines, fibre flax, fibre quality, flexibility, methods, tenacity, fineness, varieties.

Introduction

One of the means to increase flax raw material is to enhance flax yield. Choice of a high-yielding flax variety and modern growing technology could increase flax yield by 10–30 % /Lazauskas, Dapkus, 1995; Burdyga, 1997; Rolski, Heller, 1998/. The characteristics of the variety can determine yield quantity as well as the quality /Marchenkov, Zhuchenko, 1996; Zhuchenko, Rozhmina, 1998/.

High fibre quality is one of the key requirements in fibre flax breeding for textile purposes /Heller, Rulskij, 2002/. Furthermore, new flax varieties should be resistant to lodging and diseases /Wlaswinkel, 1994; Trouve, 1996; Doronin et al., 1998; Krylov, 2002; Krylova et al., 2002/. Flax cultivation techniques, weather and soil conditions as well as the primary flax straw processing (scutching, hackling) have a great effect on fibre quality /Grashchenko, 1963/.

The most important criteria describing fibre quality are fibre fineness, tenacity and flexibility. Many authors have reported that improvement of fibre quality could primarily be achieved by creating new flax varieties, using different breeding methods /Loshkov, 1977; Karpunin, 1995; Dylenok et al., 1998; Polonetskaya et al., 2001; Pavlova, Alexandrova, 2002/. High fibre quality could be achieved by growing the following varieties: 'Svetoch', '1288/12', 'Orshanskij 2', 'Saldo', 'Belinka', 'Batist'. The varieties 'Belochka', 'T-9', 'P-359', 'Kijevskij', 'Dashkovskij', 'Baltuchiai', 'Rodnik', 'Pskovskij 85', 'Regina', 'Laura', 'M-5', 'K-65' can be attributed to the group of varieties characterised by a slightly lower fibre quality /Sharov et al., 1991; Karpets et al., 1997; Sharov et al., 1999; Tixvinskij et al., 2002/. Fibre quality of 'T-10', 'Slavnyj 82', 'K-6', 'Torzhokskij 4' etc. is lower (less flexible and fine, coarser) /Sharov et al., 1999/.

For a long time flax fibre quality in the former USSR countries was evaluated following uniform methods elaborated by Russian scientists /Metodiki texnologicheskoj, 1961; Rogash et al., 1987/. The methods and equipment for fibre quality testing generally used in European countries /Sharma, 1988; Kessler et al., 1998; Sharma, Faughey, 1999; Sharma et al., 1999; Faughey, Sharma, 2000; Pawula, Mazur, 2001/ are not available in our country.

Presently, at our research station we are able to estimate flax fibre flexibility, strength and thinness, but the methods are very time and labour-consuming, all the equipment is obsolete and needs to be upgraded. So it is necessary to learn more about the new methods and equipment for flax fibre quality evaluation.

A good possibility to learn more about up-to-date equipment for the evaluation of flax fibre quality was given by COST Action 847 conducted Short Time Scientific Mission STSM in INF, Poland in 2001 and thanks to the support of the Lithuanian State Science and Studies Foundation in 2002.

The aim of the present study was to evaluate the fibre quality of the Lithuanian fibre flax varieties and new breeding lines, to compare fibre quality parameters with those of the standard and other fibre flax varieties, and to compare the data of fibre quality parameters determined by different methods and equipment.

Materials and methods

The trial was carried out during 2001–2003 at the Upytė Research Station (branch of the Lithuanian Institute of Agriculture). In the field rotation flax followed winter wheat. The trial was conducted on a Eutri-Endohypogleyic Cambisol (sandy loam) /Buivydaitė et al., 2001/. The content of available P_2O_5 in the soil plough layer was 145-205 mg kg^{-1}, content of K_2O – 160–193 mg kg^{-1} (determined in A-L extraction), pH_{KCl} level – 7.0–7.4 (potenciometrically), humus content – 1.74–2.26 % (by Tyurin method). Treatment plot was 19.2 (1.60x12) m^2, record plot 16.0 (1.60x10) m^2, 4 replications. Randomised plot design was used.

During 2001–2003 eleven new breeding lines (01057-12, 1698-13a, 1864-24, 1963-3, 2017-3, 01149-14, 1698-3, 1878-9, 1963-17, 2027-6 and 2030-6) developed at the Upytė Research Station using conventional breeding methods, nine fibre flax varieties ('Baltučiai' (LT), 'Ariane' (F), 'E-68' (BY), 'Vega 2' (LT), 'Elize' (NL), 'Kastyčiai' (LT), 'Ilona' (NL), 'Evelin' (NL) and 'Hermes' (F)) currently included in the National Catalogue, two fibre flax varieties ('Belinka' (NL) and 'Argos' (F)) that had

been listed in the National Catalogue earlier and two Dutch fibre flax varieties (‘Marylin’ and ‘Viola’) were investigated.

In the trials flax was sown by a sowing machine SNL-16 at a seed rate of 25 million seed per hectare, at 10 cm inter-row spacings. Insecticide Fastac 10 EC (alfa-cipermetrine 100 g l^{-1}) 100 ml ha^{-1} was applied at seedling stage, herbicide Glean® 75 DF (chlorsulphurone 750 g kg^{-1}) 7 g ha^{-1}+ Kemiwett™ S (alcohol ethoxylate) 0.1 % – when flax was 6–10 cm in height. Flax was pulled at the stage of early yellow ripeness, threshed by a MS thresher. Stems were retted in warm water (33–37 ºC), then scutched by a machine tool SMT-200. Long fibre content was calculated from the dry mass of unretted straw. Fibre was hackled by combs No 9 and 13. In 2001 and 2002 part of the samples was analysed at Institute of Natural Fibres (INF, Poznan, Poland) using advanced methods and equipment (Automatic Tensile Tester – STATIMAT ME [Textechno]; Air Flow Electronic Fibre Fineness Meter WIRA; FIBRE IMAGE ANALYSIS – Computer Professional System). The other part of the same samples was studied locally using conventional fibre quality testing methods. The flexibility of fibre was measured by a device G-2, fibre tenacity by a device DK-60, fineness (fibre divisibility – following special methodology by counting separate fibres in a fibre sample, the length of which is 1 cm, mass 10 mg). Long fibre breaking length (in km) was calculated using the formula: BL (in km) = 0.1 x Flexibility (in mm) + 0.2 x tenacity (in kg F) + 0.013 x Fineness (in units) + 2.1; where: 0.1; 0.2; 0.013 and 2.1 are constants /Metodiki technologicheskoj…, 1961/.

Meteorological conditions during the experimental years were diverse. In 2001 the weather conditions were adverse, especially in the second half of the growing season. Heavy precipitation lodged flax stand. The year 2002 was characterised by a shortage of moisture during the growing season. In 2003 because of the lack of precipitation in the first half of the growing season flax did not perform well, the end of the growing season was rainy and the flax stand was partially lodged.

Results and Discussion

Long fibre content and yield data are presented in Table 1. Long fibre yield was lower in 2001 – 0.42–0.78 t ha^{-1}, higher – 1.61–1.66 t ha^{-1} – in 2002. Three years’ findings show that the variety ‘Ariane’ gave the highest long fibre yield 1.22 t ha^{-1}. The lowest long fibre yield was obtained from the early-ripening fibre flax variety ‘Baltučiai’ (0.80 t ha^{-1}). The new breeding lines No. 1963-3, No. 1864-24 and No. 01057-12 gave promising results. Experimental findings from 2002–2003 suggest that the highest average long fibre yield was produced by the varieties ‘Hermes’ and ‘Ilona’. From breeding lines investigated only in 2003 the highest yield was obtained from No. 1878-9 and No. 01149-14.

Due to the unfavourable weather conditions in 2001 (dew-retting started when flax was lodged), fibre content was very low 8.2–11.0 % (Table 1). Averaged data from 2001–2003 show that the variety ‘Ariane’ and breeding line 1864-24 had the highest fibre content (19.2–19.5 %), and the lowest fibre content was identified for ‘Belinka’ (15.8 %) and ‘Baltučiai’ (16.0 %) flax straw. From the varieties investigated for only 2 years, the variety ‘Hermes’ produced the highest fibre content (25.2 %), flax ‘Belinka’, ‘Vega 2’ and ‘Kastyčiai’ – the lowest (19.6–19.1 %). While investigating the new

breeding lines in 2003 we could see that some of them had sufficiently high fibre content (No. 01149-14 – 25.2 % and No. 1878-9 – 25.8 %).

Table 1. Long fibre yield (t ha^{-1}) and fibre content (%)
1 lentelė. *Ilgojo pluošto derlius* (*t ha^{-1}) ir pluošto išeiga (%)*
Upytė, 2001–2003

Variety or breeding line *Veislė arba selekcinė linija*	Fibre yield t ha^{-1} *Pluošto derlius t ha^{-1}*				Fibre content % *Pluošto išeiga %*			
	2001	2002	2003	Avg. *Vid.*	2001	2002	2003	Avg. *Vid.*
1. ‘Belinka’ (stand.)	0.60	1.11	1.05	0.94	9.2	18.6	19.5	15.8
2. ‘Baltučiai’	0.42	1.15	0.84	0.80	8.2	20.0	19.9	16.0
3. ‘Ariane’	0.78	1.55	1.27	1.22	11.5	23.6	23.3	19.5
4. 01057-12	0.64	1.61	1.05	1.09	10.5	24.0	20.6	18.4
5. 1698-13a	0.63	1.17	1.02	0.96	10.1	20.4	20.5	17.0
6. 1864-24	0.72	1.35	1.20	1.12	11.0	22.8	23.7	19.2
7. 1963-3	0.68	1.66	1.07	1.15	10.0	24.5	19.4	18.0
LSD_{05} / R_{05}	**0.12**	**0.12**	**0.15**	**0.11**	**1,25**	**3,05**	**3,23**	**2,66**
1. ‘Belinka’ (stand.)	-	1.11	1.05	1.09	-	18.6	19.5	19.1
2. 2017-3	-	1.21	1.20	1.21	-	20.5	19.6	20.1
3. ‘Vega 2’	-	1.06	1.11	1.10	-	16.5	21.6	19.1
4. ‘Hermes’	-	1.66	1.28	1.44	-	26.0	24.4	25.2
5. ‘E-68’	-	1.11	0.89	1.01	-	19.2	20.8	20.0
6. ‘Ilona’	-	1.56	1.01	1.27	-	24.7	21.1	22.9
7. ‘Evelin’	-	1.43	0.83	1.11	-	23.6	19.2	21.4
8. ‘Argos’	-	1.63	0.86	1.22	-	23.9	17.7	20.8
9. ‘Kastyčiai’	-	1.32	0.72	1.00	-	22.1	17.0	19.6
10. ‘Elize’	-	1.31	0.87	1.08	-	22.9	18.6	20.8
11. ‘Marylin’	-	1.52	0.93	1.21	-	26.4	18.4	22.4
12. ‘Viola’	-	1.37	0.94	1.15	-	22.6	22.0	22.3
LSD_{05} / R_{05}	**-**	**0.12**	**0.15**	**0.13**	**-**	**3.16**	**2,31**	**2.77**
1. ‘Belinka’ (stand.)	-	-	1.05	-	-	-	19.5	-
2. 01149-14	-	-	1.32	-	-	-	25.2	-
3. 1698-3	-	-	1.06	-	-	-	20.8	-
4.1878-9	-	-	1.35	-	-	-	25.8	-
5. 1963-17	-	-	1.07	-	-	-	19.4	-
6. 2027-6	-	-	0.91	-	-	-	16.6	-
7. 2030-5	-	-	1.04	-	-	-	18.0	-
LSD_{05} / R_{05}	**-**	**-**	**0.15**	**-**	**-**	**-**	**2.22**	**-**

Fibre quality of the variety ‘Belinka’ is known as the standard of good quality, thus for the evaluation of fibre quality in our trials the variety ‘Belinka’ was chosen as a reference variety.

The data from 2001–2003 (analyses at Upytė Research Station) indicate that the strongest fibre was obtained from the flax of the variety 'Baltučiai' and breeding lines No. 01057-12 and No.1864-24 (Table 2). Fibre tenacity was higher by 3.5; 2.4 and 2.4 kg F, or by 22.3; 15.3 and 15.3 %, respectively, compared with the tenacity of the standard variety 'Belinka'. Fibre tenacity of the variety 'Ariane' (14.7 kg F) and breeding line No. 1698-13a (15.0 kg F) was lower than that of the standard variety (15.7 kg F).

Table 2. Long fibre tenacity (kg F) and flexibility (mm)
2 lentelė. *Ilgojo pluošto stiprumas (kg F) ir lankstumas (mm)*
Upytė, 2001–2003

Variety or breeding line *Veislė arba selekcinė linija*	Fibre tenacity kg F *Pluošto stiprumas kg F*				Fibre flexibility mm *Pluošto lankstumas mm*			
	2001	2002	2003	Avg. *Vid.*	2001	2002	2003	Avg. *Vid.*
1. 'Belinka' (stand.)	12.4	15.6	19.1	15.7	35.1	40.6	50.3	42.0
2. 'Baltučiai'	14.2	18.2	25.3	19.2	48,3	55.9	52.6	52.3
3. 'Ariane'	8.1	15.2	20.2	14.7	37.8	39.0	44.7	40.5
4. 01057-12	11.8	24.0	18.5	18.1	39.9	37.1	45.3	40.8
5. 1698-13a	9.9	16.8	18.4	15.0	38.1	54.6	42.3	45.0
6. 1864-24	13.7	22.7	17.8	18.1	35.6	34.7	41.6	37.3
7. 1963-3	11.8	15.0	19.4	15.4	43.0	54.2	37.0	44.7
LSD_{05} / R_{05}	**1.32**	**2.01**	**2.27**	**1.91**	**5.03**	**4.55**	**4.02**	**4.55**
1. 'Belinka' (stand.)	-	15.6	19.1	17.4	-	40.6	50.3	45.5
2. 2017-3	-	14.5	21.4	18.0	-	51.0	45.7	48.4
3. 'Vega 2'	-	19.9	21.5	20.7	-	40.6	54.5	47.6
4. 'Hermes'	-	22.0	24.2	23.1	-	35.2	40.6	37.9
5. 'E-68'	-	14.5	19.0	16.8	-	50.9	41.6	46.3
6. 'Ilona'	-	14.7	21.7	18.2	-	38.7	43.9	41.3
7. 'Evelin'	-	18.2	22.2	20.2	-	36.2	39.1	37.7
8. 'Argos'	-	18.2	23.0	20.7	-	44.4	34.1	39.3
9. 'Kastyčiai'	-	21.7	23.4	22.6	-	38.2	41.4	39.8
10. 'Elize'	-	24.6	20.9	22.8	-	34.6	35.9	35.3
11. 'Marylin'	-	18.4	19.2	18.8	-	39.5	38.7	39.1
12. 'Viola'	-	18.4	22.7	20.6	-	38.7	36.0	37.4
LSD_{05} / R_{05}	**-**	**2.22**	**2.35**	**2.28**		**4.76**	**4.33**	**4.55**
1. 'Belinka' (stand.)	-	-	18.8	-	-	-	45.1	-
2. 01149-14	-	-	24.0	-	-	-	39.0	-
3. 1698-3	-	-	20.8	-	-	-	53.2	-
4.1878-9	-	-	25.3	-	-	-	44.1	-
5. 1963-17	-	-	18.4	-	-	-	40.4	-
6. 2027-6	-	-	21.0	-	-	-	40.8	-
7. 2030-5	-	-	18.7	-	-	-	57.9	-
LSD_{05} / R_{05}	**-**	**-**	**2.31**	**-**	**-**	**-**	**4.92**	**-**

Fibre tests of 2002-2003 suggest that the strongest fibre was obtained from the varieties ʻHermes' (23.1 kg F), ʻElize' (22.8 kg F), ʻKastyčiai' (22.6 kg F), ʻVega 2' (20.7 kg F), ʻArgos' (20.7 kg F) and ʻViola' (20.6 kg F) and it was by 5.7–3.2 kg F, or by 32.8–18.4 % stronger than that of ʻBelinka' (17.4 kg F). From the new breeding lines tested only in 2003, No. 1878-9 and No. 01149-14 had the strongest fibre (25.3 kg F and 24.0 kg F, respectively, which was by 6.5 and 5.2 kg F, or by 34.6 and 27.7 % higher than that of the standard ʻBelinka' (18.8 kg F)).

After 3 years of study we can say that most flexible was fibre from the variety ʻBaltučiai' (52.3 mm) which was by 10.3 mm, or by 24.5 %, more flexible than ʻBelinka' (Table 2). Less flexible than the standard fibre (42.0 mm) was for the variety ʻAriane' (40.3 mm) and breeding line No. 1864-24 (37.3 mm). The averaged data from 2002–2003 suggest that only fibre from the breeding line No. 2017-3 and variety ʻVega 2' was more flexible (by 6.4-4.6 %) compared with the standard variety ʻBelinka' (45.5 mm). Fibre flexibility of ʻE-68' was equal to the standard, and fibre flexibility of the other tested varieties was lower by 22.4–9.5 % compared with the standard ʻBelinka'.

The two new breeding lines (No. 1698-3 and No. 2030-5) in 2003 had more flexible fibre (53.2 mm and 57.9 mm, respectively) compared with the standard ʻBelinka' (45.1 mm).

Fibre is fine when it can be divided into thin separate fibres. In our investigation fibre divisibility data reflect fibre fineness. Fibre is fine when the content of separate fibres in the analysed sample is high and fibre is coarse when the content of separate fibres is low.

Averaged fibre testing data from 2001–2003 suggest that only fibre of the variety ʻBaltučiai' had the same value as ʻBelinka's fibre (Table 3). Value of fibre fineness of breeding line No. 1963-3 was a little lower (by 7.2 %), values of fibre fineness of the other tested varieties were much lower compared with the standard ʻBelinka'. From the varieties tested only in 2002 the finest fibre was obtained from variety ʻVega 2'.

Table 3. Long fibre fineness (in units) and breaking length (km)
3 lentelė. *Ilgojo pluošto plonumas vienetais ir nutraukiamasis ilgis km*
Upytė, 2001–2002

Variety or breeding line *Veislė arba selekcinė linija*	Fibre fineness in units *Pluošto plonumas vienetais*			Fibre breaking length km *Pluošto nutraukiamasis ilgis km*		
	2001	2002	Avg. *Vid.*	2001	2002	Avg. *Vid.*
1	2	3	4	5	6	7
1. ʻBelinka' (stand.)	250	278	264	11.3	12.9	12.1
2. ʻBaltučiai'	253	267	260	13.1	14.8	14.0
3. ʻAriane'	240	215	228	10.6	11.9	11.3
4. 01057-12	193	181	187	11.0	13.0	12.0
5. 1698-13a	220	206	213	10.8	13.6	12.2
6. 1864-24	195	197	196	10.9	12.7	11.8
7. 1963-3	247	242	245	12.0	13.7	12.9

Table 3 continued
3 lentelės tęsinys

1	2	3	4	5	6	7
8. 2017-3	-	235		-	13.2	-
9. ʻVega 2ʼ	-	284	-	-	13.8	-
10. ʻHermesʼ	-	202	-	-	12.6	-
11. ʻE-68ʼ	-	226	-	-	13.0	-
12. ʻIlonaʼ	-	182	-	-	11.3	-
13. ʻEvelinʼ	-	196	-	-	11.9	-
14. ʻArgosʼ	-	266	-	-	13.7	-
15. ʻKastyčiaiʼ	-	229	-	-	13.2	-
16. ʻEliseʼ	-	168	-	-	12.7	-
17. ʻMarylinʼ	-	133	-	-	11.5	-
18. ʻViolaʼ	-	176	-	-	11.9	-

Long fibre breaking length (in km) describes resumptive long fibre quality. Experimental results from 2001–2002 indicate that the best result was given by the variety ʻBaltučiaiʼ – long fibre breaking length was the highest (14.0 km) and by 15.7 %, or by 1.9 km, higher than that of standard ʻBelinkaʼ (Table 3). The result of breeding line No. 1963-3 was close to the standard – long fibre breaking length was by 6.6 %, or by 0.8 km, higher than that of standard ʻBelinkaʼ. The lowest mean was of the variety ʻAriane', it was by 6.7 %, or 0.8 km lower than that of the standard ʻBelinkaʼ.

Experimental findings from 2002 show that fibre breaking force calculated for the breeding line 2017-3 and varieties ʻVega 2', ʻArgos' and 'Kastyčiai' was by 0.3–0.9 km, or by 2.3–7.0 % higher compared with the standard variety.

After fibre analyses at INF in 2001–2002, the highest fibre tenacity was determined for the fibre of breeding line No. 1864-24; it was by 4.67 cN/tex, or by 4.68 %, higher than that of the standard ʻBelinkaʼ (Table 4). Fibre tenacity of breeding line No. 01057-12 was equal to the standard. Fibre tenacity of the variety ʻBaltučiaiʼ and breeding lines No. 1698-13a and No. 1963-3 was slightly lower (by 3.02–3.75 cN/tex, or by 5.6–6.9 %) than that of the standard ʻBelinkaʼ.

From the varieties grown in 2002, varieties ʻHermesʼ, ʻIlonaʼ, ʻArgosʼ, ʻElizeʼ and ʻViolaʼ had strong fibre; it was by 5.2–1.8 cN/tex, or by 8.8–3.0 % stronger than that of the standard ʻBelinkaʼ.

When analysing fibre tenacity by two different methods (using dynamometer DKV-60 or STATIMAT ME) the strongest fibre was identified for the breeding lines No. 01057-12 and No. 1864-24. The data of other measurements varied.

A reliable (P = 99 %) linear correlation (y = 34.783+1.24x; r = 0.73) between fibre tenacity assessed by Dynamometer and fibre tenacity assessed by STATIMAT was found.

Power regression type was selected since it showed the highest correlation (among the other types of correlation) (determination coefficient $R^2 = 0.57$) between fibre tenacity data obtained using two different methods.

Table 4. Long fibre breaking force (N) and its variation, long fibre tenacity (cN/tex)
4 lentelė. *Ilgojo pluošto nutraukimo jėga (N) ir jos variacija (%) bei ilgojo pluošto stiprumas (cN/tex)*

INF, 2001–2002

Variety or breeding line *Veislė arba selekcinė linija*	Breaking force N *Nutraukimo jėga N*			Variation of breaking force % *Nutraukimo jėgos variacija %*		Fibre tenacity cN/tex *Pluošto stiprumas cN/tex*		
	2001	2002	Avg. *Vid.*	2001	2002	2001	2002	Avg. *Vid.*
1. ‘Belinka’ (stand.)	72.41	73.57	72.99	4.78	10.23	48.70	59.33	54.02
2. ‘Baltučiai’	89.21	67.69	78.45	16.11	23.42	47.28	53.44	50.36
3. ‘Ariane’	72.88	67.25	70.07	17.36	13.36	43.73	53.04	53.39
4. 01057-12	85.13	64.12	74.63	1.38	13.37	47.82	60.87	54.35
5. 1698-13a	84.03	81.56	82.80	15.15	3.84	42.02	59.97	51.00
6. 1864-24	73.03	66.97	70.00	17.32	6.79	47.63	69.76	58.70
7. 1963-3	67.79	52.84	60.32	15.64	8.59	46.24	54.29	50.27
8. 2017-3	-	54.15	-	9.09	-	-	58.86	-
9. ‘Vega 2’	-	62.26	-	18.39	-	-	53.67	-
10. ‘Hermes’	-	82.85	-	12.71	-	-	61.52	-
11. ‘E-68’	-	54.03	-	11.58	-	-	57.07	-
12. ‘Ilona’	-	85.55	-	9.69	-	-	61.12	-
13. ‘Evelin’	-	67.90	-	15.08	-	-	47.15	-
14. ‘Argos’	-	75.18	-	6.57	-	-	63.35	-
15. ‘Kastyčiai’	-	73.15	-	8.98	-	-	54.86	-
16. ‘Elize’	-	65.40	-	14.44	-	-	64.54	-
17. ‘Marylin’	-	67.45	-	15.99	-	-	59.52	-
18. ‘Viola’	-	84.21	-	7.16	-	-	62.53	-

Data of fibre fineness measured at INF are presented in Table 5. The finest was fibre obtained from varieties ‘Belinka’ and ‘Baltučiai’ and breeding line No. 1963-3 (fibre fineness index – 70.2–82.6). When comparing fibre fineness data obtained by different methods the results were similar.

A reliable (P = 99 %) linear correlation (y = 125.574-0.181x; r = 0.507) between fibre fineness data obtained by measuring fibre divisibility and fibre fineness index by WIRA was found.

Modified power regression type was selected since it showed the strongest (amongst the other types of correlation) paired correlation (determination coefficient $R^2 = 0.31$) between the data obtained using two different methods.

Table 5. Long fibre fineness index (IFS) and its standard deviation s
5 lentelė. *Ilgojo pluošto plonumo indeksas (PPI) ir jo standartinis nuokrypis s*
INF, 2001–2002

Variety or breeding line *Veislė arba selekcinė linija*	IFS / *PPI*				*s*	
	2001	2002	Avg. *Vid.*	Relative values *Sant. sk.*	2001	2002
1. ʻBelinkaʼ (stand.)	75.73	64.58	70.16	100.0	5.26	4.60
2. ʻBaltučiaiʼ	80.05	67.04	73.55	104.8	2.86	4.23
3. ʻArianeʼ	113.4	99.29	106.35	151.6	4.24	1.89
4. 01057-12	89.27	86.62	87.95	125.4	5.69	2.60
5. 1698-13a	84.56	92.77	88.67	126.4	5.88	0.95
6. 1864-24	112.64	92.96	102.80	146.5	2.15	5.83
7. 1963-3	88.23	77.04	82.64	117.8	3.33	4.72
8. 2017-3	-	70.18	-	108.7	-	1.36
9. ʻVega 2ʼ	-	64.37	-	99.7	-	4.05
10. ʻHermesʼ	-	80.93	-	125.3	-	5.41
11. ʻE-68ʼ	-	77.54	-	120.1	-	3.50
12. ʻIlonaʼ	-	99.83		154.6	-	4.08
13. ʻEvelinʼ	-	95.63	-	148.1	-	2.89
14. ʻArgosʼ	-	100.45	-	155.5	-	4.97
15. ʻKastyčiaiʼ	-	78.77	-	122.0	-	3.71
16. ʻElizeʼ	-	79.79	-	123.6	-	2.23
17. ʻMarylinʼ	-	90.07	-	139.5	-	1.93
18. ʻViolaʼ	-	95.60	-	148.0	-	1.12

The assessment of cross sections of fibres was carried out using FIBRE IMAGE ANALYSIS. The measurements of the diameter of fibre bundle and single fibre confirm that the quality of fibre samples tested in 2001 was not very high – the diameter of fibre bundle was very big, some bundles still had pectin skin (Figure 1) (Table 6). The diameter of single fibres was 18–21 μm (Figure 2). Polish researchers have reported that the best fibre diameter is 15 μm /Pawula, Mazur, 2001/. In 2002 the diameter of fibre bundles as well as the diameter of single fibres was smaller.

Table 6. Size (in μm) of long fibre bundle and elementary fibre diameter and its variation (V, %)
6 lentelė. *Ilgojo pluošto ryšelio bei elementarios pluošto ląstelės skersmuo (μm) ir jų variacija (V, %)*

INF, 2001–2002

Variety or breeding line *Veislė arba selekcinė linija*	Diameter of fibre bundle μm *Pluošto ryšelio skersmuo μm*	V, %	Diameter of single fibre μm *Pluošto ląstelės skersmuo μm*	V, %
	2001			
'Ilona'	98.67	25.59	19.55	30.65
'Baltučiai'	134.00	21.40	19.80	30.20
01057-12	143.50	27.84	18.28	32.54
1698-13a	119.40	26.01	20.92	24.20
1864-24	117.40	6.75	20.28	25.26
1963-3	139.00	38.68	20.30	25.99
	2002			
'Belinka'	59.21	-	17.7	24.39
'Baltučiai'	69.21	-	13.7	25.18
'E-68'	90.42	-	16.7	17.92
01057-12	86.48	-	18.1	27.18
1698-13a	62.37	-	16.0	25.49
1864-24	170.5	-	15.9	31.74
1963-3	104.1	-	16.6	30.93

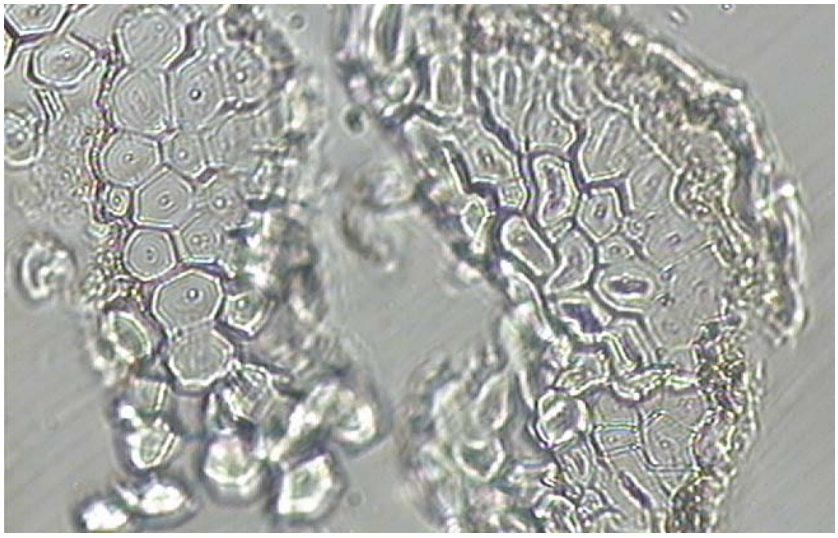

Figure 1. Light microscope picture of big fibre bundles (x 500)
1 paveikslas. *Pluošto ryšeliai padidinus mikroskopu (x 500)*

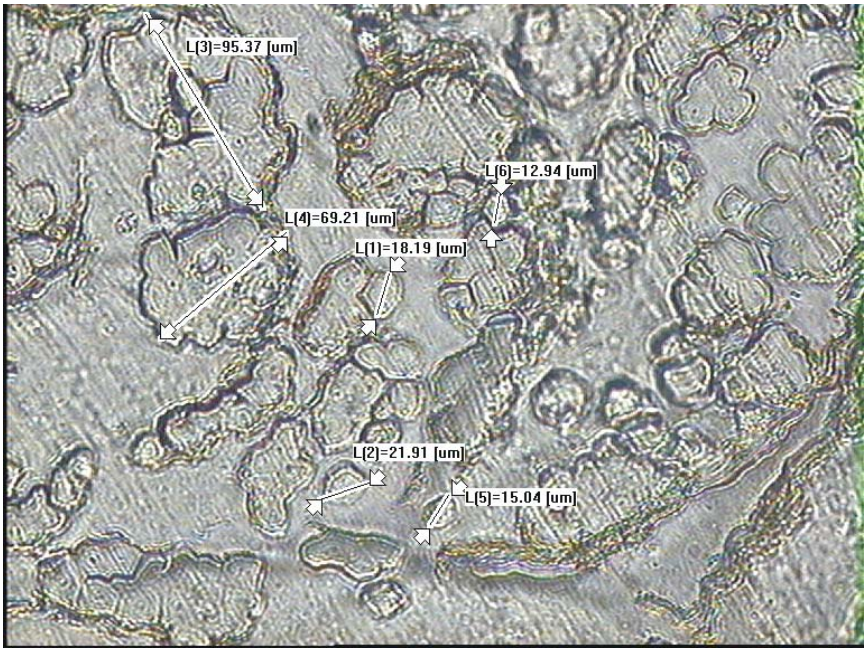

Figure 2. Light microscope picture of ultimate fibre and fibre bundle measurement (in μm) (x 500)
2 paveikslas. *Pluošto ląstelė bei ryšeliai, jų matmenys (μm, padidinus mikroskopu (x 500)*

Conclusions

1. Three years' experimental findings suggest that the variety 'Ariane' gave the highest long fibre yield 1.22 t ha^{-1}. The lowest yield (0.80 t ha^{-1}) was produced by the early-ripening variety 'Baltučiai'. Good results were demonstrated by the new breeding lines No. 1963-3, No. 1864-24 and No. 01057-12. Experimental evidence from 2002–2003 indicate that the highest average long fibre yield was produced by the varieties 'Hermes' and 'Ilona'. In 2003 the highest yield was obtained from the new breeding lines No. 1878-9 and No. 01149-14.

2. The variety 'Ariane' and breeding line No. 1864-24 had the highest fibre content (19.2–19.5 %), and the lowest fibre content was detected in 'Belinka' (15.8 %) and 'Baltučiai' (16.0 %) flax straw. From the varieties which had been investigated only for 2 years, the flax variety 'Hermes' had the highest fibre content (25.2 %), flax 'Belinka', 'Vega 2' and 'Kastyčiai' – the lowest (19.6–19.1 %). The new breeding lines tested in 2003 had sufficiently high fibre content (No. 01149-14 – 25.2 % and No. 1878-9 – 25.8 %).

3. The strongest fibre was obtained from the variety 'Baltučiai' and breeding lines No. 01057-12 and No. 1864-24. In 2002–2003 the strongest fibre was obtained from the varieties 'Hermes' (23.1 kg F), 'Elize' (22.8 kg F), 'Kastyčiai' (22.6 kg F), 'Vega 2' (20.7 kg F), 'Argos' (20.7 kg F), and 'Viola' (20.6 kg F). From the new breeding lines tested only in 2003, No. 1878-9 and No. 01149-14 had the strongest fibre.

4. The most flexible was fibre from the variety ‘Baltučiai’ (52.3 mm). The averaged data from 2002–2003 suggest that only fibre from breeding line No. 2017-3 and variety ‘Vega 2’ was more flexible (by 6.4–4.6 %) compared with the standard variety ‘Belinka’ (45.5 mm). The two new breeding lines (No. 1698-3 and No. 2030-5) in 2003 had more flexible fibre (53.2 mm and 57.9 mm, respectively) compared with the standard ‘Belinka’ (45.1 mm).

5. Only fibre of the variety ‘Baltučiai’ had the same fineness value as ‘Belinka’s fibre. From the varieties tested only in 2002 the finest fibre was obtained for the variety ‘Vega 2’.

6. The variety ‘Baltučiai’ – long fibre breaking length was the highest (14.0 km) and by 15.7 %, or by 1.9 km, higher than that of the standard ‘Belinka’. Results obtained in 2002 indicate that fibre breaking force calculated for breeding line No. 2017-3 and varieties ‘Vega 2’, ‘Argos’ and ’Kastyčiai’ was by 0.3–0.9 km, or by 2.3–7.0 % higher compared with the standard variety.

7. Fibre analyses done at INF during 2001–2002 suggest that the highest fibre tenacity (58.70 cN/tex) was identified for the breeding line No. 1864-24. From the varieties grown in 2002, the varieties ‘Hermes’, ‘Ilona’, ‘Argos’, ‘Elize’ and ‘Viola’ had strong fibre; it was by 5.2–1.8 cN/tex, or by 8.8–3.0 %, stronger compared with the standard ‘Belinka’.

8. Reliable correlation between the data of fibre tenacity obtained using different methods as well as between the data of fibre fineness obtained by different methods was found.

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PLUOŠTINIŲ LINŲ VEISLIŲ BEI SELEKCINIŲ NUMERIŲ PLUOŠTO KOKYBĖS TYRIMAI SKIRTINGAIS METODAIS

Z. Jankauskienė, K. Bačelis

Santrauka

2001–2003 m. Lietuvos žemdirbystės instituto Upytės bandymų stotyje buvo tirtos įvairios pluoštinių linų veislės bei nauji selekciniai numeriai. Tyrimų tikslas – nustatyti ilgojo pluošto kokybinius parametrus ir palyginti juos su pluoštinių linų standartinių veislių rodiklais, išryškinti naujai kuriamų ar jau sukurtų tirtų veislių pranašumus, palyginti pluošto vertinimo duomenis, nustatytus turima įranga (įprastais metodais) bei naujais, Europos šalyse naudojamais metodais.

Pluošto stiprumas Lietuvos žemdirbystės instituto Upytės bandymų stotyje buvo nustatytas dinamometru DK-60, pluošto lankstumas – prietaisu G-2, pluošto plonumas (susikaidymas) – suskaičiuojant atsiskyrusius pluoštelius (pagal specialią metodiką). 2001–2002 m. tų pačių pavyzdžių pluoštas buvo analizuojamas ir Natūralių pluoštų institute Poznanėje. Pluošto stiprumas buvo nustatomas automatiniu tempimo stiprumo jėgos matuokliu – prietaisu „Statimat ME“, pluošto plonumas – pluošto plonumo nustatymo prietaisu WIRA, pluošto ląstelų ir pluošto ryšelių skersmuo buvo matuotas po specialaus pavyzdžių paruošimo naudojant mikroskopą „Nikon“ su kamera bei kompiuterinę programą FIBRE IMAGE ANALYSIS.

Straipsnyje pristatomi šių tyrimų duomenys, pateikiama pluošto ląstelių skerspjūvių nuotraukų. Stipriausias pluoštas buvo selekcinių linijų Nr. 01057-12 ir Nr. 1864-24, o ploniausias – veislių ‘Belinka’ ir ‘Baltučiai’ bei selekcinės linijos Nr. 1963-3.

Nustatytas esminis koreliacinis ryšys tarp pluošto kokybės duomenų, nustatytų naudojant skirtingus vertinimo metodus bei aparatūrą.

Reikšminiai žodžiai: lankstumas, metodai, plonumas, pluoštiniai linai, pluošto kokybė, selekcinės linijos, stiprumas, veislės.