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Contents:

EXTRACTION OF GLYCANES FROM FLAX SEED (Linum usitatisssimum L.) WITH ULTRASONIC TREATMENT

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Abstract:
Flax seed (Linum usitatisssimum L.) is one of the widely known and accessible sources of polysaccharides which are used both as a drug in herbal medicine and as valuable food plant raw material. The ultrasonic extraction of polysaccharides from flax seed was carried out. Optimal parameters of ultrasonic treatment were determined. Method of extraction reduces the time of the process from 24 hours to several minutes.
Key-words: extraction, ultrasound, polysaccharides.

In recent years the interest to plant oligo- and polysaccharides has considerably grown. Earlier the glycanes were used only as subsidiary components and they are considered as independent biologically active substance due to the discovery of new properties. Antihypoxic, antitumoral, antiviral, antimicrobial, sorption, antiatherosclerotic properties of plant polysaccharides were detected.

One of the widely known and accessible sources of polysaccharides is flax seed (Linum usitatisssimum L.) which are used both as a drug in herbal medicine and as valuable food plant raw material. From the point of view of photochemistry flax seed contain a lot of biologically active substances with a variety of pharmacological action. Flax seedcoat contains 10% mucilage [1,2].

Flax glycanes are prospective prebiotics. Prebiotic action of polysaccharides is connected with following factors: the increase of the number and activity of bifido- and lactobacteria, optimization of intestinal motility, increase of calcium, magnesium and other metal absorption, decrease of the level of cholesterol and triglycerides, prevention of intestines cancer. Besides polysaccharides of flax can be used as water-retaining and binding agents in bakery production, rendering, thus, protective action on the digestive system [3].

The prospective method to intensify the extraction of plant polysaccharides from natural raw material is the use of ultrasonic (US) treatment [4]. Under the influence of ultrasonic oscillations quicker and more active destruction of the tissues of plant raw material takes place that results in the intensification of the extraction process and allows increasing the content of biologically active compounds of a solution [5].

In an acoustic field together with the removal of diffusion limitation the increase of interphase specific surface of the reacting components is of importance for the intensification of the extraction process. The dispersion takes place both owing to the destruction of solid phase particles and the surface friction between solid and liquid phase. The use of ultrasonic waves for the extraction of biologically active substance from plant raw material provides the combination of mechanical effect (grinding, cells breaking during the ultrasonic treatment) and turbulization of the medium [6].

In the paper presented the ultrasonic extraction of polysaccharides from flax seed was carried out. Water extracts of polysaccharides were obtained at a room temperature with the help of ultrasonic dispersant IKASONIC U50; the ratio raw materials : extraction solvent 1:10 (wt).

Optimal parameters of ultrasonic treatment were determined using the dependences of viscosity of polysaccharides solutions obtained and the mass of solid residue on ultrasonic intensity and time of treatment. The increase of viscosity in each series of experiments has extremum. The time of extremum appearance reduces as the intensity of ultrasonic treatment increases. The comparison of these 2 dependence gives optimal condition: concentration growth and viscosity decrease after the optimal point proves native polyuronides destruction.

IR Fourier-spectroscopy was used for the identification and confirmation of structure of the glycanes obtained [7]. For the analysis by method of IR spectroscopy the tables with KBr were prepared from the obtained glycanes. The parameters of spectrum registration were from 500 sm-1 up to 2000 sm-1, the resolution 1 sm-1. IR-spectra of polysaccharides of flax seeds obtained by traditional infusion were compared to the spectra of glycanes obtained by ultrasonic extraction at optimal parameters of the process (intensity – 276 W/sm2 and duration 16 minutes) (Table).

Functional group	Oscillation frequency, sm^{-1}
C-H	2920-2850
C=O	1740
COOH	1598
OH	1430

Table – Frequencies of oscillation of flax polysaccharides functional groups

The analysis of the spectra obtained shows that the chosen optimal parameters of ultrasonic treatment do not considerably change the structure of flax polysaccharides. The spectra contain all the peaks corresponding the functional groups of flax polysaccharides. The peak correlating the carboxyl group oscillation is especially distinct that allows attributing the polysaccharides to polyuronides.

Thus, the ultrasonic treatment were revealed to considerably increase the affectivity of polysaccharides of Linum usitatissimum L. extraction and to reduces the time of the process from 24 hours to several minutes without causing glycanes destruction. The analyses conducted prove that the use of ultrasonic treatment does not result in the qualitative change of fraction composition of glycane extracts but allows obtaining the extracts more homogeneous by composition. The polysaccharides extracted from flax seeds have no unpleasant odour, they improve the structure of the product, they are non-toxic, promising prebiotics and can be used as components of functional foodstuffs.

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GENETIC RESOURCES AND BREEDING FIBER FLAX FOR NEXT CENTURY

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Abstract:

Because of rapid growth of the human population and changes in agroecological conditions, which are due to the intensification of agricultural and rapid development of industry we are facing an enormous pollution of soil, water and air.

These staggering changes may be to some extent counteracted by human action such as the increase of genetic yield potential of field, crops, breeding of cultivars to meet the requirement of sustainable agriculture, and the introduction of new plant species into agriculture.

During long term experiments taking place between 1976-2008 on the brown soil at the ADRS Livada under intensive cropping more than 500 fiber cultivars were tested, representing all typical ecological region that exist in the majority of growing center of 22 countries, from Europe, South and North America, Asia and Middle Orient.

After this study from total collection were selected only cultivars which present interest for breeding process.

Key words: Linum usitatissimum L collection, breeding for wilt, lodging resistance, and productivity; technical length, fiber content.

Introduction:

Impressive results of fiber and oil flax have been reported all over the world depending on economical importance and destination.

In Romania the largest fiber flax breeding program is located at the Agricultural Development Research Station Livada department Satu Mare situated in North-West of Romania. This program has been successful in producing new fiber flax varieties which replaced the foreign varieties dominating in the Romanian agriculture L1120, Primo, Milenium and Hera.

Precipitation of area, the presence of acid soil, poor in organic and mineral colloid, with implication over yielding capacity of fiber flax, have conducted to the initiation and profound of this study towards elements of productivity at an assortment of fiber flax compound 500 cultivars coming from different area 22 countries from Europe, South-North America, Asia, and Middle Orient

Collection study during 1976-1980 has got as final object to specify the best varieties for Romania and use in the breeding program for obtaining new valuable cultivars.

The principal problem to approach in this study was to select from the total collection only those cultivars that present importance for crossing under aspects of characters and appropriation of quality.

After this study from total collection were selected 151 cultivars for total and technical length and 20 for productivity and wilt and lodging after rainfall.

Experimental Part:

The testing was done on a brown luvic soil with a weak acid reaction (pH -5,6) provided with mobile phosphorus (60 ppm),and potassium (300 ppm). Optimum fertilizer rates were N60.P60. K60 (complex N15. P15 K15) applied in the spring.

Sowing date was every year in the period 10-20 April. Experimental plots for collection study were three meter square in three repetition, to provide 2400 grains/ meter square, and for the productivity study (20 cultivars) experimental plots were 25m meter square in five repetition.

During these years we estimated the stem and seed production, fiber content of stem using a 1,8 %,solution of NaOH.

The calculation of the of the experiments was performed by variance analysis methods (Ceapoiu 1968 and Snedecor 1968) and regression method (bx) proposed by Finlay and Wilkinson, (1963),

The resistance to Fusarium sp. was tested in the field infection, flax monoculture and stem infected incorporated in soil with plough in autumn to facilitate the natural infection accumulated year by year.

For evaluation of the resistance level the scale proposed by Kommedahl et all. (1970) was used all observation in the resistance reveled in this study have been made in the full maturity stage.

The estimation of the rainfall resistance was done on the first and the seventy day after 1 st rain (Scale 1-9)

In the 1982 breeding season, inbreads and single cross of ten cultivars of flax Bertelin, K-6, Silva, Ariane, Regina, Waza, Mira, Thallasa, L40010-70 and Lazurnii, selected to represent a range of values for the characters of interest in this study were crossed in all ossible combination including diallel n(n-1)/2 experiment. Parental, F1 and F2 plants were evaluated in the field at Livada during 1983 and 1984 in a split plot desingn with four replications. Each whole plot contained the parent and F1 between them. Seed of each parents and hybrid were planted in plot 1-m long. Date were collected from 50 plant/plot. These date were used for estimates the differentiation between the combination using block method after Ceapoiu (1968) and Snedecor (1968).

Estimates of heterosis for height total, technical and number of ramification/plant in the first generation (F1) were obtained based on the middle parents averaged and on the high parent. Both general and specific combining ability were important for plant, total, technical height and number of ramification.

Estimates of general and specific effects were obtained according to Griffing,s (1956) method 2 model 1 analysis.

From this study in period 1995-2003, State Commission had homologated 16 new varieties .

Results and discussion:

The success in the improvement of the plants is conditioned in pursuit of clear objectives ; productivity capacity, the resistance to lodging and wilt (Fusarium sp) associated with high fiber content .An important step in the process of breeding fiber flax varieties has been the indentification of the most valuable existing in flax germoplasm at ARS Livada

Duration of vegetation period

Vegetation period at studied was comprised between 84-102 days comparision with Milenium (PL) varieties (90 days) which was cultivated in our area (table 1)

Vegetative Period	84	90	96	<102	Total
Diff.days± Milenium	-6	90	+6	+12	
% Cultivars from collection	31%	26%	32%	11%	100 %
Group maturity	precocity	half percocity	half tardy	Tardy	.

Table 1 Vegetative period for the investigated genotypes

From total genotypes 31% present an evident precocity and 11% a pronounced tardiness.at blow flowering while at yellow maturity.

Resistance to lodging:

Lodging resistance is a principal component of the high quality of stem. Final note put in evidence 17,2% cultivars very resistance, 15,8 % resistance, 39,6 maderately resistance, 22,2 moderately susceptibile and 5.2 % susceptibile (table2)

Classified	Scale FAO 1-9	Nr	%
Very resistance	1	72	17,2
Resistant	2	66	15.8
Moderately Resistance	3-4	166	39,6
Moderately Susceptible	5-6	93	22,2
Susceptible	7-8	22	5,2
		419	100

Table 2 Genetic resources for resistance to lodging, cultivars with total length over 80 cm

The cultivars which present interest for breeding with total length over 8o cm is present in table 3

Experimental date obtained in the comparative trials with cultivars considered as most productive in Europe to put in evidence a large variability of crops capacity and may be used in breeding programs for growing of genetic contribution of new cultivarsThe amplitude of stem yield (y max-y min) indicate that the crops capacity is differential and variable year by year in function of climate condition and comportment of genotypes.

The greatest amplitude of yielding by cultivars Belinka, Olina, and Ariane over 74% (table 3) Another indicator is the minimum crops/yield (y min) in comparison with average yield (y x) which indicated that the majority of cultivars were not very tolerant to climatic condition

Rapport between yield maximum and yield minimum as an indicator for classify the genotypes,that indicates that all the cultivars which registered value is more than two are intensive cultivars.

A modality of estimation of the cultivars which correspond to the amplitude of the production is also that of coefficient of variability (cv%).The value obtained presents a middle (over 10%) of seven cultivars and a high variability (over 20%) of 1

Soiul	$\frac{y\,max - y\,min}{0{,}01\bar{y}}$	$\frac{y\,max - \bar{y}}{0{,}01\bar{y}}$	%	$\frac{\bar{y} - y\,min}{0{,}01\bar{y}}$	%	$\frac{y\,max}{y\,min}$	Cv %	Coeficient regresie (b)
1.Lintex	56,5	24,3	43	32,2	57	1,83	22,8	1,062
2.Olina	74,8	37,1	50	37,7	50	2,20	25,9	1,086
3.Primo	54,7	26,1	45	30,1	55	1,78	19,7	0,872
4.Natasja	51,8	24,8	48	27,0	52	1,71	20,2	0,906
5.L 40189-74	46,3	20,9	45	25,4	55	1,62	16,0	0,827
6.Bertelin	59,2	32,3	54	26,9	46	1,80	22,1	1,244
7.Hera	58,7	29,3	50	29,4	50	1,83	22,3	0,960
8.Belan	48,5	23,4	48	25,1	52	1,65	18,0	0,854
9.Linda	55,4	21,8	39	33,6	61	1,83	20,8	1,015
10.Thallasa	41,1	19,6	48	21,5	52	1,53	16,7	0,821
11.Silva	59,2	30,2	51	29,0	49	1,83	21,8	1,035
12.Ariane	74,4	43,0	58	31,4	42	2,08	23,4	1,089
13.Fany	54,6	21,2	39	33,4	61	1,82	18,4	0,872
14.Eva	47,7	20,3	43	27,4	57	1,66	18,5	0,785
15.Regina	62,0	26,2	42	35,8	58	1,96	24,0	1,077
16.Waza	67,9	32,5	48	35,4	52	2,05	23,9	1,223
17.Mira	50,0	20,7	41	29,3	59	1,70	18,4	0,868
18.Gembloux	49,8	20,3	41	29,5	59	1,70	22,7	1,020
19.Belinka	78,9	39,1	49	39,8	51	2,31	25,7	1,260
20.Pet	61,1	27,1	44	34,0	56	1,93	23,0	1,138

Table 3 Element of variability in stem yield without capsules Livada 1983-1991

Another modality of analysis of the cultivars is the coefficient of regression (bx), comparative with year average of all the cultivars in function of (y=a+bx) regression line which permit classification of varieties in the classes with general stability, (bx=0.785-1,26); great (bx=0,5-0,785); and reduced bx, over 1,26 Belinka, Waza and Bertelin .

Conclusion:

On the basis of this study was established the real importance of some of the cultivars concerning the length, of the phase of development from spring to maturity stage included in 84-102 days.

The estimation of the resistance to lodging we have concluded that among the cultivars there exists a sufficient variability.

The verification of the productive potential and estimation of the variability of production based on the following parameters , amplitude, relation between the maximum and minimum, coefficient of cv% and the regression coefficient bx underlined the existence of some difference among cultivars.

From total germoplasm exested at ARS Livada the most frequently were used in cross dialle year by year 10 varieties.

Since 1995 just 2003 State Comission have homologated 16 new cultivars Codruta, Ioana, Carolina, Elena, Monica, Alin Cosmin, Iordan, Rares, Bazil, Louis, Martin Sabena, Radu, Elisa and Paula in 2003

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Achievements of Lithuanian fibre flax breeding – new varieties 'Dangiai', 'Snaigiai' and 'Sartai'

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Abstract:

The paper presents description of development and investigation of three new fibre flax varieties, bred at the Upytė Research Station of the Lithuanian institute of Agriculture. Promising breeding lines No. 2018-8, No. 2243-13 and No. 2635-15 were tested in the control nursery in 2001-2002, in the initial variety testing trials in 2003 and in the competitive variety trials in 2004-2005. Main characteristics of breeding lines tested prevailed over that of the standard varieties, therefore, new fibre flax varieties 'Dangiai' (breeding line No. 2018-8), 'Snaigiai' (breeding line No. 2243-13) and 'Sartai' (No. 2635-15) have been tested for VCU and DUS. Tests were found to be positive, therefore, new fibre flax varieties are included to the Lithuanian National List of plant varieties and EC Common catalogue of varieties of agricultural plant species since 2009.

Key words: breeding, fibre flax, fiber quality, variety, yield.

Introduction:

For 4 thousand years flax has been serving Lithuanians as a raw material for clothing, food, medicine and other purposes. During all the periods of Lithuanian State development flax cultivation was one of the key branches of crop production economy [Bražukienė, 2001].

Fibre flax breeding has been carried out in Lithuania since 1922. Since 1922 to 2005 eighteen fibre flax varieties have been developed in our country [Bačelis, 2001]. The prime aim for fibre flax breeders is to increase fibre yield per hectare, but this character has low heritability, it is not easy to evaluate because it is largely influenced by the environment [Fouilloux, 1989]. High fibre quality is one of the key requirements in fibre flax breeding for textile purposes [Хеллер и Рульский, 2002]. But the quality is yet less heritable than fibre productivity. Furthermore, the new flax varieties should be resistant to lodging and diseases.

Our aim is to develop novel high yielding fibre flax varieties, resistant to lodging, with a high fibre yield and quality, less susceptible to fungal diseases, with a moderately long vegetative growth period, well adapted to Lithuania's soil and climate conditions.

Materials and methods:

The flax breeding was conducted on a Eutri-Endohypogleyic Cambisol [Buivydaitė et al., 2001]. Flax was sown after winter wheat. Conventional cultivation practices were used. Fibre flax breeding was carried out according to the following scheme: 1) nurseries of initial material (collection, hybrids, mutants), 2) breeding nursery, 3) hybrids nursery, 4) selection nursery, 5) control nursery, 6) initial variety trials, 7) competitive variety trials. Competitive variety trials involve 3-4 replications, the size of a record plot is 16.0 m2. All field trials were conducted (with a few modifications) in compliance with published methodology [Методические, 1978; Рогаш и др., 1987].

In the competitive variety trials the plots were sown by a sowing machine SNL-16 at a seed rate of 25 million seed per hectare, 10 cm space between rows. Insecticides were sprayed against flax flea beetles and herbicides were used to control weeds.

During vegetative growth period of flax the phenological observations were conducted; resistance to lodging and the incidence of fungal diseases on flax at the natural background etc. were assessed [Лошакова и др., 2002]. Flax was pulled at the stage of early yellow ripeness, threshed by a MS thresher, the stems were retted in a warm (33-37°C) water, then stems were break up by machine tool SMT-200, fibre was hackled. Quality number of long fibre was determined in the laboratory, flexibility – by a device G-2, strength of fibre – by a device DK-60 and thinness (divisibility) – following special methodology by counting separate fibres in a fibre sample, the length of which is 1 cm, mass 10 mg. Long fibre rupture length (in km) was calculated using the formula: RL (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 [Методики, 1961]. Morphological analysis of plants was carried out also. Stem, seed and fibre yield was evaluated using analysis of variance. For calculations we used the statistical software developed at the Lithuanian Institute of Agriculture [Tarakanovas, Raudonius, 2003].

Meteorological conditions during the period 1978-2005 were not every year favourable and had a marked effect on the yield.

Results and Discussion:

The new fibre flax varieties 'Dangiai', 'Snaigiai' and 'Sartai' have been bred at the Upytė Research Station of the Lithuanian institute of Agriculture using the method of intervarietal crossing. 'Dangiai' (breeding line No. 2018-8) was developed by crossing female variety 'Milenium' of Polish origin with flax variety 'Belan' developed in Czech Republic. 'Snaigiai' (breeding line No. 2243-13) was obtained by crossing female variety 'T-10' (of Russian origin) with flax variety 'VNIIL-6' (developed in Russia). 'Sartai' (breeding line No. 2365-15) was created by crossing 'Belinka' of Dutch origin with 'Oršanskij 80' developed in Belarus.

Dr. K. Bačelis is the author of presented varieties. Since 2005 the initial variety testing and initial seed multiplication is continued by dr. Z. Jankauskienė.

In the competitive variety trials 'Dangiai', 'Snaigiai' and 'Sartai' were tested in 2004-2005. Average data of 2 years competitive trials showed that the new variety 'Dangiai' compared to the standard 'Hermes' (Table 1) had higher fibre content, more thin fibre (higher divisibility data), higher quality number, taller plants, produced more capsules per plant, had shorter vegetation period, plants were more resistant to Fusarium spp. and Colletotrichum lini. 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 (standard) variety. When compared to data of 'Belinka' (quality standard), new variety 'Dangiai' had higher fibre content, firmer fibre and better its divisibility.

In the competitive trials new variety 'Snaigiai' had taller plants, higher stem and long fibre yield, more flexible and thinner fibre (higher divisibility data), higher quality number and rupture length, compared to the standard variety 'Hermes'. Plants of 'Snaigiai' were more resistant to Fusarium spp. and Colletotrichum lini. Compared to the data of 'Belinka' (quality standard), flax of the new variety 'Snaigiai' had higher fibre content, more flexible fibre, higher fibre divisibility and rupture length.

Flax of new variety 'Sartai' produced stem yiled of 6,21 t ha–1, seed yiled – of 0,74 t ha–1 and long fibre yield of 1,58 t ha–1 in the competitive trials. 'Snaigiai' had taller plants, longer technical stem part, higher stem and long fibre yield, higher fibre quality number, when compared to the standard variety 'Hermes'. Plants of 'Sartai' were more resistant to Fusarium spp. and Colletotrichum lini. Compared to the data of 'Belinka' (quality standard), flax of the new variety 'Snaigiai' had rather high fibre content, fibre was more flexible and firm.

Indice	'Hermes' stand.	'Dangiai' (Nb. 2018–8)		'Snaigiai' (Nb. 2243–13)		'Sartai' (Nb. 2635–15)	
		2 years average	*compared to stand.*	*2 years average*	*compared to stand.*	*2 years average*	*compared to stand.*
Yield, t ha^{-1}:							
stem (LSD_{05} 0.67)	5.85	5.57	95.2	6.30	107.7	6.21	106.2
seed (R_{05} 0.11)	0.74	0.71	96.0	0.61	82.4	0.74	100.0
long fibre (R_{05} 0.19)	1.57	1.52	96.8	1.65	105.1	1.58	100.6
content, %	26.5	27.2	102.6	26.2	98.9	25.4	95.9
Long fibre quality:							
flexibility, mm	38.1	35.8	94.0	46.6	122.3	37.7	99.0
strength, kg F	15.6	15.3	98.1	13.9	89.1	14.6	93.6
divisibility, units	248	275	110.9	283	114.1	255	102.8
rupture length, km	12.3	12.3	100.0	13.2	107.3	12.1	98.4
quality Nb.	11.9	12.4	104.2	12.4	104.2	12.5	105.0
Agrobiological indices:							
Plant height, cm	73.8	76.3	103.4	80.1	108.5	80.1	108.5
Technical stem length, cm	69.3	68.8	99.3	70.6	101.9	74.2	107.1
Number of capsules per plant	1.80	2.50	138.9	1.25	69.4	1.75	97.2
1000 seed weight, g	5.59	4.73	84.6	5.53	98.9	5.41	96.8
Growing period, days	91	87	85.6	89	97.8	90	98.9
Resistance to lodging, points	8.95	8.55	85.5	8.90	99.4	8.45	94.4
Disease incidence on stems, %	37.0	10.6	28.7	12.8	34.6	7.2	19.5

Table 1. Data of the yield, long fibre content and quality, agrobiological indices investigation of the promising breeding lines at the competitive variety testing trials. Upytė, 2004–2005

Main characteristics of 'Dangiai', 'Snaigiai' and 'Sartai' at the competitive variety testing trials prevailed over that of the standard variety, therefore, new fibre flax varieties have been tested for VCU (Value for Cultivation or Use) and DUS (Distinctness, Uniformity and Stability) in 2007-2008.

The new fibre flax varieties 'Dangiai', 'Snaigiai' and 'Sartai' were found to be superior to different standard varieties. Tests were found to be positive, therefore, new fibre flax varieties are included to the Lithuanian National List of plant varieties and EC Common catalogue of varieties of agricultural plant species since 2009.

Some results of varieties' DUS testing are presented in the table 2.

Characteristics	'Dangiai'	'Snaigiai'	'Sartai'
Plant: natural height (including branches)	6 – medium to tall	6 – medium to tall	6 – medium to tall
Stem: lenght (excluding very short branches)	5 – medium	5 – medium	5 – medium
Flower: size of corola	3 – small	3 – small	3 – small
Flower: sepal-dotting	3 – weak	3 – weak	3 – weak
Flower: colour of petals of corolla at bud stage	2 – blue-violet	1 – white	1 – white
Flower: colour of petals of corolla	3 – blue	1 – white	1 – white
Flower: longitudinal folding petals of corolla	1 – absent	1 – absent	1 – absent
Flower: colour of filament of stamen	1 – white	1 – white	1 – white
Flower: colour of anther	3 – grey	3 – grey	3 – grey
Flower: colour of style at base	3 – blue	1 – white	1 – white
Boll: size	3 – small	5 – medium	3 – small
Boll: ciliation of false septa of boll	1 – absent	1 – absent	1 – absent
Seed: 1000 seeds weight	6 – medium to high	6 – medium to high	6 – medium to high
Seed: colour	3 – light brown	4 – medium brown	3 – light brown
Time of begining of flowering	3 – early	5 – medium	5 – medium

Table 2. The charctersation of new fibre flax varieties 'Dangiai', 'Snaigiai' and 'Sartai' according UPOV descriptors

Conclusions:

'Dangiai' is blue flowering, moderately early ripening variety, lodging resistant, seeds are brown, 1000 seeds weight – around 4.73 g, fibre quality is good, fibre is suitable for textile purposes.

'Snaigiai' is a white flowering, high fibre yielding, moderately late ripening, lodging resistant variety. Fibre quality is satisfactory and suitable for textile production. Seeds are brown, 1000 seed weight – 5.53 g.

'Sartai' is a white flowering, moderately ripening, high yielding variety, resistant to lodging. The seeds are brown, 1000 seed weight is 5.41 g. Fibre quality is also good, fibre is suitable for the textile production.

VCU and DUS tests in 2007-2008 showed that new fibre flax varieties met the requirements, therefore, they could be included to to the Lithuanian National List of plant varieties and EC Common catalogue of varieties of agricultural plant species since 2009.

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The investigation of industrial hemp acclimatization in Lithuania

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Abstract:

The industrial hemp (Cannabis sativa L.) is rather new plant in Lithuania. The biometrical indices of five hemp varieties (Beniko, Bialobrezskie, Epsilon 68, Felina 32 and USO 31) have been investigated at the Upytė Research Station of LIA in 2008. The data from 2008 led to draw preliminary conclusion that plants of industrial hemp varieties tested could be successfully grown in Lithuania. Hemp produced enough high amount of green (up till 36.8 t ha-1) and dry (up till 19.0 t ha-1) biomass. The highest were plants of Beniko (2.45 m) and Epsilon 68 (2.42 m). Crop density, weediness and the reduction of them, stalk and seed yield were also evaluated.

Key words: Cannabis sativa L., fibre, hemp, seed rate, varieties.

Introduction:

Hemp (Cannabis sativa L.) has been cultivated over a period of many centuries in almost every European country. It once represented a significant raw material source for the production of rope, canvas, textiles, paper, and oil products [Bocsa, Karus, 1998].

The demand for renewable raw materials is increasing. Many new products processed from strong fibres such as hemp and flax appear all over the world [Pallesen, Eriksen, 2002].

In many countries the cultivation of hemp lays under the ban. Because hemp varieties with low THC (Tetrahydrocannabinol) content have been bred, many of them are allowed to grow in the countries of EC. The EC common catalogue of varieties of agricultural plant species in 2009 contains the list of 43 industrial hemp varieties [Cannabis sativa…, 2009].

The question is which variety from the EC list could be the best to grow in Lithuania? The nearest to Lithuania country where industrial hemp is grown and even hemp breeding is carried out is Poland, therefore, hemp varieties developed is this country could be the most suitable for Lithuania's pedoclimatical conditions.

In Poland hemp varieties of Polish origin Beniko and Bialobrezskie were investigated in 1986-1988. Plants of Bialobrzeskie showed higher seed (550 kg ha-1) and stalk (10 t ha-1) yield, but the plants of Beniko had higher fibre yield (total fibre yield 2.89 t ha-1, long fibre yield 2.67 t ha-1) [Poradnik plantatora, 1994]. Investigation in 2000-2001 provided with information that from 14 hemp varieties tested in Poland, plants of Beniko and Bialobrezskie had the highest total fibre content (28.5 and 26.9 %, respectively) while the highest stalk yield was obtained from plants of Hei Bei (18.9 t ha-1) and Kompolti (18.0 t ha-1) [Rolski et al, 2000].

E.P.M. de Meijer reported that from tested 16 hemp accessions, Beniko and Bialobrezskie were the earliest ripening. The most fibrous were Beniko (32.7 %), Uniko-B (28.8-30.8 %), Kompolti (28.0-29.1 %), Bialobrzeskie (29.1-29.5 %) [Meijer, 1995].

Even in more southern country – Finland – industrial hemp (varieties Fedora 19, Felina 34 and Futura 77) was successfully grown and investigated in 1999-2001 [Svennerstedt, 2002].

There were found some data, that hemp was grown and investigated in Lithuania just after the World War II [Kriščiūnas, 1959].

The aim of our investigation was to evaluate the productivity potential of various hemp varieties in the pedoclimatical conditions of Lithuania.

Materials and methods:

The investigation was conducted at the Upytė Research Station of LIA on a Eutri-Endohypogleyic Cambisol [Buivydaitė et al., 2001] in 2008. The content of available P_2O_5 in the soil plough layer was 228 mg kg-1, content of K_2O – 122 mg kg-1 (determined in A-L extraction), pHKCl level – 7.5 (potentiometrically), humus content – 3.62 % (by Hereus apparatus). In the field rotation hemp followed winter wheat. Before sowing 250 kg of complex fertilizers $N_5P_{15}K_{30}$ have been applied. Hemp of varieties Beniko (PL), Bialobrzeskie (PL), Epsilon 68 (FR), Felina 32 (FR) and USO 31 (UA) was sown by a sowing machine SNL-16 at a seed rate of 70 kg per hectare on the 13th of May in the plots of 10 m2, triplicate, harvested in September 5th (USO 31) and 30th (the rest varieties) by trimmer. Hemp was harvested when first matured seeds appeared. But the birds could influence to that, because they were eating some seeds. Therefore, in 2008 the vegetation period of USO 31 was 16 weeks (115 days) and 20 weeks (140 days) for the rest part of varieties. The biometrical indices of hemp plants – crop density, weediness, height and stalk diameter in the middle of the stalk at harvesting time, amount of green and dry over ground mass, and fibre content were evaluated. One part of hemp stalk samples (0.5 kg per plot) was water-retted (temperature 37 ° C) for 5 days, other part (0.5 kg per plot) was dew-retted on the grassland; then dry straw was scuthched by tool SMT-200. Fibre flexibility was determined by a device G-2, strength – by a device DK-60. For calculation and statistical evaluation the statistical software developed in the Lithuanian Institute of Agriculture was used [Tarakanovas, Raudonius, 2003].

Results and discussion:

Hemp crop density and weediness have been evaluated after full crop germination and just before harvesting. The established crop density was between 255-317 plants m-2 (Table 1). Crop density before harvesting was rather lower than that at the beginning of vegetation.

We found great weed reduction in the hemp crop – 40-54 weeds m-2. The amount of weeds in hemp crop at harvesting was quite low – only 5-13 plants m-2 (Table 2). The main part of weeds found at hemp harvesting time consisted of white goosefoots (Chenopodium album L.).

In 2008 hemp produced enough high amount of green over ground (stalks, leaves and panicles) mass (Table 3). Plants of Epsilon 68 and USO 31 produced significantly more green mass (respectively, 36.8 and 36.2 t ha-1) than other varieties tested. According to the data of hemp green biomass and amount of crop moisture content at harvesting, the yield of absolutely dry hemp biomass was calculated. The most productive were plants of Epsilon 68 and USO 31 – respectively, 19.0 and 16.2 t ha-1 of absolutely dry hemp biomass were produced.

The highest stalk yield (air-dry) was obtained from variety Epsilon 68 plants (16.3 t ha-1) (Table 4). Plant of variety Epsilon 68 produced highest seed yield, but the seed yield of other varieties was influenced by the birds.

The highest plants (Table 5) were that of varieties Beniko and Epsilon 68 (respectively, 2.45 and 2.42 m) (please, have in mind that the stubble of 5-8 cm was left in the field). Plants of Beniko had significantly higher technical stalk length (2.22 m), diameter (0.65 m).

The highest fibre content from dew-retted stalks was established for varieties Beniko and USO 31 (Table 6). Fibre from Beniko plants was the most flexible, but had the lowest strength.

Fibre content from water-retted stalks was lower that that from dew-retted ones (Table 7). Plants of variety USO 31 showed the highest fibre content and the best strength results.

Varieties tested	Crop density after full germination, units m^{-2}	Crop density at harvesting, units m^{-2}	Reduction, units m^{-2}
1. Beniko	255	207	47
2. Bialobrzeskie	311	264	47
3. Epsilon 68	269	232	37
4. Felina 32	317	261	57
5. USO 31	274	241	33
Mean	286	241	44.1
LSD_{05}	41.0	36.6	21.6

Table 1. Hemp crop density after full germination, at harvesting, and reduction of plants (units m-2). Upytė, 2008.

Varieties tested	Crop weediness after full germination, units m^{-2}	Crop weediness at harvesting, units m^{-2}	Reduction, units m^{-2}
1. Beniko	46.7	8.0	38.7
2. Bialobrzeskie	54.7	6.7	48.0
3. Epsilon 68	46.0	4.7	41.3
4. Felina 32	67.3	13.3	54.0
5. USO 31	53.3	13.3	40.0
Mean	53.6	9.20	44.40
LSD_{05}	17.82	5.50	17.06

Table 2. Hemp crop weediness after full germination, at harvesting, and reduction of weeds (units m-2). Upytė, 2008.

Varieties tested	Green biomass, kg ha^{-1}	Moisture of green biomass , %	Dry biomass, kg ha^{-1}
1. Beniko	33 143	53.9	15 299
2. Bialobrzeskie	31 476	53.9	14 512
3. Epsilon 68	36 762	56.0	16 170
4. Felina 32	30 524	52.2	14 589
5. USO 31	36 190	47.4	19 016
Mean	33 619.0	52.7	15 917.4
LSD_{05}	1 822.4	2.32	1 299.9

Table 3. Hemp crop green and dry biomass yield. Upytė, 2008.

Varieties tested	Stalk yield (after threshing), kg ha^{-1}	Seed yield, kg ha^{-1}
1. Beniko	12 833	86
2. Bialobrzeskie	14 076	128
3. Epsilon 68	16 343	276
4. Felina 32	13 982	167
5. USO 31	11 816	517
Mean	13 810	234.7
LSD_{05}	1 915.7	61.68

Table 4. Air-dry hemp stalk and seed yield. Upytė, 2008.

Varieties tested	Plant height, m	Technical stalk length, m	Stalk diameter, cm
1. Beniko	2.45	2.22	0.65
2. Bialobrzeskie	2.34	2.16	0.54
3. Epsilon 68	2.42	2.15	0.60
4. Felina 32	2.18	1.98	0.52
5. USO 31	2.17	1.95	0.60
Mean	2.31	2.09	0.58
LSD_{05}	0.142	0.115	0.052

Table 5. Morphological indices. Upytė, 2008

Varieties tested	Fibre content, %	Flexibility, mm	Strength, kg F
1. Beniko	22.1	29.4	16.8
2. Bialobrzeskie	13.1	24.7	18.2
3. Epsilon 68	15.1	17.0	20.9
4. Felina 32	17.1	17.4	22.3
5. USO 31	24.1	17.6	21.9
Mean	18.32	21.20	20.00
LSD_{05}	1.61	7.13	2.43

Table 6. Dew-retted hemp stalk fibre content (%), fibre flexibility (mm) and strength (kg F). Upytė, 2008

Varieties tested	Fibre content, %	Flexibility, mm	Strength, kg F
1. Beniko	16.4	24.3	14.8
2. Bialobrzeskie	14.3	28.2	13.9
3. Epsilon 68	10.8	18.2	15.7
4. Felina 32	15.2	27.6	18.6
5. USO 31	23.8	25.2	23.5
Mean	16.09	24.68	17.31
LSD_{05}	2.47	4.65	1.91

Table 7. Water-retted hemp stalk fibre content (%), fibre flexibility (mm) and strength (kg F). Upytė, 2008

Conclusions:

The trial carried out in 2008 led to draw conclusion that plants of industrial hemp varieties tested – Beniko, Bialobrzeskie, Epsilon 68, Felina 32 and USO 31 – could be successfully grown in Lithuania for biomass or fibre production. The green and dry biomass yield in average was 33.6 and 15.9 t ha-1, respectively. The vegetation period of variety USO 31 plants was 16 weeks (115 days); and 20 weeks (140 days) for the other varieties tested. Weed reduction in the hemp crop was even 40-54 weeds m-2, thus this plant could be in introduced into existing crop rotations, even in organic farms.

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In The Name of God The Clement and The Merciful

The Recent Innovations in Textile Flax and Oleaginous Flax Cultivations Which Lead to The Maximization of the Yield of Fibers and the Crop of Linseed Based on Sound Scientific Bases

By: Expert/Advisor Engineer **Anwar M. Allam**

Abstract:

Human control on the behavior of flax plants (LINUM USITATTISSIMUM) during their cultivation has been enhanced to almost more than 90%. From now on, it is practically possible to induce the plants to either successfully produce more seeds or the highest possible yield of fibers.

Maximization of these specific crops has become definitely possible.

From now on the production of flax fibers in form of pure intrinsic single filaments and having consistent excellent textile characteristics can be guaranteed by the new effective fiber-extraction method using osmotic pressure, which guarantees the production of high quality textiles that would satisfy all flax spinners including those specialized in the production of fine counts of yarns.

Key Words:

Enhance, yield, intrinsic, filaments, osmotic pressure, counts, dynamic cell, vital space, homogeneity and maximization.

Full Text:

A new more effective, non-polluting and low-cost method of vegetal fibers extraction using osmotic pressure for the first time has recently been discovered. During the application of this method, dry straw is completely immersed in virgin water, with time it becomes wet to saturation, later increasing Osmotic pressure is naturally generated only inside dynamic cells as they have semi-permeable membranes causing their bursting when this pressure becomes more than their semi-permeable membranes can stand. This would continue until the complete elimination of all dynamic cells. Inside the plant, the tissue tightly-surrounding the fibers is entirely formed of dynamic cells and as a result of their complete elimination, the fibers are smoothly liberated and thus they are obtained in a pure intrinsic form, without affecting their excellent natural textile characteristics.

Subsequent scientific studies of the different developments of flax plants, in field experiments, showed clearly that, under specific conditions flax plants could either produce more seeds or more fibers. The increase in fiber production has been observed in finer straws, while the increase in seeds production has been observed in plants that gave birth to numerous tillers and sub-branches that bear more capsules containing seeds. The finer straws were due to the high density of the plants; the tillers and the sub-branches were due to the lower density of the plants.

It has been established that:

1. The high density of close-spaced plants prevents them from giving birth to tillers and sub-branches, the number of plants per surface unit is higher, their stalks are finer and yield a higher amount of fibers.
2. The low density of far-spaced plants allows them to give birth to tillers and sub-branches, which bear a high number of capsules containing seeds. The plants take advantage from the larger free spaces around each plant, which allow them to expand freely their root-hairs in these larger spaces and collect as much water solution as possible, without the interference of other plants root-hairs, to be able to increase the rate of nutritive sap production to cover the needs of the extra tillers and sub-branches.
3. Therefore, if the aim of the cultivation is to maximize the yield of fibers the highest density of close-spaced plants should be adopted (1600-2500 successful plants per square meter) and would provide the

finest flax straws and would not expose the plants to lodging.

4. But, if the aim of the cultivation is to maximize the seeds crop, the lowest density of far-spaced plants should be adopted (180 – 280 successful plants per square meter), to allow the plants to give birth to the greatest numbers of tillers and sub-branches that bear the greatest number of capsules containing seeds.

5. The extent of the surrounding free spaces is an important factor that governs the future behavior of the plants.

6. The increase of this extent, causes the decrease of the number of plants per square meter, but increases the coefficient of multiplication of the seeds, per plant

7. The decrease of this extent, causes the increase of the yield of fibers, but decreases the coefficient of multiplication of the seeds per plant.

8. The crop of the straw containing the fibers increases by the increase of the number of plants per surface unit.

9. The crop of the seeds increases by the increase of the average of the coefficient of multiplication of all the plants in the surface unit and the increase of the number of plants per surface unit.

10. The coefficient of multiplication is a positive factor; the decrease of the number of plants is a negative factor. As long as the result of these two opposite factor is positive the crop increases, but once the result becomes negative the crop starts to decrease, in spite of the continuous increase of the coefficient of multiplication.

Important Notices:

The distribution of the seeds during sowing should be regular and even in order to surround each plant with an equal vital space to give each plant the same facilities and achieve homogeneity in the produced crops.

The proper rate of sowing seeds determined in weight should be calculated according to the aim of the specific cultivation and according to the actual weight of 1000 sowing seeds representing the lot of seeds to be used. The following formula can be helpful:

The rate is equal to the desired number of plants per unit of surface x the actual weight of 1000 seeds to be used divided by 1000.

Noting that the desired number of plants per surface unit is equal to the number of plants per square meter x surface unit in square meters.

Conclusion:

Flax (Linum Usitattissimum) has been effectively tamed, in cultivation the plant could be directed to produce more fibers or it can be directed to produce more seeds and maximization of either crop can be successfully attained

The extraction of flax fibers has also been scientifically consolidated, its performance regularized to always give stable results of much more homogenous fibers, in regular single filaments form, having consistent excellent textile characteristics, to satisfy all spinners.

Effect of seeding rate on yield and quality traits of some flax varieties (Linum usitatissimum L.) grown in newly reclaimed sandy soils

By

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Abstract:

Two field experiments were carried out at the Experimental Farm of the National Research Center at Nubria district El-Behera Governorate during the two seasons of 2005/06 and 2006/07. Giza - 8, Sakha - 1, Sakha - 2, Agretic (Venica), Posnia, Olin, Opal and Szafir flax varieties were seeded at (1500,1750,2000 and 2250 seeds/m2) in newly reclaimed sandy soils. Results indicated that flax varieties varied significantly in all studied characters. Giza - 8, Opal and Sakha - 2 varieties produced high seed yield per faddan and significantly outyielded the other varieties. On the other side, Agretic (Venica) variety produced high fiber yield per faddan and significantly outyielded the other varieties. Increasing seeding rate significantly increased seed and fiber yield per faddan as well as fiber percentage, plant height and technical length. On the other hand, increasing seeding rate decreased fruiting zone length and number of capsules per plant. Results indicated that the interaction between varieties and seeding rates had significant effect on all studied characters, except plant height, technical length and length of fruiting zone. Giza - 8 variety produced highest seed yield per faddan when it seeded at (2250 seeds / m2) and significantly outyielded the other all varieties. However, Agretic (Venica), Sakha – 2 and Olin varieties produced high fiber yield per faddan when they seeded at the highest seeding rate (2250 seeds / m2).

Introduction:

Flax crop (linum usitatissimum L.) has been known since an ancient history; it is considered the most important bast fiber source, which extracted from stem by retting process for textile. In addition it is a good source for flaxseed oil. Meanwhile, it is grown in Egypt as a dual purpose crop i.e. fibers and seeds.

Recently, there are an increase in world requirements from flax fibers and seeds, where the two products previously mentioned has great importance for several industries, where flax fibers are used in manufacturing linen cloth from long fine fibers, tent cloth, twines, best paper. Meanwhile, linseed oil is used as edible for human, medical purpose and flaxseed cakes are used as dairy cattle feeding. Moreover, the boiling seed oil is used in making paints, varnish and printing ink.

The cultivated area by flax in Egypt is relatively small and decreased dramatically in last decade. This is due to the strong competition between flax and other strategic winter season crops such as wheat and clover on the limited arable land in Nile valley and Delta. For that this investigation aimed to study the performance of some local and introduced flax varieties under different seeding rates at the newly reclaimed sandy soils using sprinkler irrigation system.

Many investigators reported significant differences among flax varieties concerning seed, straw, oil and fiber yields and there components, El-Hariri, et al., (1998 and 2004) .

Concerning seeding rate, studies raveled that increasing seeding rate increased seed, straw, and fiber yield / m2. On the other hand, straw, fiber and seed yield per plant were decreased by increasing seeding rate, El-Kady et al (1995), El-Sweify and Mostafa (1996), Abdlwahed (2002), Kineber (2003)

Concerning, seed yield components, 1000-seed weight was increased while capsules per plant was decreased by increasing seeding rate, El-Sweify and Mostafa (1996), Abdlwahed (2002) and Kineber (2003). Concerning straw yield components, harvested plants and plant height were increased by increasing seeding rate while stem diameter and branches per plant were decreased, Badr et al., (1998), Casa et al.,(1999), and Hassan and Leitch (2000).

Previous studies revealed that the response of flax varieties or genotypes to seeding rates was different El-Hariri, et al., (1998a) and El-Hariri, et al., (1998b) .

Materials and methods:

Two field trials were performed during 2005/06 and 2006/07 seasons to evaluate yield and quality of eight flax varieties grown in the Agricultural Experimental Farm of the National Research Centre (NRC) at Nubria, El-Behera Governorate. Every experiment included 32 treatments which were the combinations of eight different flax varieties and four seeding rates were investigated.

a- Flax cultivars:

- Giza-8, Sakha-1 and Sakha-2: local double purpose varieties (Egypt).
- Agretic: cultivar of flax variety (Cczech R.).
- Posna: flax variety of (Bosnia Herzegovina).
- Olin: flaxseed variety of (Romania).
- Opal and Szafir: flaxseed varieties (Poland).

b- Seeding rates:

Four seed rates were practiced (1500, 1750, 2000 and 2250 seeds/m2) Seeds of flax cultivars were sown on 7th December in the first season and 17th November in second growing season.

Irrigation was carried out using the modern sprinkler irrigation system where water was added every 5 days. Only P2O5 and K2O fertilizers were added during seed bed preparation at the level of 31.00 and 24.00 (kg/fed) respectively, while nitrogen fertilizer as ammonium nitrate (33.5%) was added at the rate of (75 kg N/fed). The experiments were laid out in split plot design with four replications where flax varieties were randomly assigned in main plots, while seeding rates were distributed randomly in sub-plots. The experimental unit was 6 m2 (1/700 fed.) 3 m long and 2 m wide which formed of ten rows of 20 (cm) between rows (one faddan = 0.42 of hectare).

Flax plants were pulled at full maturity, then left on ground for air-drying. Capsules were removed carefully, then retting was carried out at Tanta flax and oil Company using warm water retting system. At harvest the follwing characters were recorded on a random sample of ten guarded plants from each plot:

Data recorded:

1- Straw yield and its components:

Total Plant height (cm), Technical stem length (cm), Straw yield / plant (g), Straw yield (tons/fed), Fiber percentage (%) and Total fiber yield (kg/fed)

2- Seed yield and its related Characters:

Number of fruiting branches / plant, Number of capsules / plant, Fruiting zone length (cm), Seed yield / plant (g), 1000 seed weight (g), Seed yield (kg / fed), Seed oil % and Oil yield (kg/fed)

Data were statistically analyzed separately for each season. The combined analysis was conducted for the data of the two seasons after tested the variances homogeneity of both seasons according to Gomez and Gomez (1984).The least significant difference (LSD) was used to compare between different means.

Results and Discussion:

1 – Varietal differences:

Combined data of Tables 1 and 2 cleared that the used flax varieties differed significantly in all studied characters. Giza -8, Sakha –2 and Opal varieties produced significant high seed and oil yields per faddan compared to other ones. This was due to the high seed index value of Giza -8 and Sakha –2 varieties (8.02 and 7.91 g / 1000-seeds) compared to low values of other varieties which ranged from (4.96 to 6.57) g. On the other side, the high seed yield of Opal variety was mainly due to the relatively high number of capsules per plant (8.45) which ranked 2nd after Posnia variety (9.91). Also, Opal variety showed highest seed oil content with significant difference compared to other varieties (Table 2).

Data in (Table 1) cleared that Sakha –1, Sakha –2, Agretic (Venica) and Posnia varieties produced high straw yield per faddan with significant differences when compared with other varieties. These was due to the high straw yield per plant of this varieties (Table 2) which was attributed to plant height of Sakha –2 and Posnia varieties (Table 1).

Data in (Table 2) cleared that highest fiber yield per faddan (497.23 kg) was obtained from Agretic variety. This was due to its high straw yield per faddan (2.979 tons) and the highest fiber percentage (16.55 %). Differences among tested varieties, may be due to the different origin and / or different genetical make up which affects growth habit and purpose of its products. Such results are in agreement with that obtained by other investigators El-Hariri, et al., (1998 a, 1998 b, and 2004) and Kineber and El-Kady (1996).

Varieties	Total Plant height (cm)	Technical length (cm)	Fruiting zone length (cm)	Number of Fruiting Branches / plant	Number of capsules / plant	1000 seed weight (g)	Seed oil %	fiber %
Giza 8	64.56	54.48	10.08	3.64	6.70	8.02	37.55	14.38
Sahka1	66.26	56.77	9.49	3.48	6.18	8.17	37.74	14.53
Sahka2	66.14	56.67	9.46	3.53	6.05	7.91	38.03	15.40
Agretic	60.02	48.07	11.94	3.65	7.46	4.96	38.76	16.55
posnia	68.20	53.76	14.44	3.55	9.91	5.14	38.17	13.94
Olin	59.92	49.15	10.77	3.66	8.28	6.57	37.80	15.27
Opal	57.46	44.45	13.00	3.58	8.45	5.69	39.13	13.60
Szafir	63.12	52.03	11.09	3.87	8.72	5.61	37.93	13.68
LSD (5%)	3.47	3.18	0.92	0.18	0.71	0.17	0.41	0.83

Table (1): Effect of flax varieties on seed and straw yield components (combined analysis of 2005/06 and2006/07 seasons)

Varieties	Seed yield/ plant (g)	Straw yield/ plant (g)	Straw yield (ton/ fed)	Seed yield (kg / fed)	Oil yield (kg/fed)	fiber yield (kg/fed)
Giza 8	0.34	0.99	2.809	545.98	205.2	406.39
Sakha- 1	0.36	1.01	3.054	495.55	187.3	447.18
Sakha- 2	0.33	1.01	2.944	523.05	199.4	460.14
Agretic	0.32	0.90	2.979	438.65	169.9	497.23
posnia	0.32	1.05	2.985	478.98	183.1	424.34
Olin	0.36	0.93	2.609	455.33	172.6	405.81
Opal	0.35	0.89	2.655	539.72	211.3	363.96
Szafir	0.35	1.07	2.748	456.27	173.2	378.49
LSD at 5%	0.03	0.05	0.13	32.8	13.21	31.99

Table (2): Effect of flax varieties on seed, straw, oil and fiber yields (combined analysis of 2005/06 and2006/07 seasons).

2- Effect of seeding rate:

Data in Tables 3 and 4 cleared that seeding rate had significant effect on all studied characters. Results indicated that highest seed yield per faddan (618.35 kg) was obtained at seeding rate of (2250 seeds/m2). This may be due to extra number of seeds/m2 which counter balance the decrease in biomass as well as the greatest number of harvested plants / m2 because the seed yield components (number of capsules per plant and seed yield per plant) were gradually decreased by increasing seeding rate (Table 3 and 4).

Table (4) showed that, fiber yield per faddan was gradually increased with each increase in seeding rate. Thus the highest fiber yield per faddan (559.43 kg) was obtained from the highest seeding rate. This was due to the increase in all fiber yield components, (plant height, technical length, straw yield per plant and per faddan as well as fiber percentage) by increasing seeding rate.

Increasing seeding rate from (1500 to 2250 seeds/m2) increased fiber yield per faddan by (88.20 %). This was attributed to an increase in plant height (19.02 %), technical length (32.88 %) and straw yield per faddan (53.60 %). In addition to extra number of seeds/m2 which in turn counter balance the decrease in metabolites synthezed owing to sever competition between plants in the same unit area These results were greatly in accordance with that obtained by, Esmail and Morsy (1994), Badr et al., (1998), Casa et al.,(1999), Hassan and Leitch (2000) and Abdalla et al., (1989).

Seed rate (seeds/ m^2)	Plant height (cm)	Technical length (cm)	Fruiting zone length (cm)	Number Of Fruiting branches / plant	Number of capsules / plant	1000 seed weight (g)	Seed oil %	fiber %
1500	57.88	44.71	13.17	4.33	10.28	6.19	37.99	13.27
1750	61.56	49.80	11.76	3.75	8.26	6.39	38.06	14.25
2000	64.50	53.78	10.72	3.44	6.84	6.59	38.22	14.93
2250	68.89	59.40	9.49	2.96	5.49	6.87	38.28	16.21
$LSD_{5\%}$	0.95	1.01	0.26	0.07	0.21	0.06	N. S	0.25

Table (3): Effect of seeding rate on seed and straw yield components (combined analysis of 2005/06 and2006/07 seasons).

Seeding rates (seeds / m^2)	Seed yield / plant (g)	Straw yield / plant (g)	Straw yield / (ton /fed)	Seed yield (kg / fed)	Oil yield (kg/fed)	fiber yield (kg/fed)
1500	0.46	1.20	2.244	360.78	137.32	297.24
1750	0.37	1.05	2.640	449.39	170.77	377.24
2000	0.29	0.91	3.061	538.26	205.91	457.85
2250	0.24	0.77	3.447	618.35	236.91	559.43
LSD at(5%)	0.01	0.03	0.04	14.05	5.36	9.96

Table (4): Effect of seeding rate on seed, straw, oil and fiber yields (combined analysis of 2005/06 and2006/07 seasons).

3- Effect of interaction:

Combined data of Tables 5 and 6 showed that the interaction between flax varieties and seeding rate had significant effect on all studied characters, except plant height, technical length and fruiting zone length.

Results in Table (5) showed that number of branches and number of capsules per plant were gradually reduced by increasing seeding rate for all tested varieties, but with different magnitudes; for example, increasing seeding rate from (1500 to 2250 seeds/m2) decreased number of branches per plant of Sakha -1 and Szafir varieties by (26.71 % and 35.68 %) and number of capsules per plant by (42.5 6% and 54.36 %), respectively.

On the other side, data in Table (5) showed that 1000-seed weight and fiber percentage were increased by increasing seeding rate. Also, the rate of increase was relatively different for flax varieties. For example, 1000-seed weight was increased by increasing seeding rate from (1500 to 2250 seeds/m2) for Sakha and Posnia varieties by (6.1 and 14.5 %) respectively. Also fiber percentage was increased by (25.6 and 37.1 %) on the same order.

Varieties	Seeding rate (seeds/ m^2)	Plant height (cm)	Technical length (cm)	Fruiting zone length (cm)	No.of Branches / plant	No.of Capsules / plant	1000 seed weight (g)	Seed oil %	fiber %
Giza 8	1500	57.90	45.99	11.91	4.05	8.71	7.79	37.39	13.62
	1750	62.04	51.53	10.51	3.58	6.89	7.93	37.29	14.11
	2000	65.44	55.94	9.50	3.40	6.01	8.08	37.77	14.53
	2250	72.86	64.46	8.40	2.91	5.20	8.28	37.76	15.26
Sakha- 1	1500	60.84	49.66	11.18	4.23	7.94	7.97	37.40	12.73
	1750	65.35	55.14	10.21	3.74	6.68	8.04	37.01	14.34
	2000	67.53	58.75	8.78	3.49	5.55	8.20	38.23	14.95
	2250	71.33	63.54	7.79	3.10	4.56	8.46	38.33	16.11
Sakha- 2	1500	60.27	48.88	11.39	4.10	8.44	7.48	37.49	13.33
	1750	64.03	54.33	9.70	3.63	6.16	7.74	38.02	14.70
	2000	66.48	57.61	8.86	3.44	5.26	8.01	37.95	15.69
	2250	73.78	65.88	7.90	2.98	4.34	8.43	38.66	17.86
Agretic	1500	55.96	42.31	13.65	4.39	9.56	4.78	38.68	14.78
	1750	58.10	45.84	12.26	3.89	8.45	4.90	39.19	16.41
	2000	61.43	49.71	11.71	3.40	6.51	5.01	38.71	17.05
	2250	64.58	54.43	10.15	2.94	5.30	5.16	38.44	17.94
posnia	1500	62.49	46.01	16.48	4.31	13.69	4.77	37.87	11.98
	1750	66.60	51.53	15.08	3.66	10.45	5.05	38.31	13.14
	2000	69.82	56.06	13.76	3.30	8.44	5.27	38.49	14.24
	2250	73.90	61.45	12.45	2.91	7.08	5.46	38.00	16.42
Olin	1500	54.63	42.40	12.23	4.58	10.61	6.05	37.71	14.12
	1750	58.19	46.96	11.23	3.73	8.94	6.38	37.80	14.57
	2000	61.64	51.21	10.43	3.46	7.71	6.75	37.63	15.10
	2250	65.24	56.04	9.20	2.89	5.85	7.09	38.06	17.27
Opal	1500	52.21	36.49	15.73	4.35	11.26	5.38	39.53	12.97
	1750	56.08	42.50	13.58	3.65	8.95	5.61	38.74	13.26
	2000	58.96	46.95	12.01	3.38	7.48	5.75	39.21	13.85
	2250	62.58	51.88	10.70	2.93	6.11	6.02	39.02	14.31
Szafir	1500	58.76	45.96	12.80	4.68	12.03	5.30	37.88	12.63
	1750	62.14	50.60	11.54	4.15	9.59	5.47	38.09	13.51
	2000	64.75	54.03	10.73	3.65	7.79	5.64	37.77	14.05
	2250	66.84	57.54	9.30	3.01	5.49	6.04	38.00	14.52
LSD(5%)		N. S	N. S	N. S	0.20	0.60	0.17	0.69	0.71

Table (5): Effect of interaction between flax varieties and seed rates on seed and straw yield components (combined analysis of 2005/06 and2006/07 seasons).

Data in Table (6) demonstrated that seed and straw yield per plant of varieties were significantly decreased as seeding rate was increased but with different reduction rate between varieties. Seed yield per faddan was increased as seeding rate was increased for flax varieties. However, the highest seed yield per faddan of each variety was markedly different and ranged from (576.76 to 702.33 kg). The greatest seed yield of Giza -8 (702.33) at (2250 seeds/m2) was reduced by (49.8 %) at (1500 seeds/m2), while it reduced by (34.3 %) for Opal variety on the same order.

Also, straw, fiber and oil yields of all varieties were increased as seeding rate was increased but with different magnitudes. Greatest fiber yield per faddan of flax varieties ranged from (482.16 to 625.69 kg) when seeding rate was decreased from(2250 to 1500 seeds/m2), respectively. It could be concluded that similar conclusion were obtained by Esmail and Morsy, (1994), El-Kady, (1996), El-Hariri, et al., (1996 and 2004) and Abdlwahed, (2002).

Varieties	Seeding rates (seeds/m^2)	Seed yield/ plant (g)	Straw yield/ plant (g)	Straw yield (ton /fed)	Seed yield (kg / fed)	Oil yield (kg/fed)	fiber yield (kg/fed)
Giza-8	**1500**	0.47	1.19	2.27	352.70	131.77	309.30
	1750	0.35	1.03	2.72	513.63	191.17	384.51
	2000	0.29	0.93	2.97	615.26	232.55	431.92
	2250	0.23	0.81	3.27	702.33	265.19	499.83
Sakha-1	**1500**	0.46	1.32	2.58	394.61	147.58	328.12
	1750	0.38	1.07	2.88	478.58	177.11	412.18
	2000	0.31	0.94	3.25	529.86	202.51	485.54
	2250	0.27	0.71	3.50	579.14	222.06	562.87
Sakha-2	**1500**	0.46	1.20	2.40	417.98	157.09	320.48
	1750	0.37	1.08	2.74	490.51	186.55	404.21
	2000	0.29	0.96	3.18	541.63	205.57	499.34
	2250	0.22	0.82	3.45	642.09	248.19	616.52
Agretic	**1500**	0.41	1.08	2.46	308.96	119.85	362.85
	1750	0.35	0.93	2.81	359.44	140.61	461.45
	2000	0.27	0.86	3.16	505.13	195.03	538.92
	2250	0.24	0.75	3.49	581.09	224.02	625.69
posnia	**1500**	0.43	1.33	2.30	342.31	129.76	274.05
	1750	0.35	1.13	2.60	441.40	168.84	341.53
	2000	0.28	0.91	3.39	555.46	214.28	483.22
	2250	0.23	0.85	3.65	576.76	219.40	598.56
Olin	**1500**	0.50	1.08	1.80	300.40	113.53	254.77
	1750	0.39	1.02	2.40	385.23	145.62	350.48
	2000	0.30	0.89	2.76	500.71	188.93	416.99
	2250	0.25	0.72	3.48	635.00	242.27	601.02
Opal	**1500**	0.48	1.09	1.91	428.36	169.62	247.53
	1750	0.38	0.97	2.38	509.05	197.37	315.04
	2000	0.31	0.80	2.91	569.65	223.96	404.45
	2250	0.25	0.70	3.42	651.81	254.22	488.82
Szafir	**1500**	0.47	1.30	2.22	340.89	129.33	280.83
	1750	0.39	1.15	2.58	417.26	158.91	348.53
	2000	0.29	1.01	2.86	488.36	184.46	402.44
	2250	0.24	0.83	3.32	578.55	219.89	482.16
LSD(5%)		**0.02**	**0.09**	**0.12**	**39.73**	**15.15**	**28.18**

Table (6): Effect of interaction between varieties and seed rates on seed, straw, oil and fiber yields (combined analysis of 2005/06 and 2006/07 seasons)

General Conclusion:

Under the condition of this experiment, the newly reclaimed sandy soils, results indicated that highest seed and oil yields per faddan could be obtained by growing Giza -8 variety at the highest seeding rate of (2250 seeds/ m2). However, highest fiber yield per faddan could be obtained by growing Agretic variety at the same seeding rate. However in Egypt, flax crop usually grown as a dual purpose crop, thus, Sakha -2 variety seams to be the most suitable variety as a dual purpose variety because it produced (98.5 %) of the highest fiber yield of Agretic (Venica) variety and (91.4 %) of the highest seed yield of Giza-8 variety.

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THE POSSIBILITY OF INCREASING FIBRES FLAX PLANTS RESISTANCE TO DROUGHT

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Abstract:

The basic and applicative research on methods of increasing the tolerance of fibrous flax to drought have been carried out at Institute of Natural Fibres and Medicinal Plants since 2002. The studies include:

Basic research:

- Drought effect on morphogenesis and ontogenesis of flax
- Determination of critical periods of flax regarding drought resistance/tolerance
- Evaluation of drought tolerance of Linum genotypes from INF gene collection

Applied research:

- Biological assessment of biostimulators in flax cultivation for increasing plants drought tolerance
- Assessment of the usefulness of Poly asparginian acid compounds in flax cultivation for increasing root biomass and drought tolerance .

The most important water period in fiber flax development is the period from phase of "fast growth" (BBCH 20) until beginning of bloom (BBCH 61). Application of the controlled drought stress (for 30 days, beginning from the fast growth stage of flax – when the plants are 18-20 cm tall) had a significant effect on the morphological structure and yields of fibre flax. The individual plant development and the straw yield under the drought stress conditions were evaluated by comparison of 30 Linum genotypes. The most resistant to the drought stress were the late maturing flax cultivars. In other words, the correlation was found between the length of the vegetation period and plant resistance to drought. Application of ASA (0,4 kg ha-1), Atonik (0.5 l ha-1) and IWN-11 (1,0 l ha-1), in conditions of controlled drought stress (soil moisture content at 25% FWC) had a beneficial effect on growth, development and yields of flax.

Key words: fibre flax, drought resistance, biostimulators

Introduction:

The life phenomenon on the earth is the result of water existence, which is often called „the life solvent". The existence of liquid water is a fortunate consequence of two features of our planet:

- The mass of Earth is sufficiently large that there is adequate temperature to retain gaseous water molecules (in contrast with Mars),
- The distance from the Sun is such that temperatures on Earth favour water in the liquid phase (in contrast with Venus) (Sinclair &Gardner 1998).

Among many water properties that make it suitable for being the „life solvent" the most important are the following:

- Polar structure of water molecules,
- Water is excellent solvent (as polar substance solves other substances easily),
- Cohesion and adhesion forces are present in water,
- Water facilitates maintaining constant temperature in life organisms,
- Water molecules are dysociated to a large extent (Sinclair & Gardner, 1998)

Water plays an important role in plants. Several physiological and biochemical methods of the plant cell operate in a watery medium. Some of the molecules are dissolved in the watery medium, while others are suspended in it. The water plays important role as a constituent, a solvent and a reagent in various chemical reactions in the plants the properties of solutions, suspensions, emulsions, and colloidal solutions (Singh 2005).

The insufficient water supply in the environment is the factor responsible for inhibiting most processes crucial for growth and development of plants. With the increasing lack of moisture in the soil, the consecutive processes are inhibited: cell growth, protein biosynthesis, activity of nitrogen reductase, the ABA (abscisine acid) level, decrease of cytokine level, stomatal close-up, photosynthesis suppression, breathing disorders, accumulation of proline, accumulation of sugars, wilting, protoplasm circulation inhibition. Water scarcity affects the lipase and kinase enzyme systems, ABA synthesis, stomatal movement, photosynthesis, and oxidative stress (Gupta 2007). The most intensive reaction of plants to lack of moisture is inhibition of cell growth, which has a decisive effect on the height and quality of yields (Kopcewicz and Lewak 1998).

The plant especially susceptible to water deficiency is fiber flax. Schantza and Priemeisel (1927), who evaluated water requirements of 288 plant species found that fiber flax and the leguminous are the plants using the highest amounts of water during vegetation.

In numerous studies (Wannemacher, 1949; Schantza and Priemeisel, 1927; Białołusowa et al., 1954; Tobler 1928) proved high water requirements of fiber flax and strong effect of water condition in the environment on the yield of straw, seed and fiber, as well as on the quality (thinness) of obtained fiber (Staniszkis, 1937, Durant, 1958; Herzog, 1920;Byczyńska & Heller, 2004; Heller et al., 2006). Flax belongs to the group of plants of relatively high transpiration rate compared to other plants (787-1093), while the rate for maize varies between 233-369. (Kozłowska, 2007).

The paper presents the scope and preliminary results of the studies conducted at INF Poznan in order to increase the tolerance of fiber flax to periodical water deficit in the habitat.

Materials and methods:

The basic and applicative research on methods of increasing the tolerance of fibrous flax to drought has been carried out at INF&MP since 2002. The studies include:

Basic research:

- Drought effect on morphogenesis and ontogenesis of flax
- Determination of critical periods of flax regarding drought resistance/tolerance
- Evaluation of drought tolerance of Linum genotypes from INF gene collection

Applied research:

- Biological assessment of bio-stimulators and antitranspirants in flax cultivation
- Assessment of the usefulness of Poly asparginian acid compounds in flax cultivation for increasing root biomass and drought tolerance .

The above mentioned studies were carried out in pot experiments under drought stress conditions (soil of moisture at 25% to 45% field water capacity (FWC)). The optimal soil moisture was 45 % FWC. The biological assessment of antitranspirants and PKA compounds was made under controlled drought stress conditions (soil at 25% FWC). The pot experiments were arranged in randomized blocks in four replications.

The following observations and measurements were conducted during the experiment:

- weather observations – temperature measurements,
- development stages of flax,
- phytotoxic effect of antitranspirants on flax,
- growth dynamics (in vivo measurements),
- morphological structure of the plant,
- total, straw and seed yields,
- 1000 seed weight,
- total fiber content,
- fiber yield and quality,
- germination capacity of flax.

The harvest was performed in full flax maturity stage. The plants were cut at the level of the root necks. The root part was washed out from the soil to determine its weight.

Results:

Drought effect on morphogenesis and ontogenesis of flax

The pot experiments in 2002-2005 were conducted to determine the effect of periodical and controlled drought stress (soil moisture content at 25% of the field water capacity) on the development (ontogenesis) of fiber flax plants. Application of the controlled drought stress (for 30 days, beginning from the fast growth stage of flax – when the plants are 18-20 cm tall) had little effect on the length of vegetation period (acceleration of maturation by 2-3 days). A significant effect of applied drought stress on the morphological structure and yields was observed as a result of introduced water stress at 25% of field water capacity (FWC). In object with a water deficiency the technical length of stem was shorter, the straw and fiber yields were lower, as compared to the object where soil water content was optimal (45% FWC) (Byczynska & Heller 2004).

Determination of critical periods in flax cultivation regarding drought tolerance

The pot trials carried out in controlled drought stress showed that the most important water period in fiber flax development is the period from phase of "fast growth" (BBCH 32) until beginning of bloom (BBCH 61).

The assessment of drought tolerance of Linum genotypes collected at INF

The individual plant development and the straw yield under the drought stress conditions were evaluated by comparison of 25 Linum genotypes. The most resistant to the drought stress was the late maturing Polish cultivar Nike. In other words, the correlation was found between the length of the vegetation period and plant resistance to drought. These studies served as the base for selecting parental pairs in flax breeding directed to increase resistance to drought. Moreover the current evaluation cultivated in Poland varieties regarding their water requirements should be made in order to distribute cultivation accordingly.

Biological assessments of antitranspirants in flax cultivation

The baseline of the research was the pot experiment conducted in 2002-2005 in a vegetation hall of the Experimental Station of the Institute of Natural Fibers and Medicinal Plants in Pętkowo (Wielkopolskie district).

The experimental factors were preparations with the following action:

- coating

Nu-Film 96 EC (0.3 l ha-1)
Glycerin + Olejan 85 EC (0.6 l ha-1 + 1.5 l ha-1),
Paraffin + Olejan 85 EC (0.6 l ha-1 + 1.5 l ha-1),
Linseed mucilage + Olejan 85 EC (10 l ha-1 + 1.5 l ha-1),

- fertilizing

Potassium (K2SO4) + Olejan 85 EC (2 kg ha-1 + 1.5 l ha-1)

- dessicant

Reglone Turbo 200 SL (200 l ha-1 of 50 and 100 ppm water solution)

- regulating growth

Atonik SL (0.5 l ha-1)

- with specific action

Acetyl salicylic acid [ASA] (0.01 kg ha-1, 0.1 kg ha-1. 1.0 kg ha-1)
Bio-stimulator IWN-11 (a.i. ASA)

Application of ASA (1.0 kg ha-1 and 0.1 kg ha-1), Atonik (0.5 l ha-1) and Reglone Turbo 200 SL (50 ppm), bio-stimulator IWN-11 (1,0 l ha-1) in conditions of controlled drought stress (soil moisture content at 25% FWC) had a beneficial effect on growth, development and yields of flax. (tab. 1). A statistically proven increase of total and technical length was found as an effect of application of ASA (1.0 kg ha-1 and 0.1 kg ha-1), Atonik (0.5 l ha-1) and Reglone Turbo 200 SL (50 ppm), in conditions of controlled drought stress (soil moisture content (25% FWC). Application of ASA (1.0 kg ha-1 and 0.1 kg ha-1), Atonik (0.5 l ha-1) and Reglone Turbo 200 SL (50 ppm), in conditions of controlled drought stress (soil moisture content at 25% FWC) resulted in significant increase of total yield of flax and straw yield. The tested antitranspirants only slightly modified the fiber efficiency (in %) in relation to the straw yield. Only the growth regulator Atonik at 0.5 l ha-1 and Reglone Turbo 200 SL in 50-ppm solution significantly increased value of this parameter. Application of ASA (1.0 kg ha-1 and 0.1 kg ha-1), Atonik (0.5 l ha-1) and Reglone Turbo 200 SL (50 ppm), in conditions of controlled drought stress (soil moisture content (25% FWC), caused a significant increase of total fiber yield (by 12.8-25.5%) (Heller et al. 2006).

Bio-stimulator IWN-11 shows beneficial effect on increasing crop resistance to drought. The plants fibre flax sprayed with IWN-11 can adjust better to the unfavorable for growth and development conditions during drought by employing a number of metabolic routes.

In the pot and fields experiment conducted in years 2002-2008, at the Experimental Farms of the Institute of

Natural Fibres and Medicinal Plants (INF&MP) using IWN-11 resulted in higher yields of fibre flax (increase in fibre yields by 14%). IWN-11 belongs to the group of environmentally friendly compounds. The preparation has been developed as a result of collaboration between the INF&MP and Poznan University of Life Sciences.

The effect of antitranspirants on the average values of morphological measurements of fibre flax (EF Pętkowo - 2002-2004) Table 1

Objects Antitranspirant name	Dose/ha	Total ler of flax cm	Technical length flax ci	Stem diame mr	Slende s lox	Length pani	Number seed caj	Numbe brar	Number seeds capsi
Control – optimum soil moisture content in pots during vegetation period 45% FWC		110,61	99,29	1,56	642,9	11,32	4,06	4,02	21,9
Control – controlled drought stress at 25% FWC)		81,45	74,43	1,28	586,1	7,01	3,58	3,81	23,3
Nu-Fim 96 EC	0,3 l	78,44	71,76	1,27	568,9	6,68	3,74	3,81	23,0
Acetic salicylic acid ASA	0,01 kg	77,62	71,76	1,24	586,1	6,01	3,44	3,49	20,3
Acetic salicylic acid ASA	0,1 kg	89,75	81,99	1,33	624,4	7,76	3,82	3,64	21,5
Acetic salicylic acid ASA	1 kg	87,84	80,17	1,35	602,1	7,56	3,51	3,53	20,9
$K(K_2SO_4)$ + Olejan 85 EC	2 kg + 1,5 l	84,93	77,33	1,32	592,8	7,61	3,70	3,79	22,1
Paraffin + Olejan 85 EC	0,6 l + 1,5 l	84,57	77,65	1,31	596,9	6,88	3,72	3,68	22,3
Glycerine + Olejan 85 EC	0,6 l+1,5 l	80,59	73,64	1,29	577,0	6,96	3,83	3,62	21,5
Linseed mucilage + Olejan 85 EC	10 l + 1,5 l	80,21	73,88	1,29	573,9	6,33	3,78	3,71	22,0
Atonik SL	0,5 l (1%)	89,33	81,59	1,38	599,0	7,80	3,83	3,61	20,8
Reglone Turbo 200 SL	200 l of 50 ppm water solution	86,26	78,90	1,38	581,9	7,37	3,93	3,71	22,7
Reglone Turbo 200 SL	200 l of 100 ppm water solution	74,18	66,76	1,35	500,6	7,44	4,03	3,89	25,6
LSD 0,05		**4,00**	**4,08**	**0,05**	**37,61**	**0,77**	**0,24**	**0,20**	**2,14**
F Fischer's Test		****41,53**	****30,34**	****17,17**	****6,33**	****22,92**	****4,67**	****4,30**	****3,339**

**highly significant differences between means (Fcalc. > F0,01 = 2,675). If none of the compared pairs of means has any common letter it means that it is significantly different acc. to the t Student's Test at 0,05 significance level 0,05).

The influence of derivatives poly (aspartic acid) (PAA) sodium and ammonium salts - on the average values of morphological measurements and yields of fibre flax (EF INF Pętkowo 2005-2007) Table 2

L p.	Objects	Dose	Total length of flax stem [cm] [cm]	Technical length of flax stem[cm]	Total flax yield [g/pot]	Straw field [g /pot]	Seed yield [g/pot]	Fibre yield [g/pot]	Total fibre content [%]	Roots biomass [g/pot]
1	Control $N_{30}P_{50}K_{120}$		65,54	61,62	14,70	10,08	2,87	2,21	21,97	3,91
2	N P K_{120} + poly (aspartic acid) sodium) PAA	100 g/ha	67,81	63,02	15,71	10,95	3,21	2,35	21,42	4,07
3	$N_{30}P_{50}K_{120}$ + poly (aspartic acid) sodium) PAA	500 g/ha	79,66	72,83	16,80	12,30	2,84	2,90	23,55	4,41
4	$N_{30}P_{50}K_{120}$ + poly (aspartic acid) sodium) PAA	1000 g/ha	79,91	73,89	16,57	12,11	2,88	2,83	23,35	4,47
5	$N_{30}P_{50}K_{120}$ + 20% poly (aspartic acid)ammonium) PAA	2 ml/kg seed	82,21	74,82	16,94	12,34	2,70	2,86	23,18	4,75
6	$N_{30}P_{50}K_{120}$ + 20% % poly (aspartic acid)ammonium) PAA	3 ml/kg seed	82,29	75,88	16,77	12,31	2,83	2,89	23,49	5,17
7	$N_{30}P_{50}K_{120}$ + poly (aspartic acid)ammonium) PAA + Oxafun T	3 ml/kg 3 g/kg+ seed	81,88	75,22	15,67	11,57	2,73	2,76	23,93	4,58

Assesment of the usefulness of Poly asparginian acid compounds in flax cultivation for increasing root biomass and drought tolerance

The baseline for the study was the evaluation of efficacy of poly (aspartic) acid compounds in flax cultivation. In the pot trials carried out at the Experimental Farm Petkowo (2005-2007) the application of PAA-Na and PAA-NH4 in conditions of controlled drought stress had a beneficial effect on growth, development and yields of flax. The increase of total and technical length was found as an effect of application of PAA compounds (seed dressing, post emergent application) in conditions of controlled drought stress (soil moisture content 25%

FWC). Application of PAA resulted in significant increase of total yield of flax and yield of straw. The tested PAA compounds modified the fiber efficiency (in 128,0 131,8 %) in relation to the straw yield (tab.2). The best results in flax growing were obtained when PAA compounds were applied as seed dressers (2-3 ml/1 kg seeds) and as post emergent plant spraying (500 g/ha).

Conclusions:

1. Evaluation of water requirements of INF& MP collection of flax cultivars regarding drought resistance is the base for further breeding.

2. Estimation of fibre flax cultivars water requirements allows for optimalization of distribution of flax cultivation in regions of Poland.

3. The best results, in the tested group of antitranspirants and bio-stimulators, in increasing the drought resistance in flax were obtained for compounds IWN-11 and Asahi SL.

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YIELDING POTENTIAL OF BAST FIBROUS PLANTS IN EUROPE

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Abstract:

The paper presents the results of the project of the European Commission: 4 F CROPS, which deals with crops for food, feed, fiber and fuel. The project is coordinated by Dr. Eftinia Alexopoulouů (CRES), Greece. At the Institute of Natural Fibres and Medicinal Plants work on the project is coordinated by Prof. Dr. Ryszard M. Kozlowski and M. Mackiewicz-Talarczyk.

The main aim of the 4F CROPS project is to survey and analyze all the parameters that will play an important role in successful non-food cropping systems in the agriculture of EU27 alongside the existing food crop systems.

The aim of the work for INF in Task 2.3 YIELDING POTENTIAL OF FIBER PLANTS IN EUROPE was to evaluate and compare the yielding potential of fiber plants.

The best results achieved in the field trials were compared with the reported yields obtained in practice, called here commercial yields.

The comparison has been done for fibrous flax, hemp, grown in European countries.

Presented results have been sourced from the publicly available statistical databases and from the databases complied in the Institute of Natural Fibres & Medicinal Plants/ FAO-ESCORENA European Research Network on Flax and other Bast Plants.

The results on potential yielding have been gained as well from the official bodies responsible for registration of the cultivars such as research centres for cultivar testing, as well as, directly from the flax and hemp research institutions. The information on commercial yields has been provided by the relevant bodies, responsible in the particular countries for the collection of the data in agriculture and industry.

The resource data regarding commercial yields are available at the corresponding author.

Introduction:

As far as the scientific and flax varieties potential in scope of fibrous flax is concerned – the major research centres having long lasting and recognized achievements are in Europe (including the Institute of Natural Fibres, which conducts research in scope of flax and hemp for almost 80 years). The linseed (oil flax) research and very valuable varieties are in Canada, which is the biggest producer of linseed. The significant linseed (oil flax) producers are: Argentina, USA, India. In Europe major players in scope of linseed: Hungary, Turkey, Poland, Ukraine, Czech Republic. It is necessary to underline that there is the lack of the GM research in the scope of fibrous flax.

III. YIELDING POTENTIAL OF FIBER PLANTS IN EUROPE

III. 1. The yielding of fibrous flax

Table 1. Fibrous flax cultivated area in the world [ha]

Country	2000	2001	2002	2003	2004	2005	2006	2007	2008 est.
AUSTRIA	450[1/]	132[1/]	171[6/]	142[5/]	109[6/]	134[1/]	129[1/]	0,02[10/]	°/
BELARUS	81 800	70 000°	67 900	70 900	79 000	78 500	75 200	78 500[1/]	°/
BELGIUM	13 355[3/]	16 990[3/]	15 315[5/]	19 306[5/]	19 823[1/]	18 670[1/]	16 354[1/]	14 630[1/]	12 030[/]
BULGARIA	300	210	470	150°	70	°/	°/	°/	°/
CHINA	100 000[6/] °	100 000[6/]	80 000[6/]	133 000[6/]	200 000[6/] 130 00 0[7/]	130 000	118 500	110 000	°/
CZECH REPUBLIC	6 302-	7 095	5 885	6 003	5 500	4 318[1/]	2 736[11/]	824[10/]	°/
DENMARK	45[1/]	19[1/]	0[1/]	0[1/]	°/	°/	°/	°/	°/
EGYPT	3 994[9/]	7 649[9/]	8 936[9/]	13 010[9/]	17 138[9/]	5 847[9/]	°/	20 000[1/]	°/
ESTONIA	137	89	35	17	0	Fibrous Flax 0, Linseed 91ha	°/	°/	°/
FINLAND	1 067[1/]	365[6/]	202[5/]	97[5/]	67[5/]	57[1/]	17[1/]	°/	°/
FRANCE	55 629[3/]	67 970[3/]	68 416[1/]	76 439[5/ x]	80 081[1/]	81 508[1/]	76 497[1/]	75 523[1/]	67 000[1/]
GERMANY	402[1/]	200[1/]	200[6/]	224[6/]	180[6/]	38[1/]	30	51	°/
IRELAND	°/	0[3/]	°/	°/	°/	°/	°/	°/	°/
ITALY	°/	1[3/]	0[5/]	20[5/]	80	18[1/]	°/	°/	°/
LATVIA	300-linseed; 1600-fiber flax	°/	°/	°/	1 654[6/]	2 072[1/]	1 420	220[10/]	°/
LITHUANIA	8 600	9 600	9 346	9 444[1/]	5 494	3 599[1/]	1 057[1/]	950[1/]	°/
THERLANDS	4 016[1/]	4 415[1/]	4 000[5/]	4 615[5/]	4 517[1/]	4 691[1/]	4 366[11/] [1/] *	3 458[1/]	2 500[1/]
POLAND	5 093[4/]	4 520[4/]	5 100[4/]	6 000[4/]	6 345[4/]	6 843[4]	4 225[11/]	2 056[10/]	1991[4/]
PORTUGAL	3 522[3/]	0[3/]	0[1/]	°/	°/	°/	°/	°/	°/
RUMANIA	2 000[6/]	300[6/]	300[6/]	°/	°/	°/	°/	107[10/]	°/
RUSSIA	107 610	127 340 127 361[6/]	110 820 100 000[6/]	118 060 104 000[6/]	112 300	95 450	86 000	75 000	81 000
Slovak Rep.	°/	°/	°/	°/	°/	°/	°/	67[10/]	°/
SPAIN	13 595[3/]	342[1/]	60[5/]	2[5/]	°/	°/	°/	°/	°/
SWEDEN	21[1/]	32[3/]	25[1/]	0[1/]	30[1/]	°/	°/	34	°/
UKRAINE	19 300	28 280	28 200	32 480[8/]	38 220[8/]	25 530[8/]	16 164	12 000[8/]	°/
UNITED KINGDOM	11 816[3/]	4 430[1/]	156[5/]	175[5/]	1 820[1/]	196[1/]	21[1/]	°/	°/

Total flax cultivated area in EU countries: in 2000 103 8673/ ha, in 2001 94 6313/ha, in 2002: 88 8851/ha, in 2003: 98 9651/ha., in campaign 2004/2005: 118 251 ha, in campaign 2005/2006: 122 379 ha, 2006: 10/105 025 ha; in 2007: 10/78 500 ha. In entire Europe total flax cultivated area in 2007: 10/95 117 ha.

Source: Generally, data provided by relevant countries' official organizations (see also the country data). Those data are not marked. Another source of information is described below:

1/ A. Daenekindt: Algemeen Belgisch Vlasverbond, Oude Vestingsstraat 15, B-8500 Kortrijk, Belgium, e-mail: albert.daenekindt@vlasverbond.be

2/ FAOSTAT Statistical Database Results 1997 http://apps.fao.org

3/ Mr. Jordi Petchamé Ballabriga, Administrateur, Olives, huile d'olive et plantes textiles, D.G. VI.C.4 - Loi 130 7/126, European Commission, Rue de la Loi 200, B-1049, Bruxelles, Belgium

4/ Polish Chamber of Flax and Hemp, office at the Institute of Natural Fibres, Poznan, Poland, t.: +48-61 8 455 851, f.: +48 61 8 417 830, hempflax@inf.poznan.pl, data provided by the Ministry of Agriculture and Rural Development.

5/ 54ème Congrès CELC – Berlin, Réunion d'information Générale / Section commune Culture-Teillage

6/ CELC/MASTERS OF LINEN, 15, rue du Louvre, 75001 Paris, France, t.: +33(0)1 42 21 06 83, f.: +33(0)1 42 21 48 22, e-mail: info@mastersoflinen.com

7/ Research Institute of Industrial Crops of Heilong Academy of Agricultural Sciences, Harbin, China, 150086, t:(86)0451-55261351, f.(86)451866 77431, E-mail: wuguangwenflax@163.com

8/ Dr Pavel Goloborod'ko, Institute of Bast Crops, Lenina 45, 245130 Glukhov, Sumy, Ukraine, t./f: 3805444 22643

9/ Prof. Dr. D. M. El-Hariri, The Network Representative in the Near East, NRC, Cairo, Egypt, e-mail: profelhariri@netscape.net; acc. to Agricultural Economics Bulletins of the Central Administration for Agricultural Economics and Statistics of Egypt.

10/ Ministry of Agriculture and Rural Development of Poland (basing on European Commission documents)

11/ Data of European Commission, DG AGRI of May 2008, Doc. No 9875/08.note: in all tables the mark °/ means data not available

III.1.1. The potential yielding of fibrous flax in Europe

III. 1.1.1. In-depth examples of potential fibrous flax yielding in selected European countries

III.1.1. 2. Fibre flax yielding potential in France

Table 2. Fibre flax yielding potential in France

	Specification	One of the best results in 2008/ real farmer field
1.	Total yield [t/ha]	
2.	Ginned (deseeded) straw yield [t/ha]	10.76
3.	Seed yield [t/ha]	0.55
4.	Total fibre content in ginned straw yield [%]	33.32
5.	Long fibre content in ginned straw yield [%]	26.76
6.	Short fibre content in ginned straw yield [%]	6.56
7.	Yield of total fibre [t/ha]	3.584
8.	Yield of long fibre [t/ha]	2.879
9.	Yield of short fibre [t/ha]	0.705

Source: Eng. Trouvé Jean-Paul, Responsable de la Recherche, Research Manager, Terre de Lin, 76740 Saint Pierre le Viger, France, +33 (0)2 35 97 41 33, fax: +33 (0)2 35 97 13 18, www.terredelin.com

III.1.1. 3. Fibre flax yielding potential in Poland

The results of over 40 years of the observations (years 1967-2008); 315 plot trails indicate that there is significant diversification in the flax yields and their quality, according to the environmental conditions.

In the years with the weather conditions favourable for this plants: (i.e. moisture level, the length of growing period, amount of light, etc.; and when the optimal flax cultivation technologies have been applied, total yield and yield of ginned straw of fibre flax totalled over 10.0 t/ha. Those parameters resulted in the total yields of fibre at the level of 2,266 kg/ha and 1,740 kg/ha of fibre, with total fibre content and content of long fibre

(22.0% and 16.9% accordingly). The described results have been obtained for the flax variety Svapo (Pl), in the conditions plot trials conducted over 20 years ago.

In the described over 40 years observation and trials, the total flax yielding potential was often recorded at the level over 10.0 t/ha, while the average commercial yields (Tab. 1) were able to deliver only 50% of potential yielding. This lower yield was observed even in the countries having a high level of agriculture, and at the optimal climatic conditions for flax (cool and rainy weather during vegetation period).
The results of the plot experiments indicate on the significant yielding potential, which might be double comparing to the yields obtained in the current practice.

Table 3. Fibre flax yielding potential in Poland
(the best results from 315 field trials carried out in the period 1967-2007)

No.	Specification	The results Experimental Farm of INF, Wojciechow, Poland, 1984
1.	Total yield [t/ ha]	11.75
2.	Ginned (deseeded) straw yield [t/ha]	10.30
3.	Seed yield [t/ha]	0.90
4.	Total fibre content in ginned straw yield [%]	22.0
5.	Long fibre content in ginned straw yield [%]	16.9
6.	Short fibre content in ginned straw yield [%]	5.1
7.	Yield of total fibre [t/ha]	2.266
8.	Yield of long fibre [t/ha]	1.740
9.	Yield of short fibre [t/ha]	0.525

Source: Computer Data Base Access 2007, the Institute of Natural Fibres, Poznan, Poland

Table 4. Fibre flax yielding potential in the Netherlands

	Specification	The best results in breeding or field trials
1.	Total yield [t/ha]	
2.	Ginned (deseeded) straw yield [t/ha]	6.0
3.	Seed yield [t/ha]	0.1
4.	Total fibre content in ginned straw yield [%]	40.0
5.	Long fibre content in ginned straw yield [%]	22.5
6.	Short fibre content in ginned straw yield [%]	17.5
7.	Yield of total fibre [t/ha]	2.4
8.	Yield of long fibre [t/ha]	1.35
9.	Yield of short fibre [t/ha]	1.05

Source: Van de Bilt Zaden en vlas bv, Netherlands

III.1.1.4 Fibre flax yielding potential in Czech Republic

Table 5. Potential yield of straw, seeds and fibre of flax obtained from experimental trials in Czech Republic [Pavelek, Tejklova, Journal of Natural Fibres 2002]

Variety	Unretted stem yield [t/ha]	Total fibre content [%]	Long fibre content [%]	Total fibre yield [t/ha]	Long fibre yield [t/ha]	Short fibre yield [t/ha]	Seed yield [t/ha]
Agatha	8.27	37.6	24.1	2.51	1.66	0.85	1.27
Escalina	8.04	35.6	21.6	2.28	1.43	0.85	1.23
Electra	7.96	35.7	22.6	2.22	1.39	0.83	1.25
Ilona	7.73	34.7	23.0	2.31	1.42	0.89	1.29
Viola	7.65	34.5	22.3	2.07	1.27	0.8	1.12
Viking	7.41	37.5	21.8	2.18	1.29	0.89	1.19
Bonet	7.67	37.6	24.8	2.23	1.39	0.84	1.3
Jordan	7.9	38.1	22.8	2.39	1.51	0.88	1.14
Tabor	7.6	37.8	21.8	2.31	1.37	0.94	1.27
Jitka	6.92	33.9	20.9	1.9	1.21	0.7	1.18
Venica	7.37	36.9	21.8	2.23	1.39	0.84	1.34

III.1.1.5 Fibre flax yielding potential in Russia

Table 6. Fibrous flax potential of yielding in Russia

	Specification	The best results in breeding of late varieties
1.	Total yield of unretted straw [t/ha]	7.5-8.0
2.	Ginned straw yield [t /ha]	5-6
3.	Seed yield [t/ha]	1.8
4.	Total fibre content in ginned straw yield [%]	45
5.	Long fibre content in ginned straw yield [%]	24
6.	Short fibre content in ginned straw yield [%]	11
7.	Yield of total fibre [t/ha]	2. 5
8.	Yield of long fibre [t/ha]	1. 6
9.	Yield of short fibre [t/ha]	0.9

Source: 1 Alexander Goncharov, Deputy Director, Department for Public and International Relations, Federal Service of State Statistics of the Russian Federation, Moscow, Russia.
2 Flax Research Institute(VNIIL), Torzhok, Russia, E-mail: uschapovsky@mail.ru;

III.1.1.6 Fibre flax yielding potential in Belarus

Table 7: Fibrous flax yielding potential in Belarus

	Specification	Cultivar	The best results in field trials
1.	Total yield [t/ha]	Bielich	12.48
2.	Ginned straw yield [t/ha]	Bielich	11.58
3.	Seed yield [t/ha]	Iva	2.01
4.	Total fibre content in ginned straw yield [%]	Tabor	43.7
5.	Long fibre content in ginned straw yield [%]	Tabor	26.0
6.	Short fibre content in ginned straw yield [%]	Tabor	17.7
7.	Yield of total fibre [t/ha]	Medium yield	5.060
8.	Yield of long fibre [t/ha]	Medium yield	3.011
9.	Yield of short fibre [t/ha]	Medium yield	2.049

Source: Results of the official sorts testing of crops of the Republic of Belarus in 2005-2007. Data provided by the Institute of the Agrarian Economics, Minsk, Belarus, E-mail: agrecinst@mail.belpak.by

Generally, potential production capabilities of fibre flax are significant. As from results of table 2, flax cultivated in good conditions can give following yields: straw yield – 7-8 t/ha, total fibre yield – 2.5 t/ha, long fibre yield – 1.6 t/ha, short fibre yield – 0.8 t/ha, seed yield – 1.3 t/ha, total fibre content – 38%, long fibre content – 24.8% (Tab.2) .

However, average yields of fibre flax varieties from industrial cultivation are at the level of: total fibre yield – 1.7 t/ha, long fibre yield – 1.2 t/ha, seed yield – 0.9 t/ha, total fibre content – 30% and long fibre content – 22% (Tab. 3) and those results are 30-35% lower than data observed in the trials.

III.1.2. The commercial yielding of fibrous flax Europe

Table 8. The survey of average commercial yields of fibre flax in western and eastern Europe

	Specification	Years															
		2002		2003		2004		2005		2006		2007		2008		Average	
		Eastern Europe	Western Europe	Eastern Europe	Western Europe	Eastern Europe	Western Europe	Eastern Europe	Western Europe	Eastern Europe	Western Europe	Eastern Europe	Western Europe	Eastern Europe	Western Europe	Eastern Europe	Western Europe
1	Ginned straw yield [t/ha]	4.49	5.40	3.23	5.20	3.57	4.95	3.85	4.45	3.56	4.75	3.46	48.00	36.20	56.0	36.83	49.9
2	Seed yield [t/ha]	0.82	1.00	0.60	0.98	0.70	0.92	0.80	0.83	0.65	0.89	0.60	0.90	0.73	1.05	0.70	0.93
3	Total fibre content in ginned straw yield [%]	30.00	35.30	30.20	36.10	33.60	33.90	31.10	31.80	30.80	31.20	28.80	32.30	30.70	32.10	30.74	33.50
4	Long fibre content in ginned straw yield [%]	18.90	22.60	18.50	25.00	22.40	21.80	19.50	21.30	19.60	20.60	18.70	20.80	20.70	25	19.76	22.50
5	Short fibre content in ginned straw yield [%]	11.10	12.70	11.70	11.10	11.20	12.10	11.60	10.40	11.20	10.50	10.10	11.50	11.00	7.10	11.13	11.00
6	Yield of total fibre [t/ha]	1.350	1.905	0.980	1.875	1.200	1.680	1.200	1.415	1.100	1.480	1.000	1.550	1.150	1.800	1.134	1.675
7	Yield of long fibre [t/ha]	0.850	1.220	0.600	1.300	0.800	1.080	0.750	0.950	0.700	0.980	0.650	1.000	0.750	1.400	0.723	1.130
8	Yield of short fibre [t/ha]	0.500	0.685	0.380	0.575	0.400	0.600	0.450	0.465	0.400	0.500	0.350	0.550	0.400	0.400	0.411	0.545
9	Cultivation area [ha]	5 200	15 315	3 000	19 306	6 345	19 823	6 000	18 670	4 243	16 354	2 056	14 630	1 991	12 030	4 119	16 590

Source: The data in the above table are based on the data achieved in the commercial scale, in the flax industries of Poland and Belgium.

The data are provided by the following sources: in case of Poland— Flax and Hemp Chamber, which obtains the data from the Ministry of Agriculture and Rural Development and the Institute of Natural Fibres data; in case of Belgium—Algemeen Belgisch Vlasverbond (Belgian Flax Association), Kortrijk, Belgium. The data from Belgium, provided by the Belgian Flax Association- the member of CELC (Confédération Européenne Du Lin et Du Chanvre) are comparable with data on fibrous flax parameters and yielding in France and the Netherlands.

The next tables gather together the data regarding the average commercial yields of fibrous flax obtained in the different countries-the producers and processors of flax in Europe in some recent years.

Table 9: The survey of the average commercial yields of fibrous flax in flax producing countries in Europe

Specification	Belarus	Belgium	Bulgaria	Czech Rep.	Denmark	Estonia	France	Latvia	Lithuan.	Nether.	Poland	Russia	Spain	UK	Ukraine
Straw yield [t/ha]	2.73	4.99	2.26[1]	3.11	0. 746[1]	0.888	7.05	n/a	3.15	5.014[1]	4.43[3]	2.84[5]	1.27[1]	3.44[1]	2.3
Seed yield [t/ha]*of fibre flax	0.25	0.93	n/a	0.51	n/a	0.9	0.472	0.294	0.39	0.798	0.70[3]	0.11[5]	n/a	n/a	0.23
Long fibre yield [t/ha]	0.304	1.125	n/a	0.412	n/a	n/a	1.459	0.073 2	0.3.3	1.041	0.729[3]	0.459[5] - 0.565[4]	n/a	n/a	0.149
Long fibre production [t]	n/a	n/a	n/a	1 865	n/a	n/a	n/a	1 258	2 108	n/a	10 52 3[3]	52 71 2[4]	n/a	n/a	4477
Short fibre yield [t/ha]	0.324	0.545	n/a	0.506	n/a	n/a	0.891	n/a	0.50	0.662	0.411[3]	0.153[5]	n/a	n/a	0.252 5
Short fibre production [t]	n/a	n/a	n/a	2389	n/a	n/a	n/a	n/a	3 174	n/a	5 542[3]	158 1 36[6]	n/a	n/a	7841
Percentage of dew retting [%]	100[2]	100[2]	n/a	100	100[2]	100	100[2]	100[2]	100[2]	100[2]	100[3]	100[2]	100[2]	100[2]	100[2]
Cultivated area av.[ha]	75 00 0	16 590	183. 3[1]	4 822	266[1]	140	70 88 3[1]	1 728	8 158	4 516.7[1]	5 091[3]	111 930[4]	2 383[1]	4 400[1]	29 41 5

Sources of data: calculation of average data from several years
1/ EUROSTAT
2/ EUROFLAX Bulletins of the European Cooperative Research Network on Flax and other Bast Plants, No. 22-28.
3/ Polish Flax and Hemp Chamber

Note: * for 1ha harvested area, n/a- not available

Other sources than EUROSTAT regarding the particular countries are provided by:

Belarus: Institute of the Agrarian Economics, Minsk, Belarus, E-mail: agrecinst@mail.belpak.by

Belgium: Algemeen Belgisch Vlasverbond, Kortrijk, Belgium, Tel.: +32/ 56 22 02 61, Fax +32/56 22 79 30, E-mail: albert.daenekindt@vlasverbond.be

Czech Republic: P. Šmirous, H. Suchomelová, S. Krmela, ATOK Praha and Flax Union CR, Šumperk-Temenice, Czech Republic, E-mail: len@agritec.cz

Estonia: Aime Lauk, Senior Consultant of the Information and Marketing Service, Statistical Office of Estonia, Tel +372 6259 300, E-mail: Aime.Lauk@stat.ee

France: Dr. Trouvé Jean-Paul, Responsable de la Recherche, Research Manager, Terre de Lin, 76740 Saint Pierre le Viger, France, +33 (0)2 35 97 41 33, fax: +33 (0)2 35 97 13 18, www.terredelin.com with a help of Mr Christophe Mallet, Association Générale des Producteurs de LIN, 5, rue du Louvre - Boîte n°84, F-75 001 PARIS, Tel. 00.33.(0)1.40.41.11.66, Fax 00.33.(0)1.40.41.11.55

Latvia: U. Apels, Department of Information, Ministry of Agriculture of the Republic of Latvia, Riga

Lithuania: LIA – The Lithuanian Institute of Agriculture Upyte Research Station, Upyte, Lithuania; E-mail: soja@upyte.lzi.lt; "Crops". 2005 (ISSN 1648-0198) - statistical bulletin of Statistikos departamentas / Statistics Lithuania, published in Vilnius, Lithuania in 2005

The Netherlands: Source: Ms. Eugene Van de Bilt, Van de Bilt zaden en vlas bv, PO BOX 16, 4540 AA

SLUISKIL, The Netherlands, T: +31 115 471922, F.+31 115 472229, E-mail: info@vandebiltzadenvlas.com

Russia: 4/Department for Public and International Relations, Federal Service of State Statistics of the Russian Federation, Moscow, Russia, Fax: (7-095)207-31-86, e-mail: goncharov@gks.ru and 5/Flax Research Institute(VNIIL), Torzhok, Russia, E-mail: uschapovsky@mail.ru;
6/Calculated data

Ukraine: Institute of Bast Crops, Glukhov, Sumy, Ukraine, Tel.: /Fax: 3805444 22643, E-mail: ibc@sm.ukrtel.net and Prof. Dr. I. Karpets, Agriculture Institute of Ukrainian Academy of Agrarian Sciences, Chabany, Ukraine

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Table 10: Cultivation of fibrous flax and fibre production in the World

	2000		2001		2002		2003		2004	
	ha	Long flax fibre [tons]	ha	Long flax fibre [tons]	ha	Long flax fibre [tons]	ha	Long flax fibre [tons]	ha	Long flax fibre [tons]
France + Belgium + Neth.	71 016	89 900	87 836	46 647	86 153	123 856	98 360	144 500	102 621	131 445
Germany	402	n/a	200	n/a	200	280	224	n/a	180	112
Austria	450	n/a	132	n/a	171	n/a	142	n/a	109	82
Finland	1 067	n/a	365	n/a	202	n/a	97	n/a	67	n/a
Estonia	137	n/a	27	1 000	30	n/a	n/a	n/a	n/a	n/a
Latvia	1 600	1 100	n/a		n/a	n/a	n/a	n/a	1 654	317
Lithuania	8 600	2 900	9 600	1 400	9 346	2 300	10 000	3 000	5 494	2 553
Czech Rep.	6 302	2 235	7 095	1 591	5 885	2 000	6 003	2 100	5 499	2 930
Poland	5 093	2 700	4 520	2 712	5 100	1 300	6 000	4 200	5 745	4 050
Bulgaria	300	35	210	25	470	n/a	n/a	n/a	n/a	n/a
Romania	2 000	300	300	100	300	100	n/a	n/a	n/a	n/a
Russia	107 610	51 170	127 361	58 000	100 000	30 000	104 000	10 000	112 300	58 020
Belarus	81 800	20 000	70 000	17 500	40 000	16 000	60 000	10 000	79 146	16 000
Ukraine	19 300	2 509	28 280	5 076	28 200	4 323	32 000	4 000	37 000	6 000
Egypt	14 500	14 000	25 000	20 000	25 000	20 000	36 000	33 000	36 000	35 000
China	100 000	31 000	100 000	31 000	80 000	25 000	133 000	26 000	200 000	30 000
Total	420 177 ha	217 849 t	460 926 ha	185 051 t	381 057 ha	225 159 t	485 826 ha	236 800 t	585 815 ha	286 509 t
%										
France + Belgium + Netherland		41,3%		25,2%		55%		61%	17,50%	45,88%
EU									20,70%	49,38%

III.1.2.1.Discussion

III.1.2.1. i Discussion of the results regarding the flax potential of yielding

In the described over 40 years observation and trials, the total flax yielding potential was observed often at the level over 10.0 t/ha, while the average commercial yield (Tab. 1) were noticed on the level of 50% of potential yielding in the countries of high level of agriculture, in the optimal climatic conditions for flax (cold and rainy weather during vegetation period). [The Institute of Natural Fibres, Poland]

Fibre flax belongs to the plants which respond significantly to the applied cultivation technologies and the environmental conditions (soil, weather conditions).

The average commercial yield was only 30 – 35% of values of obtained in test trials, due to several factors which influence the yields in the agricultural practice as well as in processing.

The results of more than 40-year observations (the database with the 315 results of field trials carried out in INF Poznan) allow for conclusion that among evaluated habitat conditions the following ones show the strongest effect on growth, development and yielding of flax:

- sowing date – a simple positive correlation was found; the earlier sowing, the higher yield of straw, fibre and seed of fibre flax ,
- rainfalls distribution during vegetation of fibre flax – high moisture content in the habitat has a positive effect on elongation of growing season of fibre flax,
- air temperature – cool weather caused elongation of growing season,
- the highest yield of straw and fibre was obtained at long vegetation period,
- level of flax infestation with weeds – it was found that higher infestation with weeds causes decrease in number of flax plants per square unit resulting from higher thinning.

In fibre flax cultivation, the following factors have a significant effect on the fibre quality and its yield. Those measures do not require additional financial, material and energy inputs:

- forecrop – the best one for flax are cereals (oats, wheat),
- soil – the best for flax are fertile soils in a high culture, medium compacted and compacted, high humus clays and clay sandy soils, of soil valuation class (at least IVa),
- sowing density – 24-26 million of seeds per 1 ha (120-130 kg/ha),
- right-in-time and quality of plant protection treatments of flax plants

  (e.g. earlier application of herbicides allows for decreasing of a preparation),
- time of flax pulling – beginning of green-yellow maturity of flax,
- controlled dew-retting of flax.

Remarks

In remaining 80 %, physico – chemical properties of soils and climatic conditions have influence on flax production results. It is estimated, that three factors are responsible (in 20%) for so big difference in flax yield are as follows: diseases, insects and weeds.

It is generally accepted, that increase of fibre flax yield production capacity is possible to achieve through following practices:

- Breeding of cultivars with high functional characteristics
- Optimization of agrotechnical conditions of cultivation
- Regionalization of production
- Because fibrous flax and hemp are non-food crops it is very important to investigate and introduce GM crop, especially e.g. resistant to drought, with low level of pectine and lignin.

III.1.2.1. ii Discussion regarding potential yields versus commercial yields of fibrous flax in Europe

The average commercial yields are noticed in practice on the level from 50 – 70 % of potential yielding in the countries of high level of agriculture, in the optimal climatic conditions for flax. It means, that there is still potential and the need to increase the flax yielding in the commercial scale. What practices and actions are needed?

To increase practical yields of bast plants such as flax and hemp it is important to follow the well established routines, which include:

- to start the sowing process as soon as the relevant temperature of the soil is achieved;
- control the stage of retting process carefully (to avoid e.g. over-retting);
- to follow strictly the indicated, elaborated cultivation and agro techniques (described above);
- to aim towards full mechanization of the harvesting process.
- to accelerate the research and introduction of GM modified fibrous flax cultivars, which will enable e.g. production of significantly higher biomass and oil. It is also possible to conduct modification in statu nascendi (Poly-hydroxy-alcanates- PHA)

III.2. The yielding of fibrous hemp in Europe

III.2.1. The potential yielding of fibrous hemp

Table 11. Hemp harvested area in European Union countries and some other countries [ha]

COUNTRY OF EU	2000/2001[2)]	2002[1)]	2004 [3)]	2005 [4)]	Campaign 2005/2006	Campaign 2006/2007	2007Data by [8)]	2008Data by [8)]	2009-forecast Dat by
Austria	287	277	399	353	342	545	500	500	500
Belgium	0	0		6					
Czech Republic			150	159	156	1 086[6]	1 200	700	1 200
Denmark	7	0	40	n/a	n/a	n/a	n/a	n/a	n/a
Finland	59	0	7	n/a	0	0	n/a	n/a	500
France	7 700	7 729	8 800	9 600	9 315	8 083	8 103	7 500	11 500
Germany	2 967	2 035	1 730	2 005	1 985	1 233[6]	824	800	800
Hungary	n/a	n/a	500	n/a	277	n/a /	n/a	n/a	n/a
Italy	151	300	885		157	500	450	250	250
Ireland	6	0	0	0	0	0	100 OCM for Biomass	100 OCM for Biomass	n/a
Latvia	n/a	n/a	n/a	6	0	n/a	n/a	n/a	n/a
Netherlands	806	2 100	27	49	49	23			
Poland	111	83 In 2003–101 ha[3)]	910	216	129	1007[7)]	1 376	1 200	1 200
Romania						1 450[6]	108	n/a	n/a
Spain	6 103	691	654	700	853	3			
Sweden	0	0	141	368	n/a /	n/a	700 OCM for Biomass	200 OCM for Biomass	700 OCM for Biomass
UK	2 245	1 413	1 658	3 000	1 274	1 671[6]	800	1 300	2 500
Switzerland	250[1)]	°/	°/	°/	°/	°/			
Total area in EU	**20 404[2)]**	**14 584[2)]**	**14 557**	**16 462**	**14 541**	**13 974**	**14 261**	**12 650**	**18 750**
Ukraine	n/a	1 910[5)]	1 510[5)]	1 940[5)]	1 940	2 490	760	910	n/a

Source:

1) Michael Dr. Karus, nova –Institut für politische und ökologische Innovation, Nachwachsende Rohstoffe, Thielstr. 35, 50354 Hürth Germany

2) Mr. Jordi Petchamé Ballabriga, Administrateur, Olives, huile d'olive et plantes textiles, D.G. VI.C.4 - Loi 130 7/126, European Commission, Rue de la Loi 200, B- 1049, Bruxelles, Belgium

3) LEN I KONOPIE. (FLAX AND HEMP) No 4. 2005. pp. 2-10. The Bulletin of the Polish Chamber of Flax and Hemp, office at the Institute of Natural Fibres, Poznan, Poland, Ph.: +48-61 8 455 851, fax: +48 61 8 417 830, e-mail: hempflax@inf.poznan.pl

4) Polish Chamber of Flax and Hemp, office at the Institute of Natural Fibres, Poznan, Poland, Ph.: +48-61 8 455 851, fax: +48 61 8 417 830, e-mail: hempflax@inf.poznan.pl (data based on EC documents)

5) Institute of Bast Crops, Lenina 45, 245130 Glukhov, Sumy, Ukraine, Tel.: /Fax: 3805444 22643, E-mail: ibc@sm.ukrtel.net

6) Data of European Commission, DG AGRI of May 2008, Doc. No 9875/08

7) Ministry of Agriculture and Rural Development, Warsaw, Poland, E-mail: Grazyna.Bernatowicz@minrol.gov.pl

8) Mr. Sylvestre Bertucelli, Director, Federation Nationale des Producteurs de Chanvre, 20, rue Paul Ligneul, 72000 Le Mans, France, Tel: : + 33/2 43 51 15 00, Fax: +33/2 43 51 15 09, E-mail: s.bertucelli@fnpc.org

Table 12. Hemp in Europe: evolution 2007/2008/2009. Surface [ha] cultivation evolution

Country	2007	2008 (estimation)	2009 (forecast)
France	8 103	7 500	11 500
Germany	824	800	800
UK	800	1 300	2 500
Poland	1 530	1.792 *	1 800**
Czech Rep.	1 200	518	500
Hungary	200	0	200
Austria	500	500	500
Italy	450	250	250
Romania	108	n/a	n/a
Sweden (with no biomass OCM)	700	200	700
Ireland (with no biomass OCM)	100	100	n/a
Finland	300	300	300
Others	100	100	100
Total	14 915	12 768	18 550

Source:
Materials of 59th CELC Congress, 16-18.10.2008, Como, Italy
* Ministry of Agriculture and Rural Development, Warsaw, Poland, E-mail: Grazyna.Bernatowicz@minrol.gov.pl
** Polish Chamber of Flax and Hemp, E-mail: hempflax@inf.poznan.pl

Table 13. The survey of average fibrous hemp straw and fibre yields

Specification	Austria	Finland	France	Hungary	Italy	Netherlands	Poland	Romania	Turkey	Ukraine	UK
Hemp harvested straw, [1000 t]	n/a	n/a	57.57[1]	3.12[1]	1.57[1]	5.87[1]	0.23[1]	3.14[1]	178.21[1]	30.05[3]	10.05[1]
Straw yield [t/ha]	n/a	0.1 [1]	7.18[1]	6.40[1]	4.50[1]	6.58[1]	7.77	3.20[1]	12.58[1]	2.16[2]	4.58[1]
Hemp fibre yield [t/ha] (based on yield 2004/2005)	1.13	1.39	1.66	1.75	0.48	3.00	1.80	n/a	n/a	0.41[2/]	0.81

Sources of data:
1 EUROSTAT
2/ Ukraine: Institute of Bast Crops, Glukhov, Sumy, Ukraine, Tel.: /Fax: 3805444 22643, E-mail: ibc@sm.ukrtel.net
3/ calculated data
4/ Ministry of Agriculture and Rural Development of Poland, Warsaw.
5/ Steering Committee on Natural Fibres of the European Commission

III.2.1. 1. In-depth examples of hemp yielding potential:

III.2.1.2. Fibrous hemp yielding potential in France

Table 14. Fibrous hemp yielding potential in France

	Specification	The best results in fibrous hemp cultivars
1.	Total yield [t/ha] Biomass 16% RH	28.20 (Futura 75)
2.	Ginned straw yield [t/ha]	23.76 (Dioïca 88)
3.	Seed yield [t/ ha]	
4.	Total fibre content in ginned straw yield [%]	40.85 (Santhica 27)
5.	Yield of total fibre [t/ ha]	10.5 (Santhica 27)

Source: Mr. Sylvestre Bertucelli, Director, Federation Nationale des Producteurs de Chanvre, 20, rue Paul Ligneul, 72000 Le Mans, France, Tel: : + 33/2 43 51 15 00, Fax: +33/2 43 51 15 09, E-mail: s.bertucelli@fnpc.org

III.2.1.3. Fibrous hemp yielding potential in Hungary

Table 15. The potential yields of fibrous hemp observed in Hungary

No.	Specification	The best results in field trials
1.	Total yield [t/ha]	20.0
2.	Ginned straw yield [t/ha]	18.0-19.0*
3.	Seed yield [t/ha]	1.0
4.	Total fibre content in ginned straw yield [%]	35.0
5.	Long fibre content in ginned straw yield [%]	26.0
6.	Short fibre content in ginned straw yield [%]	9.0
7.	Yield of total fibre [t/ha]	4.3
8.	Yield of long fibre [t/ha]	3.2
9.	Yield of short fibre [t/ha]	1.1

Source: results partly from of the Institute of Kompolti Research Institute, partly from Tessedik Sámuel College Agricultural Water and Environmental Management research farm. *calculated data

III.2.1.4. Fibrous hemp yielding potential in Poland

The yields of fibrous hemp derived from the official trials of the Centre For Cultivar Testing

Table 16. Fibrous hemp yielding potential in Poland, based on cultivar testing trials

	Specification	The best results in fibrous hemp cultivar testing				
		2004	2005	2006	2007	Average
1.	Total yield [t/ha]	13.98	14.38	11.66	18.88	14.73
2.	Ginned straw yield [t/ha]	12.70	13.10	10.40	17.95	13.54
3.	Seed yield [t/ha]	1.23	1.23	1.21	0.88	1.14
4.	Total fibre content [%]	27.30	26.90	25.80	25.75	26.44
5.	Yield of total fibre [t/ha]	3.47	3.47	3.20	4.24	3.60

Source: COBORU- Research Centre For Cultivar Testing, Slupia Wielka near Poznan, tel.: (+48) 61 285 23 41–47, fax: (+48) 61 285 35 58, E-mail : sekretariat@coboru.pl

Table 17. Fibrous hemp yielding potential in Poland, obtained in breeding

No.	Specification	The results in breeding in field conditions
1.	Total yield [t/ha]	23.5
2.	Ginned straw yield [t/ha]	22.0
3.	Seed yield [t/ha]	1.4
4.	Total fibre content in ginned straw yield [%]	28.0
5.	Long fibre content in ginned straw yield [%]	12.0
6.	Short fibre content in ginned straw yield [%]	16.0
7.	Yield of total fibre [t/ha]	6.16
8.	Yield of long fibre [t/ha]	2.64
9.	Yield of short fibre [t/ha]	3.52

Source: Breeding farm KOW-MAR, Blaszki, average results from 2005-2007

Table 18. The potential yields of fibrous hemp observed in the experimental farm of the Institute of Natural Fibres, Poznan, Poland

No.	Specification	The best results in cultivation
1.	Total yield [t/ha]	15.0
2.	Ginned straw yield [t/ha]	12.0
3.	Seed yield [t/ha]	1.5
4.	Total fibre content in ginned straw yield [%]	35.0
5.	Long fibre content in ginned straw yield [%]	15.0
6.	Short fibre content in ginned straw yield [%]	20.0
7.	Yield of total fibre [t/ha]	4.20
8.	Yield of long fibre [t/ha]	1.80
9.	Yield of short fibre [t/ha]	2.40

Source: results of the Institute of Natural Fibres, Poznan, Poland (experimental farm LENKON, Steszew)

III.2.1.5. Fibrous hemp yielding potential in Ukraine

Table 19. The potential yielding of fibrous hemp in Ukraine

	Specification	The best results in breeding and pot or field trials
1.	Total yield [t/ha]	15.0
2.	Ginned straw yield [t/ha]	12.0
3.	Seed yield [t/ ha]	0.20
4.	Total fibre content in ginned straw yield [%]	33.0
5.	Yield of total fibre [t/ ha]	3.0

Source: Institute of Bast Crops, Lenina 45, 245130 Glukhov, Sumy, Ukraine, Tel.: /Fax: 3805444 22643, E-mail: ibc@sm.ukrtel.net

III.2.2. The commercial, practical yielding of fibrous hemp in Europe

In-depth examples

Table 20. Commercial yields of fibrous hemp in France

	Specification	
		Average
1	Total yield [t/ha]	
2	Ginned straw yield [t/ha]	7.5
3	Seed yield [t/ha]	0.9
4	Total fibre content in ginned straw yield [%]	37.0
5	Long fibre content in ginned straw yield [%]	
6	Short fibre content in ginned straw yield [%]	
7	Yield of total fibre [t/ha]	2.7
8	Yield of long fibre [t/ha]	
9	Yield of short fibre [t/ha]	

Source : Mr. Sylvestre Bertucelli, Director, Federation Nationale des Producteurs de Chanvre, 20, rue Paul Ligneul, 72000 Le Mans, France, Tel: : + 33/2 43 51 15 00, Fax: +33/2 43 51 15 09, E-mail: s.bertucelli@fnpc.org

III. 2.2.1 Commercial, practical yielding of fibrous hemp Poland

Table 21. Commercial yields of fibrous hemp in Poland

	Specification	Years							
		2002	2003	2004	2005	2006	2007	2008	Average
1.	Total straw yield [t /ha]	6.7	8.6	8.5	8.0	7.5	7.0	8.1	7.77
2.	Ginned straw yield [t/ha]	5.4	6.9	6.8	6.4	6.0	5.6	6.5	6.23
3.	Seed yield [t/ha]	0.7	0.9	0.8	0.8	0.10	0.7	0.8	0.814
4.	Total fibre content in ginned straw yield [%]	30.0	34.0	32.0	33.0	34.0	35.0	33.0	33.0
5.	Long fibre content in ginned straw yield [%]	10.0	8.0	9.0	10.0	10.0	9.0	10.0	9.43
	Short fibre content in ginned straw yield [%]	20.0	26.0	23.0	23.0	24.0	26.0	23.0	23.57
	Yield of total fibre [t/ha]	1.620	2. 346	2.176	2.112	2.040	1.960	2.145	2.057
	Yield of long fibre [t/ha]	0.540	0.552	0.612	0.640	0.600	0.504	0.650	0.585
	Yield of short fibre [t/ha]	1.080	1.794	1.564	1.472	1.440	1.456	1.495	1.472
	Cultivation area of fibrous hemp In Poland [ha]	83*	101*	909*	214*	1007*	1376*	1 791.58*	615

Source: LENKON- Experimental farm of the Institute of Natural Fibres, Steszew, Poland
*Ministry of Agriculture and Rural Development

The results in the above table derive from industrial plantations.

Table 22. Comparison between the potential yields and commercial yields of hemp in Poland

Specification	Average potential yields of hemp	Average practical yields of hemp	Practical yields versus potential yields of fibrous hemp [%]
Total yield of straw [t/ha]	14.73	8.42	57.0
Ginned straw yield [t/ha]	13.538	6.50	48.0
Seed yield [t/ha]	1.138	0.814	72.0
Total fibre content [%]	35.00	33.0	94.0
Yield of total fibre [t/ha]	3.595	1.867	52.0

Table 23. Commercial yields of fibrous hemp in Hungary

	Specification	
		Average
1.	Total straw yield [t /ha]	8.6
2.	Ginned straw yield [t/ha]	
3.	Seed yield [t/ha]	0.7-0.9
4.	Total fibre content in ginned straw yield [%]	27.0-30.0
5.	Long fibre content in ginned straw yield [%]	15.0-17.0
6.	Short fibre content in ginned straw yield [%]	12.0-13.0
7.	Yield of total fibre [t/ha]	3.00
8.	Yield of long fibre [t/ha]	2.8
9.	Yield of short fibre [t/ha]	0.9
10.	Cultivation area of fibrous hemp In Poland [ha]	615

The results in the above table derive from industrial plantations. Source: results partly from of the Institute of Kompolti Research Institute, partly from Tessedik Sámuel College Agricultural Water and Environmental Management research farm.*p. 2-9-calculated data

Table 24. Commercial yields of fibre hemp in Romania

	Specification	Years							
		2002	2003	2004	2005	2006	2007	2008	Average
1.	Total yield [t/ha]	5.3	2.7	1.6	2.2	1.2	4.7	5.0	3.24
2.	Ginned straw yield [t/ha]	4.8	2.4	1.4	2.0	1.1	4.2	4.5	2.92
3.	Seed yield [t/ha]	0.5	0.5	0.4	0.5	0.5	0.6	0.5	0.5
4.	Total fibre content in ginned straw yield [%]	33.0	33.0	34.0	32.0	35.0	35.0	33.0	33.57
5.	Long fibre content in ginned straw yield [%]	13.0	9.0	8.0	12.0	12.0	10.0	10.0	10.57
6.	Short fibre content in ginned straw yield [%]	20.0	24.0	26.0	20.0	23.0	25.0	23.0	23.00
7.	Yield of total fibre [t/ha]	1.574	0.802	0.490	0.634	0.378	1.481	1.485	0.98
8.	Yield of long fibre [t/ha]	0.620	0.219	0.115	0.238	0.130	0.423	0.450	0.31
9.	Yield of short fibre [t/ha]	0.954	0.583	0.374	0.396	0.248	1.058	1.035	0.66

Source: Ms. Ina Miu, Ministry of Agriculture in Romania - “Bast Plants Department”.
E-mail: ina.miu@madr.ro.

III. 2.2.2. Commercial, practical yielding of fibrous hemp Ukraine

Table 25. Commercial yields of fibrous hemp in Ukraine

	Specification	Years							
		2002	2003	2004	2005	2006	2007	2008	Average
1.	Total yield [t/ha]	2.38	2.25	2.23	1.75	3.00	1.38	n/a	2.16*
2.	Ginned straw yield [t/ha]	1.90	1.80	1.78	1.40	2.40	1.10	n/a	1.70
3.	Seed yield [t/ ha]	0.20	0.15	0.12	0.38	0.37	0.24	n/a	0.24
4.	Total fibre content in ginned straw yield [%]	27.0	27.0	28.0	27.0	27.0	28.0	n/a	27.0
5.	Yield of total fibre [t/ha]	0.466	0.439	0.412	0.340	0.570	0.270	n/a	0.417
6.	Hemp cultivated area [ha]	1 910	820	1 510	1 940	2 490	760	910	1 391

Source: Institute of Bast Crops, Glukhov, Sumy, Ukraine, Tel.: /Fax: 3805444 22643, E-mail: ibc@sm.ukrtel.net, *calculated data

Hemp- discussion

Hemp was a commonly grown, wide spread crop in the 1930s and 1940s. After World War II, however, the cultivation in many countries (USA, West Europe – except France) has been forbidden and stopped due to problem with narcotic properties (THC). Hemp was mainly used for production of technical textiles: twine, ropes, tarpaulin, non-wovens, plumber fibre, sacks, etc. The most intensive cultivation of hemp in Eastern Europe took place in turn of 1950s and 1960s. In the following years, hemp fibre utilization was decreasing in favour of first, cheaper tropical fibres (jute, coir, etc.) and then synthetic fibres. In most East European countries the turn of 1980s and 1990s was the time of considerable and sudden decline in hemp cultivation due to the economical changes in those countries. In early 1990s more attention was paid in Europe to non-food crops and renewable resources and as a consequence ban for hemp cultivation was lifted.

Recently the role of industrial hemp is growing due to many reasons such as developed techniques and technologies of the textile application of hemp fibre, high biomass production – potential even up to 28 tones from 1 ha. There is a growing interest of hemp application in e.g. modern composites, which are applied in such industries as transportation, building and also as by-product for agro-fine chemicals (with a very high added value).

Today the area of hemp cultivation in Europe totals for ca 12 768 ha in 2008. This makes hemp relatively marginal crop in Europe and although research on utilization of hemp for many industrial application is carried out in different research centres in the EU, the agronomic studies are very limited. This has a consequence in relative scarcity of available data in this field, both scientific and statistical. For instance EUROSTAT reports only three parameters for hemp: area of cultivation, straw production and straw yields.

The data from experiments shown above indicate that hemp has the significant yielding potential. The yields of ginned straw from experiments vary from ca 10 to almost 18 t/ha, and average at ca 13.5 t/ha. A comparison to commercial yields (6.5-7.7 t/ha on average) reveals that in practice only about 50% of plant potential is explored. This ratio is pushed even much further down when compared to data found in literature (34%). The trial results reported in the literature reach even much higher hemp (straw) yield figures – up to 22.5 t/ ha of dry matter (P.C. Struik et al. 2000). Some unpublished data reach even 25 and more t/ha.

Recently, the research at the INF and other centres has concentrated at intensive genetic and breeding work to obtain new hemp cultivars with qualities tailored to non-textile applications. With special focus on renewable energy and biomass suitable for pulp and paper industry. With this regard the work of INF is concentrated on obtaining high yields of air-dry mass (over 20 t/ha) and reduction of hallucinogenic compounds

(THC) to trace amounts.

The actually utilized fibrous hemp varieties in France have 0.0 Δ 9 THC content e.g. Santhica 27, Santhica 70, while tests proved in USO 31: 0.005 % Δ 9 THC [Mr. Sylvestre Bertucelli, Director, Federation Nationale des Producteurs de Chanvre, 20, rue Paul Ligneul, 72000 Le Mans, France, tel: : + 33/2 43 51 15 00, fax: +33/2 43 51 15 09, E-mail: s.bertucelli@fnpc.org]

Parallel work is continued on increasing fibre content which is important when hemp is used for production of different types of insulation mats and composites. High content of cellulose in industrial hemp biomass (ca 50%) and in different by-products and waste material from hemp processing is a very good raw material for second generation alcohol.

Additionally, role of hemp is growing in soil environment improvement by transferring nutrients from deeper layers of the soil and extraction of heavy metals. Another important feature is collecting CO_2 from air (10 tones of dry mass of hemp is able to extract 2.5 tons of CO_2) [Institute of Natural Fibres & Medicinal Plants].

The similar pattern can be found when seed yields are concerned. The experimental and commercial data show that they can vary from 0.88 to 1.5 t/ ha and from 0.1 to 0.9 t/ha, respectively (on average about 1.2 versus a 0.8 t/ha). This indicates that seed plant potential is explored at the level of about 67%.

The explanation of potential vs. commercial yield discrepancies is not simple and involves numerous factors including genetic, environmental and agronomic ones.

Hemp in terms of cultivated cultivars is represented by very diverse material. It involves dioecious and monoecious cultivars and cultivars belonging to different geographical types which reflect hemp susceptibility to photoperiod which especially has significant consequence for yield. There are three geographical types of hemp distinguished: northern hemp, middle European hemp (intermediate hemp) and southern hemp. The northern hemp is characterized by a short growing period (60-75 days), high yields of seeds and low yields of poor quality fibre (and straw). The southern hemp gives high yields of vegetative biomass, including good quality fibre and low yields of seeds; they also have a long growing period – over 150 days. The group of intermediate hemp is characterized by factors between these values. This way, cultivars with genetic predominance of southern type yield low seed and high straw. The differences are even bigger if such cultivars are grown further north of their origin area. Therefore, generalization on yield potential must be considered in connection with genetic potential of particular cultivar and location of cultivation.

Considering seed yields the above mentioned dependencies apply even stronger. Although offering high yield of straw and fibre, southern hemp produces very little or no seed as it requires much longer vegetation period to reach full maturity.

There is another aspect of seed yield potential in hemp. It fact hemp breeding has always been focused on the fibre. Hence, no truly seed forms, neither cultivars are selected. Therefore, certainly it is possible to improve hemp potential in this field by breeding.

Improvement in exploitation of hemp potential in terms of genetic resources lies in very well adaptation of cultivated crop to particular region of cultivation especially in seed production (cultivar regionalization). Alternatively selection of cultivars that offer the best straw potential in particular region and could include southern cultivars grown in northern countries. However, having in mind problems with seed production in southern hemp, the economical conditions, including seed supply from countries where sowing seed production is possible, should be very carefully investigated.

When investigating genetic factors that have influence on hemp yield, the fibre content is as important as potential yield of straw as it is the fibre that is the product hemp is usually grown for. Therefore, to improve the use of hemp yield potential both maximum yield of straw and maximum content of fibre should be taken into account in breeding process.

Among environmental factors limiting exploitation of hemp yield potential is water and soil, especially when considered jointly. Hemp water requirements are quite high. Although deep and well developed root system allows hemp to use water from soil levels unavailable to many other crops, for instance flax, insufficient water supply especially in connection with poorer soils results in significant yield reduction.

To minimize the effect of unfavourable environmental factors on hemp yield the actions should concentrate on agronomic solutions: optimum sowing time (to use water accumulated after winter), optimization of plant density depending on direction of cultivation (seed, fibre, and biomass), application of water saving tillage treatments, treatments reducing evapotranspiration. Naturally, one should not forget the genetic improvement of the cultivars by developing cultivars with better drought tolerance.
Among agronomic factors, besides those mentioned for minimizing the effect of unfavourable environmental, one more should be mentioned, especially in connection with seed production. Construction of more

efficient machinery is necessary to minimize losses of seed during harvest. However, seed loss in hemp is not only connected with agronomic or environmental factors. Also genetics of hemp takes responsibility for this problem. Hemp seed matures gradually in course of maturity advancement and shed when mature. By the time the seed in upper part of panicle is mature, this in the bottom part is lost. In practice farmer must compromise trying to harvest seeds when seeds are maturing in middle part of the panicle and is never able to harvest 100% of the seed yield.

In practical farm operation all these factors having limiting effect on potential of hemp are usually amplified by economics of production connected with a human factor. Farmer, trying to reduce his costs is usually not able to provide crop management at the level used for experiments.

Finally, with a scarcity of agronomic research on hemp, a grate part of our knowledge about hemp yields is missing or based on the old cultivars, that were grown in Europe twenty and more years ago. It is though advisable to set a pan European network of experiments with a reference list of cultivars that would clearly and univocally answered his problem.

Conclusion:

FLAX

1. Generally, potential production capabilities of fibre flax are significant. Flax cultivated in good conditions can give following yields: straw yield – 7-8 t/ha, total fibre yield – 2.5 t/ha, long fibre yield – 1.6 t/ha, short fibre yield – 0.8 t/ha, seed yield – 1.3 t/ha, total fibre content – 38%, long fibre content – 24.8% .

2. However, average yields of fibre flax varieties from industrial cultivation are at the level of: total fibre yield – 1.7 t/ha, long fibre yield – 1.2 t/ha, seed yield – 0.9 t/ha, total fibre content – 30% and long fibre content – 22% and those results are 30-35% lower than data observed in the trials.

3. The average commercial yields of flax are noticed in practice on the level from 50 – 70 % of potential yielding in the countries of high level of agriculture, in the optimal climatic conditions for flax. It means, that there is still potential and the need to increase the flax yielding in the commercial scale. Several practices and suggestions how to increase commercial yields of fibrous flax are described and discussed.

HEMP

The average commercial (industrial) yields of hemp are noticed in practice on the level from only 14 %, through 27-31%, 43% and 57% of potential yielding. It means that the potential is not explored in practice, but in different countries vary significantly. The reasons and several practices and suggestions how to increase commercial yields are described and discussed.

Experimental Linseed Oil Production in Banja Luka Region

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Abstract

The organic flax production with the variety Olin was carried out at the mountain experimental facility "Sitnica" at 800 m of altitude close to Banja Luka in 2008. The climate in this area is characterized with cool summers suitable for ecological agricultural production. The absence of mineral fertilizer caused the reduction of linseed yield in 2008 (890 kg/ha), what is lower than in the average year. The flax diseases were not observed, so the linseed was processed in linseed oil by cold pressing in the agricultural cooperative "Agrojapra" in Banja Luka region.

Before extracting, the linseed sample had 38 % of oil. The extracted linseed oil (34% of linseed mass) had an excellent taste and color. The heavy metal cadmium was not determined in the oil samples. Linseed oil cake had an excellent chemical composition; 38,9% of proteins, 17,8% of fat and 5,5% of minerals. By cold pressing of linseed, one can significantly increase the economical value of the product.

Key words: organic production, linseed oil, linseed oil cake, cold pressing

Introduction

Kondić and Nožinić (1998) turned the attention to the importance of returning of flax and hemp in the production in Bosnia and Herzegovina emphasizing rich tradition of growing and processing in the past. Research activities on the flax have been intensified in Bosnia and Herzegovina since the organization of the FAO international conference "Bast Fibrous Plants for Healthy Life" that was held in Banja Luka in 2004. The focus has been on linseed varieties, since fiber flax production is more demanding.

Linseed oil has very high content of omega three unsaturated fatty acids. If the consumers were better informed of the linseed oil (and other linseed products) benefits for human health, it could increase linseed production in Balkan region.

Curentlly, integral or organic flax production are possible on smaller plots, specially in the unpolluted mountain regions. Generally, pests and diseases appear rarely in such conditions for higher altitude, permanent air circulation, colder winters and extensive plant production. Besides, weeds spectrum is poorer than in lawlands where flax can not cope with agresive weeds (like Ambrosia artemisifolia).

Because of the mentioned reasons, the Agricultural institute of the Republic of Srpska Banja Luka (abbr. Institute) decided on the experimental work with flax on the mountain region Manjača behind the city Banja Luka, where research can take place on different altitudes (climate zones). In the 2008, the trial (0,2 ha) with organic flax production was placed in the mountain valley Sitnica at 800 m of altitude. The local cooperative Sitnica carried out the experimental linseed production according to the instructions by the Institute.

The Institute, some local cooperatives and farmers, as well as the biggest Company for Edible Oil Production "Bimal" Brčko are interested in developing of domestical flax products, combining the newest research methods, experience from the past as well as previous research results. Linseed oil produced by cold pressing from organic linseed from mountain Manjača was the first step towards serious flax processing in this region.

Material and Methodology

The trial with flax was set up on 0,2 ha at mountain plato Stričići (800 m of altitude) on April, 15th. Variety Olin was sown with 70 kg/ha with the row space of 25 cm. The precrop was rye. The soil had been used like sheep pasture for many years before the grains and flax were grown. Such soils have good fertility because of the sheep manure.

Cultivation included autumn plowing, two times harrowing and seedbed conditioner. Thanks to adequate agrotechnique, specially seedbed conditioner use, the great part of the rhizomal weeds were moved from the soil. The trial was manually weeded (Achilea milefolium, Agropiron repens, Lamium purpureum, Sinapis arvensis). About 15 % of trial was covered with mentioned weeds.

Weather conditions were not registered precisely since this locality does not have metereological station, than estimated using data from the neighboring station Drinić, placed at similar altitude.

Harvesting was done in two phases, the first with manual mowing machine, than with harvester. After harvesting, about 2% of weed seed remain in the linseed. Before cold pressing, the linseed had been cleaned from weed seed through two sieves.

Cold mechanical pressing was done on auger oil strainer, "Kern Kraft", KK 40/F. The nominal capacity of this machine is 40 kg per hour for oil rape seed, while for soft seeds (and linseed) is a half of the nominal capacity (20 kg per hour). The power of the electromotor moving the strainer is 4 KW.

Results and Discussion

Linseed organic production demans good estimation of optimal row space as well as the prediction of weed appearance (spectrum and intensity). Row space of 25 cm was chosen on the basis of local experience and other authors' research results obtained in simillar agroecological conditions (Stanković and Petrović, 1998; Kocjan 1999; Pospišil et al., 2004,). More or less, the weeds in flax appear every year what was a case in the experimental field in 2008 too. By manual weeding the "islands" of Ahilea milefolium and Agropiron repens were cleaned from the crop.

The linseed yield of 890 kg/ha was lower than in the average year because of absence of mineral fertilizers. Achived linseed yields with conventional agrotechnology on 20 localities in Bosnia and Herzegovina in 2004 with the same variety (Olin) were significantlly higher on 17 localities with maximal linseed yield of 1.720 kg/ha (Garić and Mandić, 2004). The average yield for these 20 localities was 1.327 kg/ha. The key problem in the agrotechnique was very difficult flax harvesting what was a problem in the previous years too.

Oil content in the linseed of 38 % was a bit lower compared with two years results (1996/97) from Serbia (Stanković and Petrović, 1998). Longer maturing period of grain is in a positive corelation with oil content (Kastori, 1991). It means that cool mountain summers could have a positive effect to oil accumulation what should be investigated with paralel trials at different altitudes (150 m of altitude to 1.000 m of altitude. The region of Manjača has very various climate conditions with annual precipitation from 1.000 mm to 1.300 l/m2 and average annual temperature from 7 ˚C - 11,5 ˚C. The wormest month is july with the average temperature from 17 ˚C (Sitnica, 800 m alt.) to 21,5 ˚C (Banja Luka, 150 m alt.). Further research including more localities and genotypes in longer period should offer clearer information of the interactions genotype/locality (adaptability) and genotipe/year (stability) for main flax traits.

Unlike some imported linseed oils, the experimental oil produced in 2008 had an excelent taste. Three oil products (imported linseed oil from Macedonia, local pumpkin oil and experimental linseed oil) were degusted by ten persons who compared those oils taste, and found experimental linseed oil like the best one. The reason for different taste might be in the freshness of oils

According to EU regulation, acceptable level of Cadmium is 0,50 mg/kg. Cadmium in two linseed oil samples from experimental production in 2008 was not determined, what was very good quality indicator. Previous results of cadmium content in linseed oil from 20 localities (variety Olin) in Bosnia and Herzegovina in 2004 showed significant variation for this trait (from 0,16 - 1,06 mg/kg). Czech authors reported of the significant differencess among varieties regarding cadmium content as well as increasing of "plant cadmium" with the intensity of fertilizing (Bjelkova et al., 2001).

Linseed oil cake could be very beneficial component for livestock feed in Bosnia and Herzegovina having in mind good quality and taste. Some farmers from municipality Prnjavor had good results with linseed component in dairy cows concentrates (personal comunication with farmers).

Conclusion

Integral and organic flax growing is demanding, but possible if one respects crop rotation, climate and soil adventages and necessary cultivation measures.

High quality linseed, linseed oil and linseed oil cake can be produced in Banja Luka region using local processing capacities.

The problems regarding linseed harvesting should be solved as soon as possible. It will encourage producers

in Bosnia and Herzegovina to decide on the larger plots for flax growing.
In order to get better information of the variability of the main flax characteristics, more cultivars should be tested at different altitudes.

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Modelling Of The Cleaning Process Of Natural Fibres Facilitates Cost Efficient Design Of Highly Productive Cleaning Systems

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Keywords: hemp, fibre processing, fibre cleaning, comb shaker, screening

Abstract

There is an increasing demand for high-grade hemp and flax fibres as a raw material. For processing lines with mass flow levels higher than 2.5 t/h hemp straw the capacity of the cleaning lines has to be increased. Comb shakers proved to have the highest potential to fulfil the requirements of modern short fibre cleaning.

Based on comprehensive experimental investigations a new 3-D screening model has been developed to predict the throughput and cleaning results for hemp processing with comb shakers. The layers of hemp fibres are considered as horizontal and vertical screen surfaces with gamma-distributed apertures sizes.

Based on the developed geometric-statistical model for the screening process general design and process parameters for comb shakers can be investigated.

Introduction

A lot of investigations of the last few years have shown that fibre cleaning represents an essential stage in the whole fibre separation process. In existing fibre plants 4 up to 7-staged cleaning lines are currently used for the production of high-quality fibres. In praxis these long cleaning lines are related to high investment cost, low mass flows and a high susceptibility to trouble.

A pilot plant for processing of hemp straw to high quality fibres at throughput rates up to 2.5 t/h has been developed at the ATB for detailed investigation of the whole process chain. The processing line is equipped with a new developed decortication machine (hammer mill) using impact stress to breake the connection between fibres and hurds (Munder, 2003). Test runs with unretted hemp and flax have shown that this machine can simplify the cleaning process considerably. But due to the different properties of the fibre-hurd mixture produced with the new technology, an adaptation of the cleaning process is necessary.

Test with different cleaning technologies have shown, that the working principle of comb shakers is suitable for a modern processing line. Comb shakers are special screening machines that consist of a fixed screen with oscillating combs mounted above them as a screening and transport aid.

Material and methods

An experimental comb shaker was developed and tested for detailed study of the machine design, the essential machine parameters influencing the throughput rate as well as the cleaning and separation process of fibres and hurds.

A new model was developed to predict the throughput and cleaning results of fibres and hurds with the comb shaker. Figure 1 shows the design of a comb shaker and the definition of general model parameters.

The separation process of fibre and hurds is highly dependent on the mass flow over the screen. A higher mass flow is connected to a shorter retention time of particles on the screen at higher transportation forces driving the fibre fluffs to the outlet of the cleaning channel. Therefore, it was necessary to develop a two step model consisting of a mass flow model and a screening model.

The mass flow model is based on the kinematics and kinetics of inclined throws of particles and their trajectory parabola considering air friction (Fig. 2). The description of the trajectory for projectile motion is given by the equations (1) and (2).

$$x = \frac{g \sin \phi_b}{2} t^2 + v_{x0} t + x_o \quad (1)$$

$$y = \frac{g \cos \phi_b}{2} t^2 + v_{yo} t + y_o \quad (2)$$

In dependence to the shaker frequency the calculation of the throwing ranges xw have to consider whether a collision between fibre fluff and next comb will take place or not. Under consideration of shaker frequency (f), material height on the screen (hm), material density and a factor c1 for density change the specific mass flow for a comb shaker with working width bs can be calculated (equation 3).

$$\dot{m}_g = x_w \cdot f \cdot c_1 \cdot h_m \cdot b_s \cdot \rho_m \qquad (3)$$

The Screening model describes the separation of hurds from fibres. Usual models describe screening as two simultaneous processes: stratification and passage of particles through the apertures in the screen surface (Wessel 1967; Soldinger 1999; Soldinger 2002). Based on detailed information about particle size and screen geometry the probability of passing the apertures can be calculated (Schubert 1999).

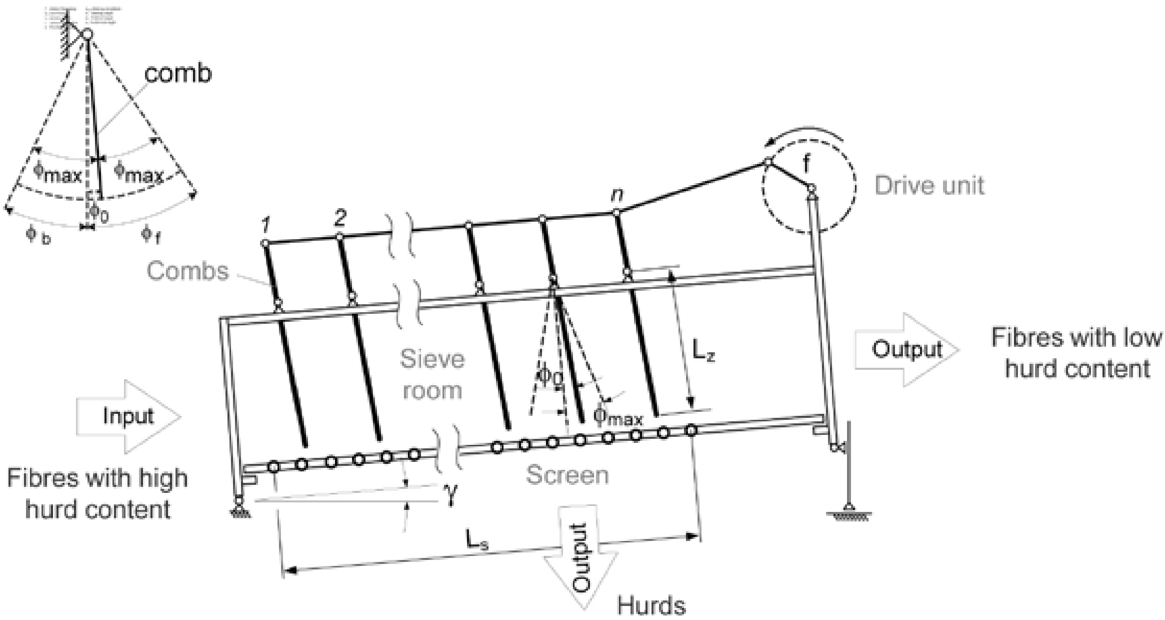

Fig. 1: General design of a comb shaker for hemp fibre cleaning and process parameters

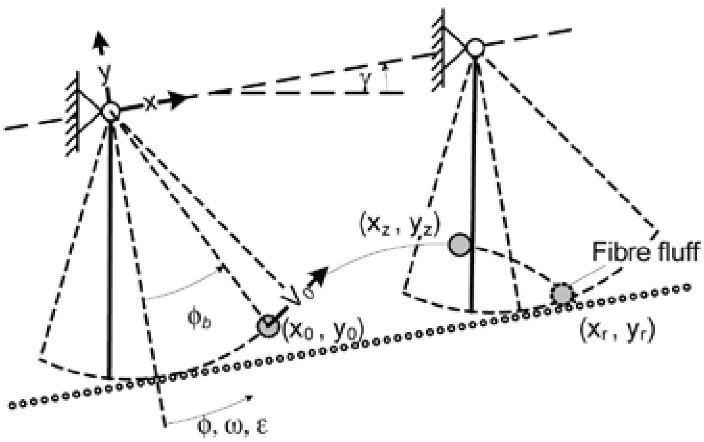

Fig. 2: Material transport by inclined throw

When the projectile-motion of the particles in relation to the screen motion is known, predictions regarding particle separation can be made. The investigation of the screening process of fibre-hurd mixtures with hurd contents of more than 50 wt% has shown that the separation of these materials is more complex. Fibres are characterised by a very high length-thickness relation. They have a wolfed shape with fibrillated ends and are agglomerated in fibre fluffs. Hurds of a broad size range are incorporated in these fluffs. Because of a low length-thickness relation of hurds in comparison to fibres, the hurds can be considered as spherical particles. This simplification proved to be precise enough for modelling.

Figure 3 shows a multi layer model of a fibre fluff with incorporated hurds of different diameters. Fibres are considered as a kind of a three-dimensional screening system. According to the investigations of Dodson 1997 a gamma-distribution has been assumed for the size of the screen apertures:

$$p = F(x \mid a,b) = \frac{1}{b^a \Gamma(a)} \int_0^x t^{a-1} e^{-\frac{t}{b}} dt \qquad (4)$$

The expectation value of equation (4) delivers the average pore size wi for further calculations of probabilities of passing the apertures of the assumed 3-D screening system (Fig. 4). The probability W of an unrestricted passage of an aperture is dependent on the effective screen aperture Aeff defined by equation (5) (Schubert 1990; Dehghani et al. 2002):

$$W_{wij} = A_{eff\, w_i} = \frac{A_{eff}}{A_o} = \frac{(w_i - d_j)^2}{(w_i + s)^2} = \left(\frac{w_i}{w_i + s}\right)^2 \cdot \left(1 - \frac{d_j}{w_i}\right)^2 \qquad (5)$$

Based on an experimentally determined distribution of hurd sizes, the probabilities of hurd passages through such a 3D-screen can be calculated with the newly developed geometric-statistical model.

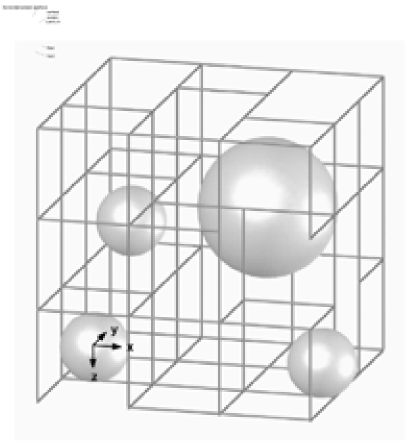

Fig. 3: Model of a fibre fluff with incorporated hurds

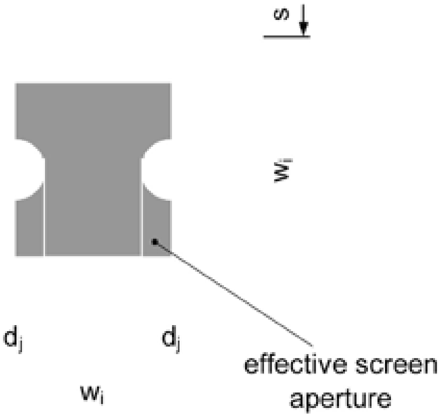

Fig. 4: Effective screen aperture for hurds with diameter d_j

RESULTS AND DISCUSSION

Figure 5 shows the comparison of the calculated specific mass flows with experimental results for different shaking angles in dependence to the shaker frequency. At low shaking angles (0 = 1°) and higher frequencies (f > 2.8 Hz) the variations are bigger. Taking into account the material inherent variation of hemp fibre quality as a natural raw material the model variations are acceptable.

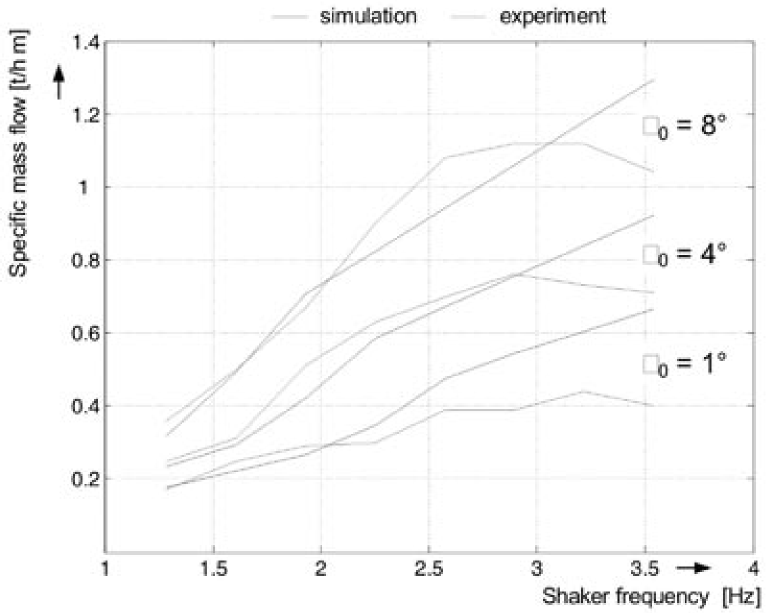

Fig. 5: Specific mass flow in a comb shaker in dependence to shaking angle and shaker frequency (screen inclination 10°)

The calculated hurd separation by the developed model shows good matches with the experimental data (Fig. 6). The variation between simulation and experimental data is smaller than 15 % in average over the screen length. Although higher shaker frequencies do lead to higher mass flows respectively lower retention times on the screen, cleaning is best at this process point. At a shaker frequency of 3.5 Hz the

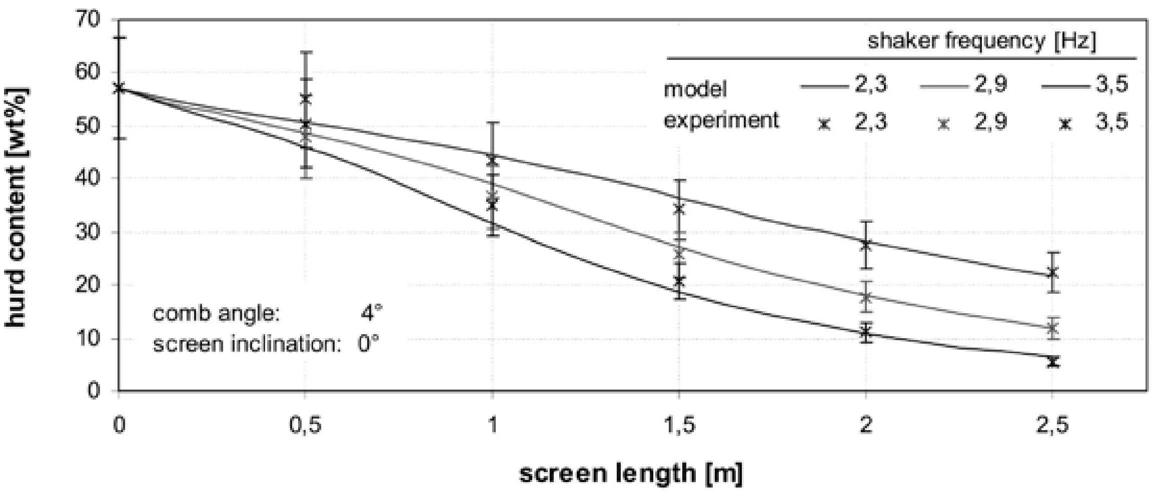

Fig. 6: Experimental and model results for hurd separation in a comb shaker in dependence to screen length and shaker frequency hurd content in the fibre fluffs is reduced to approximately 7 wt% and fulfils the common quality requirements for the first cleaning step in hemp fibre processing.

On the basis of this work, a highly productive comb shaker for hemp fibre cleaning has been designed for throughputs of the cleaning line of up to 1.6 t/h (resp. 2.5 t/h hemp straw input) and hurd contents after one cleaning stage lower than 5 wt%.

Conclusions

The developed model consisting of a mass flow model and a screening model shows good matches with the experimental data. General design parameters such as optimum shaker frequency, screen inclination as well as the necessary screen length for a required cleaning result can be easily identified.

In praxis, the developed simulation model can be very helpful for raw material specific and cost efficient design of a comb shaker. By means of simulation calculations the number of test runs can be reduced to a minimum. Furthermore, comb shakers proved to be very efficient as first cleaning stage in industrial hemp fibre processing. The hurd content can be reduced in only one stage to values lower than 5 wt%. Only one additional cleaning stage is necessary to fulfil the quality requirements of further processing to composites.

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BAST FIBROUS PLANTS RAW MATERIALS CHARACTERISTIC AND THEIR APPLICATIONS

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Abstract

The paper presents the results of the project of the European Commission: 4 F CROPS, which deals with crops for food, feed, fiber and fuel. The project is coordinated by Dr. Eftinia Alexopoulouů (CRES), Greece. At the Institute of Natural Fibres and Medicinal Plants work on the project is coordinated by Prof. Dr. Ryszard M. Kozlowski and M. Mackiewicz-Talarczyk.

The main aim of the 4F CROPS project is to survey and analyze all the parameters that will play an important role in successful non-food cropping systems in the agriculture of EU27 alongside the existing food crop systems.

The main aim of the work within task 2.4 Raw materials characteristics was to evaluate the physical, chemical, mechanical properties and quality parameters of bast fibrous plants (flax, industrial hemp) as a raw material for the specific semi-finished or final products.

It provides the base for categorization of those crops per end-use, for each end use of bast fibrous plants the favourable characteristics have been listed. It allows for prioritizing crops according to the degree of fulfilling.

Presented results have been sourced mainly from the results of many years research of the Institute of Natural Fibres as well are based on our previous involvement in the European Commission project IENICA.
The reason for this work is that the natural raw material characteristics vary widely in terms of physical and chemical composition, size, shape, moisture content, bulk density, fibres length, etc. These variations can make it difficult (or costly) to supply the relevant industries with material of consistent quality year round. The proper and complete characteristic of the raw materials such as straw, fibre, yarn for specific semi-finished and finished products should provide the background enabling the supply of the relevant industries with material of consistent and appropriate quality year round.

Introduction

The report describes the raw materials characteristic for fibrous plants such as flax and industrial hemp.

The quality of fibre for industrial purposes depends on several factors, which are directly connected with the quality of fibrous straw. The features of the straw, which determine the classification to a certain quality grade and are influencing the quality and the yield of the derivative fibre, are: length, thickness, colour, healthiness and posture. These features are the base for the quality graduation of the flax straw described in Polish standard

PN–P–80103:1006 "Fibrous Flax Straw". The other countries, where the requirements regarding flax straw quality are enclosed in the relevant standards are: Russia, Belarus, Ukraine, and The Czech Republic.

The properties and qualities of vegetable fibres, including flax and hemp are mostly genetically determined. Hence the strongest influence of the farmer on the fibre quality can be only by selection of cultivars offering best yield parameters. Nevertheless, there are also environmental and agro-technological factors that may improve or worsen the potential offered by that cultivar. They are: selection of the preceding crop and soil, sowing date, fertilisation, post–emergence treatment, time of harvest, etc. The most important effect of the farmer on the quality of the straw (and fibre) begins when straw is swathed for dew retting. It is the responsibility of the farmer to monitor and chose the right moment (green-yellow maturity of straw <in case of flax>)

to pull the straw and start the process of retting and turn the straw as well as to stop the retting (by drying and taking it out from the field) in proper time.

The most important elements of the flax and hemp agronomy practices are presented below.
It is very important to apply zink sulphate in the blend of chemical fertilizers, which guarantee the straight straw.

(Source: Elaborated by the Institute of Natural Fibres, Poznan, Poland for IENICA project, 2002)

I. THE GOOD AGRONOMY PRACTICES FOR FLAX AND HEMP

Flax for fibre production *Linum usitatissimum* L.	***Hemp for fibre and seed production*** *Cannabis sativa* L.
Crop rotation: any crop leaving the soil in good culture; minimum 6–year break before growing on the same spot.	**Crop rotation:** no particular requirements, even monoculture possible.
Seed size: length 3,0–4,9 mm, width 1,8-2,6 mm, thickness 0,5-1,0 mm. **Thousand seed weight: 4,1–5,5 g**	**Seed size**: length 2,0–5,0 mm, width 2,0–4,0 mm, thickness 2,3–2,8mm. Thousand seed weight: 10–26 g
Seeding rates: 110–130 kg ha^{-1} (2000-2400 seeds m^{-2}) **Sowing dates**: soil temperature: 7–9 °C (plants: *Caltha palustris* and *Anemone nemorosa* are in flowers)	**Seeding rates**: -for seed production 10–15 kg/ha -for fibre production 70 kg/ha **Sowing dates**: soil temperature: 8–10 °C
Fertiliser status: N: 0–20 kg/ha P_2O_5: 60 kg/ha K_2O: 80–90 kg/ha $ZnSO_4$:10-15 kg/ha	**Fertiliser status**: N: 90–120 kg/ha P_2O_5: 70–100 kg/ha K_2O: 150–180 kg/ha
Herbicides status: pre- emergence herbicides: *lenacil* , *linuron* post-emergence herbicides: for broadleaved weed control: *MCPA, bentazone, chlorsulfuron, thifensulfuron methyl +chlorsylfuron, chlopyralid + MCPA* for graminaceous weed control: *dichlofop-methyl, fluazyfop-P-butyl, setoxidim, haloksyfop-R, chizalofop-P-ethyl,*	**Herbicides status:** Highly susceptible to most herbicides; if necessary, some *linuron*-based herbicides can be used carefully prior emergence of hemp. Generally no herbicides required (high competitiveness to weeds) graminaceous weed control:
Insecticides status: - for control of *Longitarsus parvulus* Payk. and *Aphtona euphorbiae* Schr. Seed dressing: *carbofuran*, Post-emergence insecticides: *lambda- cyhalotryna* for *Trips lini* Lad. Control: Post-emergence insecticides: *lambda- cyhalotryna*	**Insecticides status:** No particular pest problems in North and East Europe and Poland, depending on needs.
Plant growth regulators status: maturity regulators: *dimetipin*	**Plant growth regulators status:** not used
Fungicides status: -for Fusarium wilt control: for seed dressing: *thiram, carboxin, guazatine, metalaxyl, thiabendazol, vinclozolin* for flax spraying: *flutriafol, thiram, carbendazin, kaptafol, azoxystrobin* - for *Colletotrichum lini* control: for seed dressing: *carboxin, thiram* - for *Rhizoctonia solani* Kühn control: for seed dressing: *carboxin, thiuram, mancozeb, talchlofos-methyl*	**Fungicides status:** not used
Harvest dates **Pulling**: beginning of the green- yellow maturity Collecting of dew-retted straw after reaching proper stage of retting.	**Harvest dates**: Seeds: full seed maturity in the middle part of the panicle – end of September High quality fibre: mowing in beginning of flowering stage. or left for dew retting. Collecting of dew–retted straw after reaching proper stage of retting. Decorticated straw: depending on needs. The later harvest the higher yield and the coarser fibre.

Source: Elaborated by the Institute of Natural Fibres, Poznan, Poland for IENICA project, 2002

II. THE EXPECTATIONS OF INDUSTRY REGARDING FLAX AND HEMP FIBRE QUALITY

Industry processing the fibres demands homogeneous and good quality raw material. The expectations regarding flax and hemp fibre quality features depend on the final destination of fibre:

STRAW SPECIFICATIONS (acc. Polish standard: PN–P–80096:1999)

Flax:

The straw must be evened in the root part and arranged parallel in bundles of at least 2 kg (retted) or 2.5–4.0 kg (raw). Bundles should be bond with natural fibre string or flax straw. Retted straw can also be baled; raw straw – not. The thickness of the straw stems should be around 0,8mm.

The most important from the farmer point of view is the colour of the straw as it has direct effect on the quality of fibre. The light – grey, steel-grey and silver – grey colours of straw are demanded (at least for 70% of stems). For raw straw the colour must be yellow (at least 65% of stems).

Feature of straw	Retted straw	Raw straw
Technical length [cm]	at least 43 cm, but for the first class straw it has to be at least 60 cm.	at least 43 cm, but for the first class straw it has to be at least 60 cm.
Posture [%]	Straight stems at least 70%	Straight stems at least 70%
Degree of retting [%]	well–retted stems content should be at least 60% but not less than 90% for the first class straw.	not relevant
Health condition	Over 80% of stems has to be healthy	Over 80% of stems has to be healthy
Moisture content	not more that 18%	not more that 20%
Impurities content	not more 15%, of which weeds are not more than 10%	not more 20%, of which weeds are not more than 15%

Source: Polish standard: PN–P–80103:1996

Hemp:

For hemp dew-retted straw steel-grey, silver-grey and light-grey, colours of straw are preferred, however also brown-grey, dark-grey and green-grey colours are acceptable for lower classes (at least for 70% of stems). For raw straw the colour must be light yellow, dark yellow and green–yellow, however also light green, light brown, light grey (at least 65% of stems) and dark green and dark–grey straw is also acceptable for lower classes.

Feature of straw	Retted straw	Raw straw
Total length [cm]	at least 80 cm, but for the higher classes straw it has to be 110-130 cm.	at least 80 cm, but for the higher classes straw it has to be 110-130 cm.
Degree of retting [%]	well retted stems content should be 90% for the first class straw for clothing textiles and 80% for second class. Under-retted stems content should not be higher than 70% for cordage.	not relevant
Health condition	Over 90% 80% and 70% of stems has to be healthy for 1st, 2nd and 3rd second class straw.	Over 90% 80% and 70% of stems has to be healthy for 1st, 2nd and 3rd second class straw.
Stem thickness [mm]	4–6, 4–8 and 3–12 for 1st, 2nd and 3rd second class straw (clothing) 3–6, 3–8, 3–12 for cordage	4–6, 4–8 and 3–12
Moisture content	not more that 20%	not more that 20%
Impurities content	not more than 15%	not more than 15%

Source: Elaborated by the Institute of Natural Fibres, Poznan, Poland for IENICA project, 2002

Main directions of utilization of raw materials obtained from flax and hemp.

1. Flax and hemp long fibres:
   a) hackled fibres for yarns for wet and dry spinning
2. Flax and hemp short fibres:
   a) for carded yarns,
   b) for "wool-like" yarns,
   c) for "cotton-like' yarns,
   d) for twines,
   e) flax and hemp green fibre (decorticated)
   f) for non-woven.
3. Flax shives and hemp hurds (shives)/ by products

Hackled long flax fibre for yarns for wet and dry spinning

Long flax scutched fibre is usually being mechanically hackled. The hackling process leads to separation of two products: the long fibre and short fibre – the hackling noils.

Long flax hackled fibre can be used for traditional flax wet or dry spinning system. Wet spinning system, including boiling process in roving is used for finer yarns.

In dry spinning system hackled yarns of higher linear density can be obtained.

Table 1. Basic parameters of long flax scutched and hackled fibre.

Raw material	Fibre length [mm]	Fibre linear mass [tex]
Long flax scutched fibre	300-1400	4.0-6.0
Long flax hackled fibre	350-700	1.4-3.3

* source: INF research

Table 2. Basic parameters of yarns obtained from long flax hackled fibre

Parameter	Unit	Value
Wet-spun hackled yarn (Nm18)	tex	60
Specific **tenacity**	cN/tex	18
Number variability coefficient	%	3
Tenacity variability coefficient	%	12

(the examples of the yarns which are most often produced)
* source: INF research

Hackled long hemp fibre used for yarns

Long hemp scutched fibre. Prior mechanical hackling the top and especially bottom ends of hemp fibre must be cut off and its length must be shortened to fit the hackling machine.

The process yields hackled fibre and to types of by-products: noils and short fibre called „ends" (cut-off ends of scutched fibre).

Long hemp scutched fibre can be used usually for dry spinning to produce dry-spun yarns with relatively high linear density. Hackled hemp fibre of high quality are wet-spun (sometimes including a roving boiling process).

Table 3. Basic parameters of scutched and hackled hemp fibre.

Raw material	Fibre length [mm]	Fibre linear mass [tex]
Long hemp scutched fibre	800-2500	8.0-12.0
Long hemp hackled fibre	350-800	3.0-5.0

* source: INF research

Table 4. Basic parameters of yarns obtained from long hemp hackled fibre (the examples of the yarns which are most often produced)

Parameter	Unit	Value
Ns 8 Yarn	tex	200
Specific **Tenacity**	cN/tex	12
Number variability coefficient	%	4
Tenacity variability coefficient	%	12

* source: INF research

Flax short fibre for spinning carded yarns

Flax short fibre: scutching and tangled noils and tow are processed by wet carding system (also including application of roving boiling and bleaching) and by dry carding system. Linear density of carded yarn varies upon the quality of fibre and used spinning system.

Table 5. Basic parameters of flax tow.

Raw material	Fibre length [mm]	Fibre linear mass [tex]
Scutching tow	80-140	3.5-5.5
Tangled tow	140-250	4.5-6.5

* source: INF research

Short hemp fibre for carded yarns.

Fibre should: show no sign of damage, be uniformed, sorted out for the class, baled and cleaned. The moisture content should not be higher than 15%.

Table 6. Basic parameters of hemp tow.

Raw material	Fibre length [mm]	Fibre linear mass [tex]
Scutching tow	250-400	8.0-10.0
Tangled tow	200-400	9.0-12.0

* source: INF research

Flax homomorphic "wool-like" fibre for blended yarn manufacture.

Main raw material for flax "wool-like" fibre is a homomorphic dew-retted flax fibre obtained from processing of straw dew-retted in the field, that was pulled out early.

A substitute of the above can be short hackling noils obtained from mechanical scutching of long dew-retted fibre.

Flax "wool-like" fibre should show the following basic quality parameters:

- average length of fibres about 60-90 mm,
- max. divisibility 2.3 tex
- max. impurities content 0.4 %
- max. length of fibres 130 mm at content of longer fibres max. 5%,
- average thickness of fibres 40-50 µm.

Table 7. Characteristic of "wool-like" flax fibre.

Raw material	Parameters		Blend	Yarn [tex]
	Linear mass [tex]	Length [mm]		
Mechanically cottonised "wool-like" fibre for blended yarn with wool	0.61-0.98	90	L30/W40/An30	64x2
			L30/W30/Arg30	40x2
	1.5-2.5	94	L30/W40/30PAN	42x2
			L30/Wis30/PAN40	
			L15/85PAN	32x2

* source: INF research

Hemp "wool-like" fibre for the production of blended yarns

Hemp "wool-like" fibre should show the following basic quality parameters:

- average length of fibres 100-250 mm,
- average linear density 6.0-8.0 tex.

Table 8. Characteristic of hemp "wool-like" fibre .

Raw material	Hemp grown for fibre		Hemp grown for fibre and seed	
	Linear mass of fibres [tex]	Length [mm]	Linear mass of fibres [tex]	Length [mm]
Mechanically cottonised hemp "wool-like" fibre	2.12-2.78	58.8-69.4	3.47-4.46	53.6-62.5

* source: INF research

Flax "cotton-like" fibre for blended yarn.

Flax noils of quality class 170-120 tex (Ns10-14) obtained from mechanical hackling of scutched fibre are the best raw material for production of flax "cotton-like" fibre. Also so called homomorphic fibre obtained from dew-retted flax straw and scutching waste fibre meeting certain technological parameters can be used for production of flax "cotton-like" fibre as well. All kinds of fibre for this purpose should be mechanically or mechanically-chemically treated to meet the requirements relevant for the technological conditions of blended yarns manufacture.

Uniformity and quality of fibre (regarding length, thickness of fibre and impurities content) are crucial for production of flax "cottonised fibre".

Table 9. Laboratory tests of "cotton-like" flax fibre.

Length class interval fibre share [mm]					Color	Impurities [%]	Fibre Tenacity [daN]
0-20	21-40	41-60	> 60	Mean			
21.1	69.2	9.7	-	30.7	Steel-gray	0.2	9.0

* source: INF research

Table 10. Parameters of "wool-like" cottonised flax fibre for the production of blended yarns.

Raw material	Linear mass [tex]	Length [mm]
Mechanically cottonised "cotton-like" fibre	0.7-2.0	18-35
	1.2-2.0	18-35
	1.11-1.98	13.4-31.8

* source: INF research

Flax cottonised "cotton-like" fibre can be spun in blend together with 30-70 % of flax or viscose or polyester yarns at linear density 30, 40, 50, 60 and 80 tex.

Table 11. Quality parameters of cotton-flax yarns with 54% of linen cottonised fibre

Nominal linear mass of yarn [tex]	Laboratory parameters				
	Real linear mass of yarn [tex]	Coefficient of variation of Linear mass [%]	Tenacity [CN/tex]	Coefficient of tenacity variability. [%]	Twist factor
40	41.8-42.6	3.1-5.2	8.5-9.2	10.0-15.1	171-186
50	50.5-52.6	3.3-5.2	7.4-8.8	12.3-15.6	149-164
60	59.8-61.3	2.9-4.5	7.5-9.5	9.8-17.2	159-184
80	81.4	2.8	9.6	12.4	176
100	102.0	5.3	10.1	10.9	143

* source: INF research

Hemp fibre "cotton-like" for the production of blended yarns (on cotton system spinning)

Hemp fibre of diversified kinds, such as hemp noils, hemp tow or homomorphic hemp fibre could be a raw material for the production of cottonised hemp fibre.

The most appropriate raw material for the production of cottonised hemp fibre is hemp from the cultivation for fibre. Hemp grown for seed or for both purposes (fibre and seed), is not suitable for production of cottonised fibre. Hemp grown specifically for the fibre is sowing at much higher densities and harvested much earlier (in flowering phase), resulting in much finer fibre than that obtained from hemp grown for seed or for fibre and seed.

It prevents obtaining excessive amounts of thick straw and lignin. Lignin in hemp fibre decreases the spinning abilities, fibre with high amount of lignin is usually less divisible, more rigid and coarse. Hemp for fibre and seed is usually cultivated for economic reasons. The long scutched hemp fibre is hackled. The hackling process provides long hackled fibre as well as short by-product fibres (noils).

The long hackled fibre is processed into hackled yarn by dry-spun system while hemp noils blended with short flax fibre are the raw material for the carded yarn.

The hemp cottonised fibre is obtained on the following machines:
- tearing – cleaning machine
- cottonising– cleaning machine arranged in a production line.

Table 12. Parameters of hemp "cotton-like" fibre.

Raw material	Cultivation for fibre, early harvest		Cultivation for fibre and seed	
	Linear mass [tex]	Length [mm]	Linear mass [tex]	Length [mm]
mechanical cottonised „cotton-like"fibre	1.76-2.15	28.42	3.1-3.25	34
chemical cottonised „cotton-like" fibre	1.5-1.76	32-43	2.66-3.74	37.4

* source: INF research

The procedures to obtain more delicate hemp fibre:
- it is advisable to cultivate dioecious hemp versus monoecious
- dioecious hemp cultivation combined with earlier harvesting

Table 13. Sampling of hemp straw from the plantation in different growth phases
(aim-to evaluate the % fibre content).

	Monoecious hemp										Dioecious hemp								
o	Harvest	Straw length [mm]		Thickness [mm]	Fibre content [%]			Nm –metric number of fibre [tex]			Harvest	Straw length [mm]		Thickness [mm]	Fibre content [%]			Nm –metric number of fibre [tex]	
	Growth phase	techn.	total		long	short	total	long	short		Growth phase	techn.	total		long	short	total	long	short
1	12.VI Phase of quick growth	68.0	85.0	3.2	6.1	7.7	13.8	170	1000		12.VI Phase of quick growth	44.0	59.0	2.8	2.7	1.6	4.3	140	1000
2	4.VII Flower buds forming (Inflorescence emergence)	140.0	160.0	5.1	13.2	8.1	21.3	200	2000		4.VII Phase of quick growth	130.0	150.0	6.5	9.3	3.8	13.1	170	1000
3	5.VIII Flowering	200.0	240.0	6.7	14.6	8.0	22.6	200	2000		5.VIII Flower buds forming (Inflorescence emergence)	220.0	260.0	7.2	9.6	7.4	17.0	170	2000
4	4.IX Early maturity of seed	210.0	250.0	7.5	19.7	12.1	31.8	200	3000		4.IX Flowering	250.0	290.0	8.8	9.7	8.1	17.8	200	2000
5	1.X Full maturity of seed	210.0	250.0	7.5	22.2	13.6	35.8	280	3000		1.X Coacere ripeness	250.0	290.0	9.2	10.8	5.0	15.8	200	2000

Source: The INF trials

Such method of hemp fibre production is seldom applied, due to lower yields of obtained fibre. In the common practice the monoecious varieties are sown and harvested later aiming at gaining high biomass production.

Green fibre (decorticated)

The raw material for the production of decorticated fibre is the straw, obtained from the following plantations:

- for seed and fibre production,
- linseed (oilseed), where the straw contains low quality fibre,

Plantations of fibre flax – where fibre is not appropriate for the spinning processing:

- plantations with high level of flax infestation by weeds,
- plantations for seed production,
- high level of flax lodging,
- plants strongly infected by diseases,
- plantations with short and under-retted straw.

Quality parameters of fibre, especially its length over 15 mm, as well as the chemical content predisposes such fibre as a good raw material to production of long-fibre cellulosic mass, applied for the production of high quality papers as well as the filler in composite materials.

Table 14. Parameters of decorticated fibre

Parameters of fibre	After decortication	After cleaning
Average impurities in fibre	20-25%	4-5%
Average length of decorticated fibre	58.9 mm	48.5 mm
Average **tenacity** of fibre	33.4 cN/tex	22.5 cN/tex

* source: INF research

The green hemp fibre - obtained from not-retted straw, decorticated for twines applied in agriculture.

The fibre production is based on the decortication of monoecious hemp derived from plantation cultivated for fibre .

Stems that are 4.5 – 6 mm in diameter, without tops and with moisture content between 15-18% are used for twines. The optimal results for twine production were obtained when moisture content hemp stems was 17%.

Table 15. The parameters of fibres applied for twines and nonwovens

Parameters	Value
Flax fibre-tow	
Length	100-400 mm
Impurities	5-40%
Divisibility	5-20 tex
Tenacity	5-9 cN/tex
Decorticated hemp fibre	
Length	100-500 mm
Impurities	4-25%
Divisibility	10-30 tex
Tenacity	10-35 cN/tex

* source: INF research

Short flax fibre is mixed with short hemp fibre for the production of twines and nonwoven in the proportion:

- short flax fibre 60-80 %
- short hemp fibre 20-40%

Flax and hemp fibre, applied for nonwovens production:

Fibres applied for the production of nonwovens are obtained mainly during decortication process of green hemp straw, sometimes of the linseed straw.

Such fibres are strong,durable and resilient. This is necessary to get appropriate resistance of nonwovens to elongation, while the resiliency enables the recovery to the original size.

The flax and hemp tow of the worse quality is suitable and applied for the production of the disinfection mats on the base of natural fibres. (Tab. 15).

The application of flax fibres in production of non–woven is connected with the adaptation to non–linen spinning systems, namely with the need of the following operations: cleaning, dividing, and shortening of fibres. The application of the appropriate blends of fibres enables their processing into non–woven with the application of traditional non–woven lines.

The production of non-woven exclusively of short flax fibres requires the application of special carding machine. It is possible to utilise green decorticated, even not clean fibre or the short fibre wastes for the production of geo–textiles e.g. grass carpets and non–woven applied in the building and furniture industries, for insulation purposes.

Flax and hemp fibres for the production of composites

The detailed requirements regarding the features of fibres for the composite production are: high cleanness and homogeneity. In some cases the fibre has to be modified and treated: by plasma/corona physical treatment or by using chemical treatment (e.g. for changing high hydrophylic to hydrophobic properties by coupling the maleic anhydrite)

The quality requirements focus mainly on very low impurity content that should be below 0,2 %. The fibres from 1 mm up to more than 10 cm of length can be used. In some cases the special forming of fibres is required, which is conducted by the pulltrusion method. However, this field of fibres application is still in the stage of research in several R&D centres and object of know-how and patents protecting the method. The Institute of Natural Fibres has got relevant know–how in this area as well.

In some cases the chemical modification should be involved, but this it is also the subject of know-how and licences. (Source: Report elaborated by the Institute of Natural Fibres, Poznan, Poland for IENICA project, 2002)

Flax and hemp fibres for the production of pulp and paper

The requirements for flax and hemp fibre in pulp and paper industry are limited to the length – maximum 50 mm and purity – maximum 5%.(Source: Report elaborated by the Institute of Natural Fibres, Poznan, Poland for IENICA project, 2002)

The directions of utilization of flax and hemp shives.

The waste material (shives) coming from the extraction of flax and hemp fibre could be applied as: bedding material for animals. The shives obtained from the processing are contaminated by dust and silica.

- The utilization as a bedding material requires removal of short fibre and dust, because fibre impurities cause conglomerates of shives,
- For mushrooms cultivation after grinding
- The building materials (according to applied technology the shives should be submitted to grinding.

Table 16. The parameters of hemp shives for the "building boards"

Parameters	Value
Humidity [%]	10-13
Weight density [kg/m^3]	90-100
Water retention [%]	360
Volume of particles [mm]	5-35
Fibre content [%]	< 0.1

Source: Lhoist, Belgium

For particle boards production generally urea formaldehyde, resin, isocianate as well as lime and Portland cement are used (Lhoist).

- for solid fuel

The utilization of flax and hemp shives for solid fuel e.g. in the briquettes production requires cleaning process to remove short fibres and silica. The silica causes quicker wearing-off the working parts of the briquetting machine adapted to briquetting of flax and hemp shives, while the short fibres decrease the stability of the briquettes especially during transportation.

Table 17. The energetic value of the shives

Raw material	Value
Flax shives	18.3 MJ/kg
Hemp shives	18.8 MJ/kg

* source: INF research

- fillers in composite materials,

The requirements: grinding of shives. The lignocellulosic raw materials are submitted to the breaking process according to the kind of final application in composite materials (fractions from 0.2 to 2 mm). Generally the requested humidity of shives is below 10% to maintain the proper technology conditions and to avoid biodeterioration.

Conclusion

1. The good agronomy practices for flax and hemp, which enable good harvested quality crop and derived products are presented:

A. In case of flax: the following appropriate parameters and practices are listed, described and advised: crop rotation, seed size, thousand seed weight, seeding rates, sowing dates, soil temperature, the status of: fertilisers, herbicides, insecticides, plant growth regulators, fungicides is given as well as: seed dressing, harvest dates, pulling dates, conditions of collecting of dew-retted straw.

B. In case of hemp: the similar appropriate parameters and practices are listed, described and advised. The difference is noticed in case of plant protection, because in case of hemp no particular pest problems in North and East Europe and Poland appear and fungicides are not needed. In case of hemp THC limit is very important according to EC Rules (below 0.2% THC is requested).

2. The expectations of industry regarding flax and hemp fibre quality are given.

3. The detailed information regarding the raw material of flax and hemp characterisation, parameters and performance, which are needed to obtain the appropriate semi-products and final products with the optimal quality are given. The specifications and requirements are elaborated and listed for the following raw materials: flax and hemp long fibres, hackled fibres for yarns for wet and dry spinning, flax and hemp short fibres: for carded yarns, for "wool-like" yarns, for "cotton-like' yarns, for twines; flax and hemp green fibre (decorticated) for non-woven, flax and hemp fibres for: the production of composites, and pulp and paper. Flax shives and hemp hurds (shives)/ by products e.g. for "building boards", and solid fuel, as bedding material, for edible mushrooms cultivation..

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MODIFIED FLAX FIBRES BLENDED WITH COTTONINE IN OPEND-END YARNS

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Abstract:

The technology of producing OE flax-cotton blended yarns with a 50-100% content of flax fibres has been described. Flax fibres (noils) were modified in a process of enzymatic cottonization. Much shorter , thinner and less stiff fibres were obtained. The fibre linear mass was decreased from 1.70 tex in the initial raw material to 0.78 tex in the cottonized fibres ,i.e. by 54% .The length decreased to 28mm i.e. by 66%. The yarn production experiments were done using a BD 200 RN OE machine. All the slivers input from the drawing machine had a mean linear mass of 4.5 ktex. The spin ability tests done for cotton-flax blends containing more than 50% of cottonized flax fibres modified with enzymes showed that a 70% share of flax fibres in the blend is the limit, with a 80 tex yarn produced. Flax-cotton yarns with a 50% and higher content of modified flax fibres have a soft touch and can be processed both in weaving and knitting.

Keywords: cotton fibres, modified flax fibres, enzymatic cottonization, flax-cotton blended, blended yarns, OE spinning.

Introduction

Woven and knitted fabrics made from natural fibres gain an increasing interest on today's market. Together with the highest supply and demand for cotton products, flax is also popular due to its specific features[1].

A research project on flax yarn was undertaken in Poland and it aimed at rational utilization of each type of flax yarn. Short fibres such as flax tow and waste are worth being subjected to enzymatic modification and use in blends with other natural and artificial fibres to produce high quality yarn for knitting and weaving.

For flax blends processing, more efficient spinning technologies are employed to compensate the costs of modifying technical bast fibres [2]. Short flax fibres modification is a process called 'cottonization', where the fibres are shortened and their linear density is reduced. In earlier times a mechanical cottonization was applied in Poland. Two types of cottonine were manufactured: wool-type cottonine with fibre length similar to wool, and cotton-type cottonine which was much thinner, similar to cotton [3].

During the last 5 years a new method of cottonizing technical bast fibres has been developed, implemented and patented by the Institute of Natural Fibres (IWN), Poznan [4]. The new method is based on the use of an enzymatic preparation to facilitate de-gumming of the fiber bundles and their separation into smaller bundles of loosely bound elementary fibres. Cottonine which is manufactured in the described process has combined properties of both types of cottonine: fibre length like wool-type and linear density like the cotton – type [5]. Flax cottonine manufactured under the IWN license is not only a good combination but also has improved softness, flexability and fibre separation. Comparing to the raw material, the modified fibres are approximately 60% thinner and 2 – 3 times shorter.

For rotor spinning purposes, flax yarn should have mean fibre length similar to that of cotton (30 – 35 mm) and even staple length containing at the maximum of 15% fibres

longer than 50 mm. Higher percentage of long fibres can cause technological disturbances in open-end cotton system spinning. Having considered the open – end spinning conditions it is vital to prepare an approximate fibre structure before implementing modified flax fibres. The enzymatic method needed further improvement to obtain thinner and evened – up staple out of short flax fibres. After enzymatic modification, flax fibres are subjected to subsequent mechanical processing where they are divided and shortened. It allows to obtain flax fibres which have comparable properties to cotton.

Flax and cotton blends application, spun on the Open – End system required determining optimal parameters of sliver preparation and spinning parameters on rotor spinners type BD 200 RN [6,7]. The research and implementation work was done in ZAMATEX spinning factory. The new type of flax cottonine obtained with Institute of Natural Fibres method enabled manufacturing Open – End cotton yarn with great proportion of flax fibres.

Experimental part

Research aim and range

The research aims at developing the enzymatic modification technology of flax cottonine to make it suitable for open – end spinning blended with cotton, and developing the technology of manufacturing Open – End yarns from cotton – flax blends, where the flax was enzymatically modified.

Range of the research:

- Developing an experimental enzymatic technology of modifying short flax fibres with mechanical evening – up.
- Evaluating changes in structure, chemical content and physico – mechanical properties of flax fibres before and after the enzyme treatment.
- Evaluating the influence of carding intensity of enzymatically treated flax cottoning on fibre properties and determining the optimum conditions for carding process.
- Evaluating cotton – flax blend spinnability where the percentage of modified flax fibre ranges from 50% to 100%. Assessment of the blend proportion influence on linear density of the yarn.
- Evaluating the flax fibre proportion influence on knitting and weaving processes on basis of experimental trials with knitted and woven fabrics that contain more than 50% of flax fibres.
- Establishing an experimental technology for manufacturing open – end cotton yarns with more than 50% flax fibres.
- Industrial trials with cotton – flax yarns.

Spinning with a rotor system, type BD 200 requires that specific conditions were complied regarding the raw material and carding process where sliver is prepared to feed the open – end spinning machine. End - use properties of cotton – flax blend depend greatly on raw material features, which also decide on criteria of selecting the machines for an experimental production line.

In the experimental work the selected blend was cotton plus modified flax fibres. Card sliver was prepared with medium – fine cotton system. The equipment for the experimental production had to ensure:

- Preliminary loosing – up the raw material before blending.
- Moistening and seasoning the modified flax fibres in climate conditions with raw material humidity 14 – 18%.
- Intensive dust removal for both components of a blend.
- Maximum loosing – up fibre bundles on each stage of the process with parallel dust and micro- dust removing.
- Maximum seed impurities removal on each stage of the process.
- Optimal climate conditions in production room: temperature 24 – 26°C and relative humidity 60 – 65%.

Raw material

In this experimental work following raw material was used:

1. Short flax fibres 1.71 tex/82 mm retrieved from flax waste 2.2 tex/168 mm obtained in carding process.
2. Flax waste fibres 3.2 tex/230 mm.
3. Flax cottonine 1.06 tex/31.6 mm.
4. Uzbek cotton from current production in Zamatex company.

Short flax fibres were used to develop an experimental technology for fibre enzymatic modification where the cottonine staple is evened up mechanically. Selected variants of modified flax fibres were used to perform spinning trials for cotton – flax blends with various flax content. Flax waste was used to examine the influence of carding intensity on enzymatically modified fibres and to carry out the spinning trials.

Flax cottonine after enzymatic modification was used in blends with cotton which served to develop the production technology for cotton – modified flax blends. In each trial of enzymatic modification followed by a mechanical process, one raw material was applied – short flax fibres of 1.71 tex linear density and 82 mm length.

The cottonization process

Cottonization process of flax fibres before and after enzymatic modification was carried out with RCZ 120 – 3.03 Rieter Elitex. The technological scheme of such equipment is presented in the Figure 1.

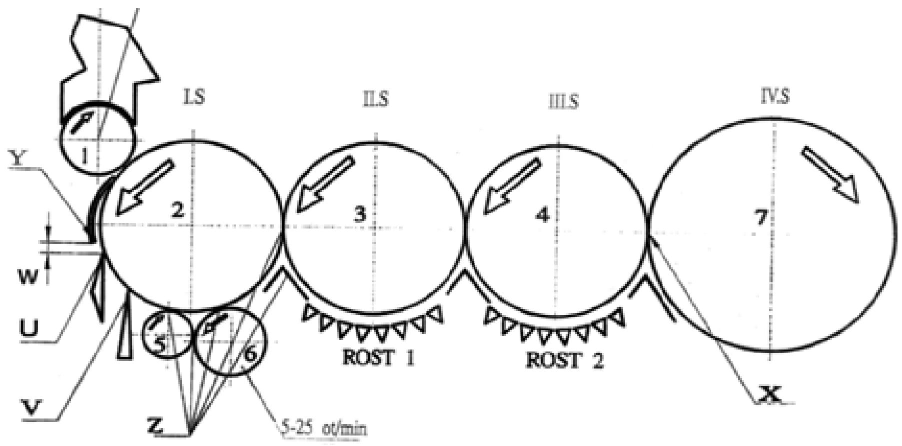

Figure 1: The technological scheme of the equipment for cottonization type RCZ 120-3.03
I.S – section I, input; II.S – section II, operation; III.S – section III, operation; IV.S – section IV, output

Working elements: Y – cover – roller 2; W – cover – knife 1; U – knife 1 – roller 2; V – knife 2 – roller 2; Z – operating-returnable roller 5,6 – roller 2; Z – roller 2 – roller 3; grill 1,2 – roller 3,4; X – roller 4 – roller 7.

The equipment consists of four sections. In the first section, the initial opening and shortening of fibres is carried out; in the next 2 sections – intensive shortening and levelling of fibre staple is performed. The fourth section is the output section. Intensity of shortening is adjusted within the range of 36-120 mm for the average fibre length.

For cottonizing the short flax fibres the machine was set at maximum cut intensity. The process was then repeated. For enzymatic modification of short fibres Pektopol preparation was applied. The following equipment was used: dyeing apparatus BA 20, a centrifugal and a beam dryer. Table 1 shows the idea of enzymatic modification of flax cottonine.

Table 1: Parameters of the flax cottonine enzymatic modification

Item	Technological process	Auxiliary means	Processing conditions
1	Bath preparation	KDK 2g/dm^3	pH 4, temp. 55 °C
2	Enzymatic treatment	Pektopol PT 400 15g/kg fibres	pH 4, temp. 55 °C, time 60 min.
3	Bath removal		bath removal without rinsing
4	Boiling	Soda 50 g/kg fibres Sulfapol 5 g/kg fibres	temp. 95 °C, time 60 min.
5	Rinsing		time 20 min.
6	Softening	Roksol AT2 20 g/kg	temp. 45 °C, pH 6, time 20 min.

The enzymatic modification was performed with dyeing apparatus type BA. After finishing the treatment, the bath was removed in a centrifugal and the flax cottonine was dried in beam dryer EB 10 in 80 °C.

The modified cottonine humidity after drying was at the level of 15%.

Parallel to the performed industrial trial, the same part of raw material was subjected to a seasoning process. Basic parameters of flax cottonine before and after enzymatic modification are shown in Table 2.

Table 2: Parameters of flax cottonine before and after the enzymatic modification

Item	Parameters	Flax cottonine		
		Before modification	After continuous modification	After modification while seasoning
1	Linear density, tex	1.06	0.83	0.87
2	Linear density reduction, %	-	21.7	17.9
3	Mean fibre length, mm	31.6	24.3	26.0
4	Mean fibre length reduction, %	-	23.1	17.0
5	Content of fibres below 20 mm, %	49.6	55.5	58.7
6	Content of fibres above 50 mm, %	25.1	8.5	17.5

After the modification was carried out in continuous and in seasoning process as well, further decrease in linear density and shortening occurred. After continuous modification the content of >50 mm fibres decreased greatly, which is convenient for their further processing in blends with cotton, in cases where drawing machine is employed to prepare sliver for BD 200 RN spinner.

The spinning process

In technological process of manufacturing Open – End yarns of 25 tex, 40 tex and 50 tex there were applied blends with 40, 50 and 60% flax cottonine. The process involved following operations: Rinsing and seasoning the modified of flax cottonine, blending while seasoning with cotton, picking, carding, drawing and spinning. Spinning was performed with a rotor spinner BD 200 RN. Basic technical and technological parameters are shown in Table 3.

Table 3: Spinner basic technical and technological parameters

Item	Parameters	Unit	Value
1	Sliver linear density	ktex	4.0 - 4.5
2	Yarn linear density	tex	20 - 100
3	Drawing amount	-	35 - 220
4	Scale	mm	120
5	Rotor diameter	mm	56 and 65
6	Rotor rotational speed	rpm	31 000 – 60 000
7	Rotational speed of the brushing drum	rpm	5 000 – 8 000

Slivers of linear density 4.5 ktex formed out of three different blends were used to produce yarns of 25, 40 and 50 tex linear density and twist factor αm 170. Table 4 shows the spinning parameters for the 25, 40 and 50 tex yarn.

Table 4: Parameters of spinning on a BD 200 RN spinning machine

Item	Parameters	Unit	25 tex 40F/60C	40 tex 50F/50C	50 tex 60F/40C
1	Sliver linear density	ktex	4.5	4.5	4.5
2	Rotor speed	rpm	31 000	31 000	31 000
3	Brushing roller speed	rpm	7 500	7 500	7 500
4	Production speed	m/min	29	36	40

Results

In spinning process described in table 4 several cotton – flax yarns were manufactured and their physico – mechanical parameters are listed in Table 5.

Table 5: Physico – mechanical parameters of cotton – flax yarn containing 40% 50% and 60% flax cottonine modified enzymatically.

Item	Parameters	Unit	25 tex 40F/60C	40 tex 50F/50C	50 tex 60F/40C
1	Real linear density	tex	25.1	37.5	52.0
2	Linear density irregularity	%	4.6	4.1	5.1
3	Tenacity	cN/tex	9.4	10.3	9.8
4	Irregularity of tenacity	%	6.6	8.2	7.9
5	Twist	TPM	1045	869	741
6	Metric twist coefficient α_m	-	166	168	169

As a result of the research it has been proved that the technological process of manufacturing Open – End yarns of 25 tex, 40 tex and 50 tex should involve following stages:

- loosening up the modified flax cottonine and seasoning without soaking, with dust removing on a blending line,
- soaking the modified of flax cottonine and seasoning for 24 hours,
- blending the flax cottonine while seasoning with cotton,
- production of sliver which linear density is 4.5 ktex on picking – carding line,
- drawing on two courses of drawing machines type RSB 951 and producing the sliver of 4.5 ktex linear density,
- spinning on a BD 200 RN.

Conclusions

The production of Open – End cotton yarns with 50% content of the flax fibre required developing both technologies of preparation the enzymatically modified of flax cottonine and the technology of manufacturing the yarns made of flax – cotton blends. The summary of the conducted research is shown below:

1. As the result of a trial to produce modified of flax cottonine with application of:
- enzymatic modification of technical flax fibres (waste) carried out continuously, periodically or during seasoning,
- mechanical levelling of staple flax fibres it has been found that the closest parameters to that of cotton has flax cottonine produced in following process:
- technical flax fibres cottonization
- enzymatic modification of flax cottonine carried out in continuous process with auxiliary means which are listed in Table 1

2. Cottonization process and enzymatic modification of short flax fibres for producing modified cottonine has following effects on basic fibre parameters:
- decrease in linear density by 25.2%, from 1.71 tex to 1.28 tex.
- decrease in mean fibre length by 71.7%, from 82 mm to 23.2 mm.
- decrease in long fibre content from 64.7% to the level of 4%.

3. Spinning trials for flax – cotton blends with enzymatically modified of flax cottonine content 50% and above showed that the performance of spinning on BD rotor spinner depends on two factors: appropriate of flax cottonine preparation and flax fibre content in a blend.

The application of cotton and 50% modified of flax cottonine in continuous process as a raw material enabled the production of 30 tex and 40 tex yarn. By increasing the content of flax cottonine to the level of 60% the obtained yarn was of 50 tex and 60 tex density. Critical flax fibre content in blend with cotton is 70%, then it is possible to produce yarns of 80 tex.

4. For cotton – flax yarns the applied twist was 10% higher than in other cotton assortment.

5. Cotton – flax yarns with flax content 50% and higher are characterized by soft touch and can be used as a raw material for knitting and weaving.

Acknowledgement

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EXPERIMENTAL STUDIES OF THE MAIN CHARACTERISTICS OF BASIC COMPLEX WEFT-KNITTED STRUCTURES

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Abstract:

The results of research of the main characteristics of the basic complex weft-knitted structure, which repeat consists of plane course and incomplete rib course, are presented at the report. The main objective of this research is to analyze the influence of the number of the turned off needles in repeat on the main characteristics of knit structure.

The fabrics are made on the flat bed-knitting machine 10 gauge from the 50 x 2 tex blended flax-consisting yarn. All measurements of the structures parameters are made on the fabrics at the fully relaxation stage after washing.

Introduction:

There is a tendency to the consumption of ecologically health products in the whole world. Such trend have been influencing on the textile industry of Ukraine, in particular on the production of knitwear. Therefore there is multiplying of the use of flax-consisting yarn in the knitting production. This tendency allows substantially shortening the import of cotton to our country.

The subject of this research work is knitted fabric of the basic complex weft-knitted structure, which is made from blended flax-consisting yarn (30 % flax and 70 % cotton fibre) the linear density of 50 x 2 tex.
The main objective of this research is to analyze the influence of the number of the turned off needles in repeat on the main characteristics of knit structure.

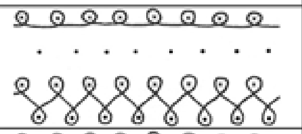
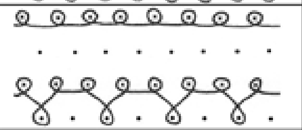
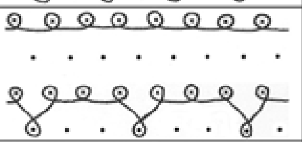
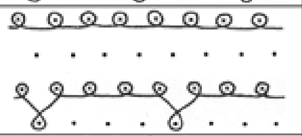
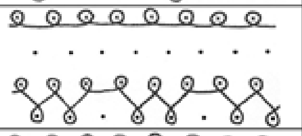
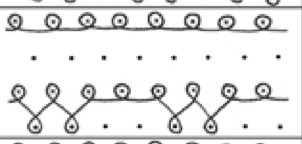
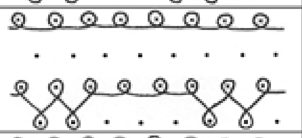
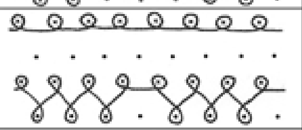
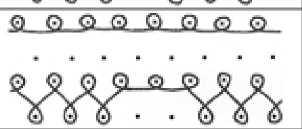
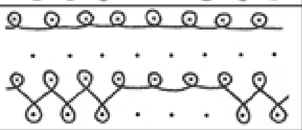
Experimental part:

The basic complex weft-knitted fabric, which repeat consists from two rows: jersey course and incomplete rib course of different repeat have been chosen to research, Fabrics have made in follows:

- the jersey course have been made by needles back needlebar only;
- the incomplete rib course have been made by all needles of back needlebar and the some needles of front needlebar, which have been worked according to a repeat.

The number of on/off needles of front needlebar is 1, 2 or 3. Nine variants of the basic complex weft-knitted structures have been produced, the graphic records of which are presented in a table. The front side of the knitted fabric is a side with the skipped loops. The knitted fabric of the simple combined interloping, in which report the jersey course and rib 1+1 course are alternated, have been produced for comparison.

All variants of knitting fabrics have been produced at flat bed knitting machine 10 gauges with the unchanging technological parameters of knitting process (depth of sinker, yarn tension and draw-off force). The measurements of the structure parameters have been made according to standards on the fabrics at the fully relaxation stage after washing in a washing-machine. The research results are presented in a table.

variant of knitted structure	Graphic of interlooping	number of the turned off needles in repeat: parts	number of the turned off needles in repeat: percent-tages	number of courses per 100 mm: face	number of courses per 100 mm: back	number of wales per 100 mm: face	number of wales per 100 mm: back	Loops length, mm: plane course	Loops length, mm: not full rib course	Thickness, mm	Basic weight, g/m²
1		0/2	0	55	108	48	48	7,27	7,00	2,11	548,6
2		1/4	25,0	49	97	28	55	6,94	7,21	1,88	464,7
3		2/6	33,3	46	90	20	58	6,94	7,14	1,67	406,4
4		3/8	37,5	46	92	15	59	6,99	7,12	1,68	415,5
5		1/6	16,7	50	98	34	51	6,91	7,48	2,07	498,8
6		2/8	25,0	49	96	28	54	6,88	7,36	1,93	456,5
7		3/10	30,0	48	95	22	54	7,09	7,34	1,83	447,5
8		1/8	12,5	49	97	38	50	7,09	7,55	2,01	503,7
9		2/10	20,0	49	97	31	52	7,11	7,55	1,93	470,8
10		3/12	25,0	51	102	27	53	7,10	7,00	1,99	490,4

Results and Discussion

The researches have showed that the structure parameters of the basic complex weft-knitted structure are depended on the variant of the combined interlooping. Graphical and analytical dependences of stitches density from the percent (x) of the turned off needles in repeat of incomplete rib are presented on fig.1-2.

The graphics show that the stitches density of the knitted fabric is different on the front and the back side. Number of the courses at the back side (Ncr) is practically two times less than at face side (Ncl). That can be explained by the structure of these fabrics. One course of knitted structure at front side is produced by two systems; here two courses are produced at the back side of fabrics.

It should be noted that the stitches density of the knitted fabric on a wales direction goes down insignificantly (to 5 %) with multiplying the number of the turned off needles at repeat of incomplete rib.

Density of the knitted fabric on a courses direction which is expressed the number of wales per 100 мм, has opposite dependence on the variant of knitted fabrics at the face and the back side of fabric. So when the numbers of the turned off needles in repeat of incomplete rib are multiplying, the number of wales at face side of knitted fabric diminishes, that is naturally. At the same time, the number of wales at back side of knitted fabric is multiplying. It can be explained by junctures type between nearly loops. On a fabric with the less percent of the turned off needles at incomplete rib more loops junctures connect the loops, which are formed on a different needlebars. Therefore distance between the loops, which have been formed on two nearly needles of one needlebar is growing. At the same time the number of loops which have been formed in succession on the needles of one needlebar is multiplied on a knitted fabric with more percent of the turned off needles at incomplete rib, that approaches them in fabric (areas of jersey).

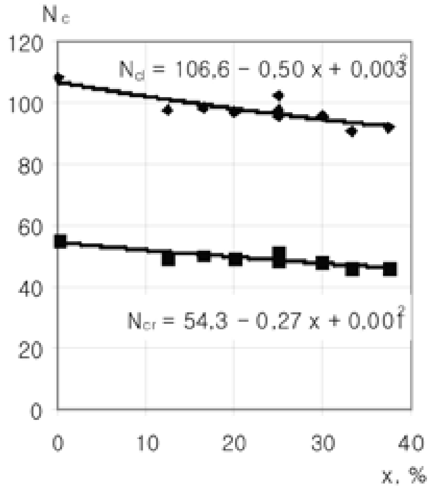


Fig.1

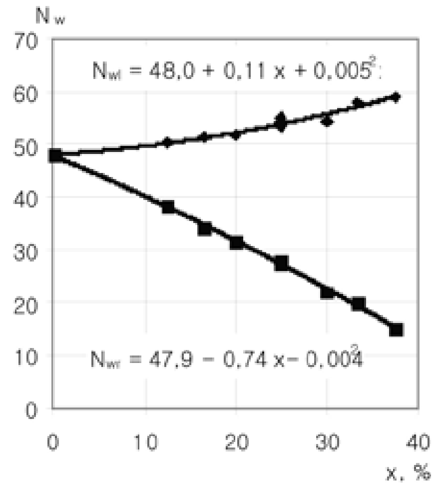


Fig.2

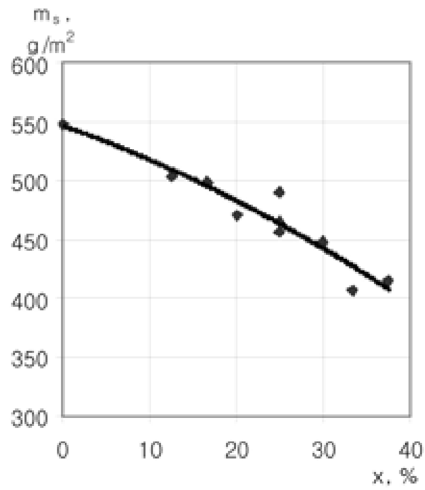


Fig.3

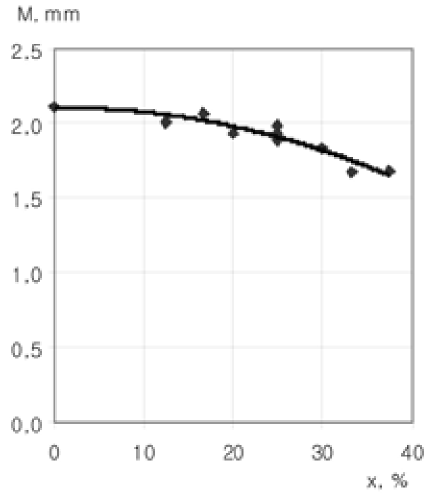


Fig.4

It should be noted that the stitches density is practically identically for the fabrics variants with the identical percent of the turned off needles (variants 2, 6 and 10) and don't depend on the repeat of incomplete rib.

The investigation of loops length show that in knitted fabrics, which have got alternation of rib 1+1 course and jersey course, the loops length of jersey exceeds the loops length of rib by 5%. The loops length of jersey is less the loops length of incomplete rib for all other variants knitted fabric of the basic complex weft-knitted structure. This difference diminishes with multiplying the number of the turned off needles in repeat, I.e. with multiplying the areas of jersey in interlooping. In addition, the middle loops length of both courses: jersey and incomplete rib decreases with multiplying the number of the turned off needles in repeat.

The basic weight (ms) and the thickness (M) of knitted fabrics diminishes with multiplying the number of the turned off needles in repeat of incomplete rib (fig. 3 and 4). The variants knitted fabric of the basic complex weft-knitted structure, in which the percent of the turned off needles does not exceed 20 %, have got practically an identical thickness. The thickness of fabric goes down considerably with the further increase of number of the turned off needles in repeat, I.e. with multiplying the areas of jersey, .

The analytical dependences, which allow supposing the knitted fabrics properties on the planning stage, have been received on the basis of the mathematical processing of experimental data:

- the basic weight (R^2=0.91)
  ms = 546,73 - 2,60 x - 0,03 x2 ,
  where **x** is the percentages of the turned off needles at not full rib course;

- the thickness (R^2=0,89)
  M = 2,1 + 0,0007 x - 0,0003 x2 .

Conclusion

This researches show that number of the turned off needles in incomplete rib have substantial influence on main characteristics of the basic complex weft-knitted structure, which repeat consists of jersey course and incomplete rib course. The mathematical dependences of structure's parameters of knitted fabric from the percent of the turned off needles have been received as a result of the experiment. That allows supposing the knitted fabric properties on the stage of design.

RESEARCH REGARDING THE MANUFACTURING PROPERTY OF KNITS MADE OF NATURAL ENVIRONMENTALLY-TREATED YARNS

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Abstract:

The fabrication of the surfaces knitted from new types of yarns, based on mixtures of linen and cotton, with environmental treatment for the yarns and for the knitted surface, being this the object of the CEEX/2006 contract, request the continuation of the research regarding the behaviour of these fabrics during the technological flow of converting them into clothes.

To this end, the study approaches the main creation problems for three types of fabric, with the following structure: cotton, rib, plaited cotton, which can be used for products for children and adults: T-shirts, blouses, jumpers, track-suits, etc.

The experiments made during the operation of layering, cutting, sewing and wet-heat processing, underlined the particular problems typical to these fabrics and they allowed the quantification of the dependencies and the improving of the technological working parameters, all these due to the statistical data processing.

Introduction:

Research in the field of clothing comfort have shown that the health state of the human body is also influenced by clothing products. Clothing must ensure the continuity of the biological and psychological processes, the effort capacity of the body, the exercise of the self-adjustment and recovery functions following climatic disturbances, etc.

The world textile market has been invaded with clothing products made of synthetic fabrics, more or less adequate for use in clothing products. The indisputable advantage of synthetic fabrics in what concerns their resistance to wear, the resistance of the dyes, the low price, etc., has imposed this category of raw material on the market, but today, less and less users wish to wear clothes made of synthetics, because of the sensation of discomfort they create, especially when the clothing product is in contact with the skin.

The Romanian tradition regarding clothing sets high value on natural raw materials: flax, hemp and wool. Traditional embroidered blouses and men's shirts as well as textile objects intended for interior decoration of homes are made of flax, cotton, hemp and wool cloth, obtained by means of strictly environmentally-friendly technologies. In order to obtain the white background of the cloth, the beige or grey hue of flax or hemp was eliminated by simple and ingenious procedures, being whitened by exposure to the sun through repeated washes and exposures or by boiling.

From an environmental point of view, the clothing products made of synthetic fibers are a real danger for the environment, and the recycling of the used or unsold products is made with high-costs. In this context, the clothing products of natural raw materials are not only fashionable, but they are also more beneficial in the relationship with the human body.

Flax is, admittedly, the most complex natural textile fiber. Its indisputable properties have started to be rediscovered: more and more specialists attest to the fact that clothing products made of flax are much healthier. Flax proves to be the best material that contributes to ensuring a proper microclimate for the clothing-skin interface and it is the only fiber to suppress the effect of bacteria and mycoses. The superiority of flax knits over cotton knits consists in the fact that, in warm weather, they ensure optimum microclimate conditions for the human body and eliminate risk of electrostatic discharges, which are not well tolerated by the body. The studies that have been made show that a content of 11% flax is sufficient to prove this property.

From an environmental perspective, flax technologies, waste, products and sub-products have a minimum impact upon the environment.

Experimental Research

1. The Main Technical Characteristics of Knits

The initial experimental research was made under the research contract CEEX 55/2006, which had as an objective to set new technologies, applied to fabrics of bast fibers, by using chemical and enzymatic processes in ultrasounds in order to obtain high-performance fabrics. The research theme required:

- setting technologies of obtaining flax fibers, by means of environmental treatments made with emollients, ultrasounds, enzymes and catalysts with a view to setting the optimum treatment parameters: the concentration of the preparation solution, the hydro-module, temperature and time;
- obtaining yarns from mixtures of flax and cotton, in different ratio combinations (between 30 ..70% flax), with different fineness (Nm 20...Nm 54) and their testing;
- making knits in different types of structures, in different conditions of adjustment of the technological parameters;
- setting the characteristics of the knitted structures and setting the comfort parameters of knits in raw state;
- environmentally-friendly finishing of knits and setting the comfort parameters.

In this paper, the experimental research have targeted the manufacturing properties of previously made finished knits, discussing three types of knit: plain jersey (A), plated plain jersey with lining yarn (B) and Swiss rib (C).

The structure parameters of knits (density on the horizontal Do, density on the horizontal, on the two sides of the Swiss rib knit, Do' and Do", density on the vertical, Dv, and the knit thickness g), tested in the processes specific to the manufacture of clothing products, are gathered in table no. 1.

Table no. 1. Characteristics of tested knits

Fineness of the yarns [Nm]	Yarn processing		Composition	Structure	Do/Do' [ş/50mm]	Do" ş/50mm	Dv [r/50mm]	g [mm]
54/1	Double carded		30%flax+70%cotton	Plain jersey (**A**)	45	-	60	0.920
54/1	Backgroun d:	In albite	30%flax+70%cotton	Plated plain jersey with lining yarn (**B**)	40	-	60	1.470
54/1	Plating:	In albite	30%flax+70%cotton					
20/1	Lining:	Double carded	70%flax+30%cotton					
34/1x4	In albite		50%flax+50%cotton	Swiss rib (**C**)	19	19	24	2.450

2. Testing the manufacturing properties of knits

At the same time with the extension of the studies of total quality control, an important field of the clothing manufacturing technologies research is of interest again, namely the study of the properties of the textile fabrics in relation to their manufacturing capacity, with the maintenance of their shape and final appearance, that is the relationship with the quality that is obtained by transforming the fabric into a product.

The capacity of a textile fabric of being processed without any difficulty by means of existing technologies is referred to as manufacturing property.

The estimation of the quality of the processes with the purpose of objectivelly directing the quality of the clothing products requires the identification of the characteristics of the textile fabrics that significantly influence the processing procedures and may affect the appearance of the finished product, at the same time with the development of a system of methods and means of strict measuring of the values for these characteristics.

The manufacturing property is primarily determined by these characteristics of the tested materials:

- Geometrical characteristics (length, width, thickness, specific mass, dimensional stability);
- Mechanical characteristics (elongation, resistance to tangent friction, resistance to compression);

- Transfer and/or mass and energy assimilation characteristics (air permeability, vapor permeability, hygroscopicity, thermal resistance);
- Optical characteristics (glossiness, transparency, color stability);
- Electrical characteristics.

Following some preliminary tests, the operations were set in which those knits create specific problems, thus requiring additional measures. These operations (splitting, cutting, manufacturing) are evidenced in the technological process shown in figure 1.

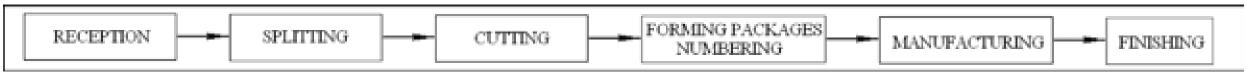

Figure 1. The technological process and the analyzed operations

2.1. The Behavior of the analyzed knits in the operation of splitting

For the operation of splitting, which consists in layering the fabrics in order to simultaneously cut the measuring marks, there was adopted the method of the discontinuous splitting, characterized by a lower consumption of fabric and identical presentation of measuring marks in the packages.

In table 2 are gathered the specific characteristics of the considered knits, the detected problems, as well as suggestions for solving those problems.

Table no. 2. The behaviour of knits to splitting

Specific Characteristic	Problems	Solutions (recommendations)
Uneven edges	Difficulty in creating a straight wall (in all knits)	-splitting machines with edge detection -splitting table with needles on the edge
Low transversal stability	Uneven width of the cutting (mainly in version C)	-deposition cylinders with limiters for edges or with nozzles for compressed air ejection
Longitudinal stability	Uneven tension, subsequent dimensional deviations at the cut measuring marks (especially at A and C)	-Adjustment of unfurling tension and deposition tension of the layers at minimum values
Low rigidity upon bending	Appearance of longitudinal folds (at A)	-Deposition cylinders that can be adjusted on the vertical, placed immediately above the cutting

It was ascertained that the presence of the plating yarn determines a better behaviour to layering, the biggest problems being those of the Swiss rib knit. Solving the splitting problems requires, most of the times, additional measures, including additional equipment to the splitting machines.

.2.2. The behaviour of the studied knits to the operation of cutting

For the performance of the cutting operations, including sectioning and cutting out on the outline of the measuring marks, there have been used traditional tools, like the mobile machine with band knife for sectioning and the fixed machine with continuous band for cutting on the outline.

The main problems and some recommendations for arriving to a solution are presented in table 3.

Table no. 3. The behaviour to cutting of layered knits

Specific characteristic of the package	Problems	Solutions (recommendations)
Poor/weak links on the vertical within the package	Deformations on the edges of the packages or split sections while they are moved for cutting out.	-Cutting with mobile machines with double-jointed arm, by placing split sections on an air cushion or cutting with automatic machines, in which the cutting is compressed with vacuum.
Uneven edges at knit C, due to the low level of compactness of the cut to measure packages	Inaesthetic appearance of the edges and subsequent variation of the width of the sewing reserves.	
Deviations from the nominal direction (of the row)	The appearance of the spiralling property and of the movement of the longitudinal seams in the manufactured products.	-Better heat setting in the finishing processes of knits

Generally, the problems that arise upon cutting are caused by the low level of compactitate of the packages, due to the structure of the knits. These problems, that are related to the appearance of the cut edges, may be diminished by compacting packages, under the action of some absorbtion forces, as it happens upon cutting with automatic machines with a knife. The measuring marks cutting operation highlights the spiralling effect of the plain jersey knit (A), the causes being related to the balancing of the yarn torque and to the characteristics of that structure. This problem, which could be solved during knitting, by using latest technology machines, or upon finishing, through a better heat setting, usually comes back in the manufactured product after several washing-wearing cycles.

2.3. The behaviour of knits in the sewing operation

Taking into account the destination that may be given to those knits, it was considered necessary to test the behaviour upon sewing with overcast machines overcast stitching. These types of seams, used for the assembly of the measuring marks and elements have the largest share of the products that may be manufactured from these knits. The Swiss rib knit was used as as additions (cuffs, collar, endings, etc.), so that the main thing analyzed was its transversal assembly with knits A and B. The behaviour of the cut measuring marks both during the performance of the sewing operations phases: supply, effective sewing, cutting the yarns and storage of the sewn measuring marks, and behaviour during the effective sewing.

The supply phase, by moving, overlapping the measuring marks and their setting under the pressing foot requires a longer time for manual performance because of the deformability of the knits, especially in what concerns the plain jersey knit (A), whereas the performance method of the other auxiliary phases is not influenced by the fibrous composition and mechanical characteristics of those knits..

In what concerns the sewing, there appeared secondary effects specific to the sewing phases, with different intensities, according to the placement of the sewing line in relation to the direction of the loop rows. For sewing parallel to the direction of the rows, in which the undesirable effects are more evident, the experimental results are presented in table 4.

Table no. 4. The behaviour of knits upon sewing

The seam formation phases	Undesirable effects	Solutions (recommendations)
Piercing phase	Broken loops	Sewing with spherical head needles
Squeezing phase	Pressing of the fabric	Better balancing of the yarn tension and the reduction in the pressure of the pressing foot.
	Floating of the curl knit point on the vertical	
Transportation phase	Uneven steps	Reduction in the pressure of the pressing foot
	Relative movements of the layers	
	Lengthening of the sewing line	
	The deviation from the outline of the sewing line in case of the assembly of knits A and B with C, due to thickness variation.	Replacement of the structure Swiss rib with a structure one-and-one rib

Conclusions:

Experimental research regarding the behaviour of knits to the manufacturing property highlighted specific problems of the important operations in the manufacturing process of the clothing products, but it may be said that these problems are common for all knits with structures similar to those that were analyzed. The nature of the raw material can, most of the times, diminish these problems, compared to knits made of other fibrous compositions, e.g. of 100% cotton. The slightly higher rigidity of the flax fiber in the fibrous composition contributes to a slightly better dimensional stability and a stability of measuring marks during manipulation. Upon sewing, the biggest problems appeared in the case of the structure Swiss rib, due, on the one hand, to the much bigger transversal elasticity than of the other knits with which it is assembled, and, on the other hand, to the thickness variations, characteristic to that structure. The assessment of the manufacturing property of textile fabrics allows:

- elimination of disturbances related to the processing capacity of fabrics in the manufacturing process;
- setting the optimum parameters and technological programs, in the required technological, economic and organizational conditions;
- ensuring the conditions for the introduction of automation and robotics and for the computerization of the manufacturing processes, by creating data banks referring to the characteristics of the textile fabrics.

By identifying the specific problems of the manufacturing property and setting adequate measures, we may conclude that the behaviour of those knits is good and that they may be used to manufacture clothing products.

References:

[1] Group of authors – Research Report, Phase 2/2008, CEEX 55/2006

COTTON FIBERS AND MEDICAL PRODUCTS

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Abstract:

The paper is presenting researches on medical products made by nonwovens technologies with a high absorption capacity need in emergency cases or other types of disasters. The nonwoven technology has the fastest growing of more 10% yearly within the textile industry. The nonwoven products are realised from cotton fibres treated by alkaline boiling and bleaching processes to improve the characteristic performance of products. Products of 200 g/m2 to 300 g/m2 average basic weight, with high liquid absorption capacity can replace the woven gauze medical product. The end-uses of products are for absorbent pads, bandages, bed linen, blankets for hospitals, burn dressings, cast liners, swabs, puffs, absorbent puffs, face masks, filters, finger bandages, heat packs, incubator mattress, medical filters, procedure packs, medical equipment, wound dressings, etc. The pulp fibers have been also used to diversify the nonwoven products for very special medical end-uses with very high liquid absorbtion capacity.

Keywords: cotton, cellulose, fibers, nonwovens, absorbency, medical products

Introduction:

As an innovative technology to obtain environmentally products, the cellulose fibres nonwoven technology is more widely used to obtain environmentally friendly products [Anonym, A Guide to Fibers For Nonwoves. Nonwoven Industry, June, 1999, pp 60-82; Anonym, Natural Cotton Fiber, Nonwoven Industry, January, 1999, p 74].

From the cellulose fibres category, the fibres of cotton are the most customary fibres for nonwoven products for a very large area of end-uses including the medical products.

The criteria that have determined to obtain the nonwoven based medical products have been mainly the following:

- No indigene nonwovens for medical applications;
- The lower cost of production required for nonwovens medical by less process steps (number, length) compared to the classical woven gauze process steps, less raw materials, energy and labor.
- The highest absorption capacity compared to the classical products.
- The nonwoven equipments are of higher outputs.

The most consumers perceive cotton to be a superior fiber.

The general cotton fiber characteristics that could determine the end-uses of nonwovens and cotton processing are shown in Table 1.

Table 1 The Cotton Fiber Characteristics

Property	Value
Fineness, µm	12 – 20
Length, mm	12.7 - 30.5
Moisture regain at 65% r.h., 20°C, %	7 – 8
Dry tenacity, cN/denier	3.00 - 5.00 cotton is 20% stronger when wet
Wet tenacity, cN/den	3.50 - 6.00
Breaking extension, %	6.8
Absorbency, %	8 - 11 at standard conditions
Coefficient of friction	0.25 for raw dry cotton, strongly changes for treated and/or wet fiber

The main general characteristics which can influence the applications of the cotton fibers for technical nonwovens are the soft hand, the good absorbency, the good strength and abrasion resistance. The main chemical properties that could determine the end-use of cotton nonwovens are: cotton swells in a high humidity environment, in water, in concentrated solutions of certain acids, salts and bases, cotton is attacked by hot dilute or cold concentrated acid solutions, cold weak acids do not affect cotton, cotton degradation is usually attributed to oxidation, hydrolysis or both, cotton is extremely susceptible to the biological degradation (microorganisms, fungi, etc.)

The trash content is highly correlated to leaf grade of the sample. High trash content is not desirable for medical nonwovens.

Neps sometime detract from visual appearance. For some end-uses of cotton nonwovens such as very high absorbent products, the neps seems not to be very negativest characteristics.

Scouring is accomplished by saturating the cotton fiber with a caustic soda (sodium hydroxide) solution. In nonwovens, the cotton fibers are generally used in their bleached form.

The cotton fibers are used in the manufacture of nonwovens either alone or in a blend. The various processes for nonwoven production are carding, carding-lapping for web forming and hydroentangling, needlepunching or thermally bonding processes.

The hydroentangling process gives high strength without interfering with the absorbency, tensile strength and aesthetic properties of cotton, and without using any chemical. Known as Spunlaced, the hydroentangling process is highly attractive with cotton because it preserves the pure fiber condition which is conducive to making products with high absorbency.

The Spunlaced fabrics have many characteristics that are similar to woven cotton fabrics and many more related to high purity because of cleaning by high pressure water jets which intimately are penetrating into fibrous structure.

The needlepunched cotton nonwovens provide highly efficient filter media based on the irregular fiber shape and absorption properties. Increasing the tenacity in the wet condition can be an important advantage for cotton filters. Regular length staple cotton should be considered for needlepunching since longer lengths perform better. Even though cotton staple has random length distribution, enough long fiber is present in regular staple to form strong fabrics. Fiber finish is critical in needlepunching process. A good lubricity is needed to prevent bleached cotton fiber damage and needle breakage. Special needles (Foster Needle, Groz-Beckert or Singer type) are recommended in needlepunching process.

The thermoplastic fibers used for cotton fiber web bonding are the polyester and polypropylene. Polypropylene is preferred because of economics, density and low melting temperature considerations. Generally, an engraved calender roll with at least 30% bonding area is needed for blends of cotton and polypropylene. Unbleached cotton cannot be effectively bonded in the typical low-melt synthetic fiber blends due to the natural waxes, on raw fibers, which interfere with the adhesion expected of thermal bonding.

The proportion of cotton in the cotton-surfaced and cotton-core products, as nonwoven composites, can be adjusted to meet consumer needs and improve durability and usefulness of products developed by this method [Allen, H. Ch., Cotton in Absorbent Cores. Nonwovens World, August-September, 1999].

The cotton characteristics need in nonwoven products to be considered are excellent absorbency and feels comfortable against the skin, good strength both wet and dry, and moderate dimensional stability and elastic recovery [Anonym, A Guide to Fibers For Nonwoves. Nonwoven Industry, June, 1999, pp 60-82, Anonym, Natural Cotton Fiber, Nonwoven Industry, January, 1999, p 74, Allen, H. Ch., Cotton in Absorbent Cores. Nonwovens World, August-September, 1999].

The cotton nonwoven advantages are:

- Cotton nonwovens can be recycled, re-used or disposed off by natural degradation conditions.
- Cotton is a readily renewable resource with long-term supply assurance.
- The purity and absorbency of bleached cotton are utilized in growing medical and healthcare applications produced especially by the Spunlace process.

The cotton nonwoven disadvantages are:

- Bleached cotton fiber for nonwoven application is a relatively new fiber. It is a comparatively expensive fiber.
- Cotton use is still restricted to specialized applications. This situation is likely to change in the future as the price is further reduced and availability increased.

Conclusions:

The treated cotton nonwovens encapsulated in woven gauze are increasing besides the medical product performances also the "confidence" of the medical staff and/or of the patients to be usefully these products in the medical sector.

In emergency cases of any disaster the high absorbent nonwoven medical products is a way to be helpfull.

References:

Anonym, A Guide to Fibers For Nonwoves. Nonwoven Industry, June, 1999, pp 60-82
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Allen, H. Ch., Cotton in Absorbent Cores. Nonwovens World, August-September, 1999


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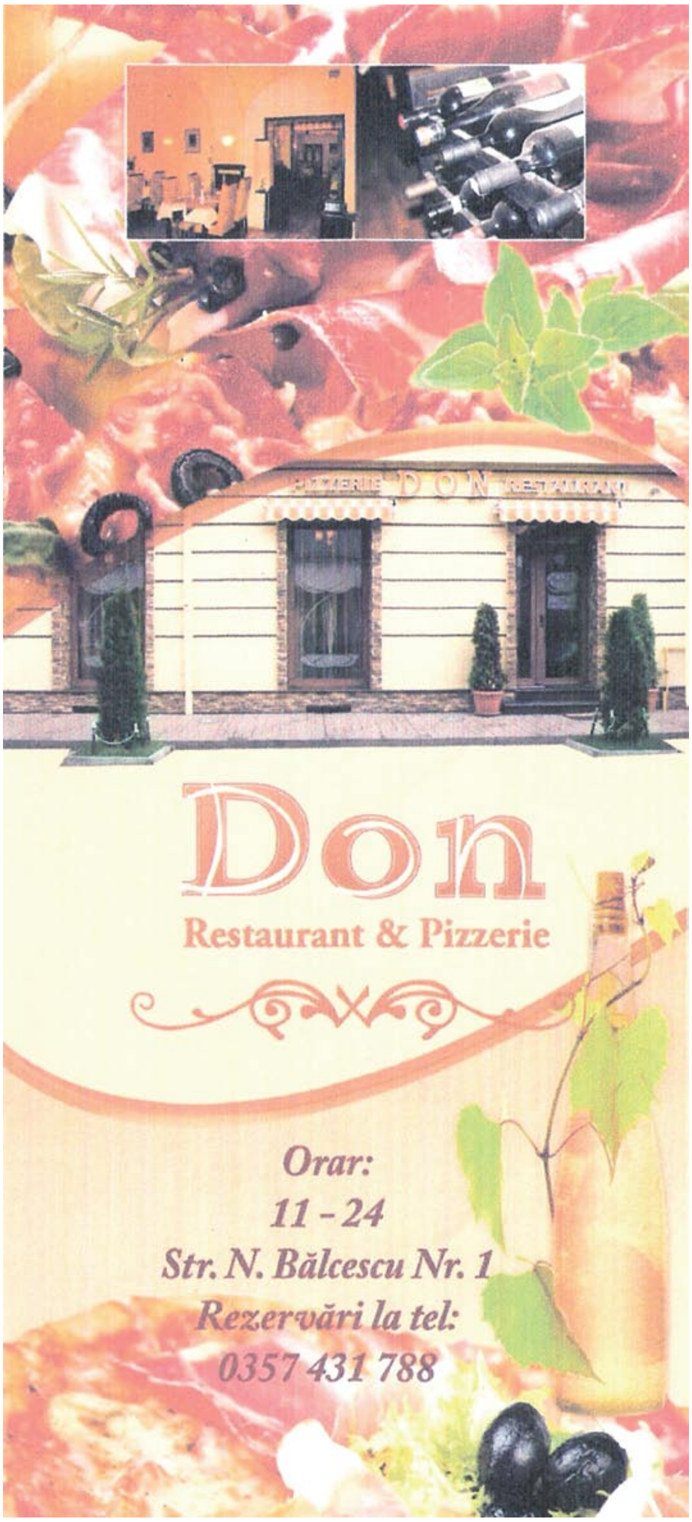
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PIF & ENA DESIGN

description

The company began its activity in December 1991,
to fulfill my family constant interest in the Art and Romanian traditions field:
in this family, the most common skills appear in the area of clothes manufacturing.

The development of the company took place in several directions:

- School uniforms for the top education establishments being the exclusive promoter in the country for this field.
- Natural clothes (hemp, linen, cotton) based 100% natural and Romanian fibremade.
- Traditional Romanian costumes. Also, we are constant promoting Romanian traditional Art and Romanian traditions in school, by workshops for 7-10 years old children, clothing ethnic and fashion classes.
- Textiles toys with manual brodery, inspired by Romanian Fairy-tales, using 100% natural fiber fabric.

Village of GHIOROC

The first documentary certification of Ghioroc dates from 1135. there is an old tradition in vine cultivation since 13th century. The wines of Minis are famous in whole Europe.

Village of Siria

The administrative territory of Siria has a surface of 12106 hectares and it is situated at the “crossroad” of Arad Plain and Zarand Mountains. Siria is 28 km far form Arad and has other two villages: Galsa and Masca.

The population number reaches over 8000 people of which 81,3% Romanians, 4,4% Hungarians, 1,8% Germans and others.

The first certification of Siria is from 1169. Although the economy is an agricultural one, lately the secondary and tertiary sectors of economy had developed. The most used exploitable resources are granite and limestone.

The traveling potential of Siria is one of great value. The ruins of Siria fortress are the most visited when in Siria. It was built in the 13th century and played a very strategic role in the area.

In Siria was born Ioan Slavici, one of Romania’s most valuable writers and Emil Montia who was a composer.

Auto Technic | Feel the difference

Recentness diagnose systems

- complete engine and security elements testing of the vehicle;
- diagnose and testing systems for breaks and silencers;
- geometrical regulation;
- tinsmith and dye works.

Auto Technic is the representative of Ford brand in Arad since 2001 and brings on the romanian market, 15 Ford car models from automobile scale to the readily commercial auto vehicles. Ford Motor Company is one of the world's leaders automobile industry; its manufacturing activities and distribution are unfolding on more than 200 markets on six continents.

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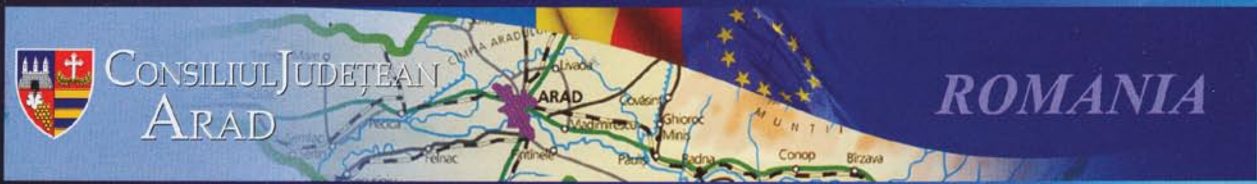


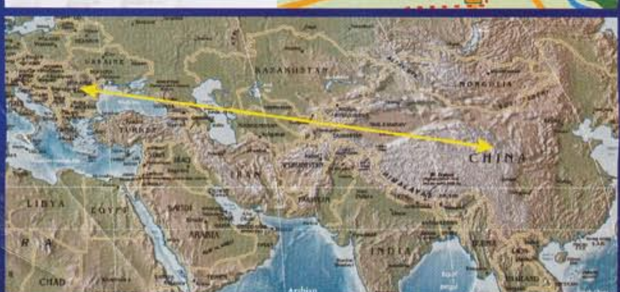
FREE TRADE ZONE CURTICI ARAD

The Free Trade Zone Curtici Arad represents a well limited territory.

Here you can develop economic activities having important incentives regarding the value added tax, the custom tax and the income tax.

Curtici Arad Free Trade Zone offers its users a well developed substructure consisting of: rain water drainage system, sewerage system, water supply system, power supply, telecommunication network, outdoor illumination and road network.

The airport company of Arad, finished building a modern Cargo Terminal for heavy traffic, with platforms and parking spaces as well.



Main advantages:

Investors in Curtici Arad Free Zone benefit from the following advantages:

Land concessioning for a period of minimum 10 years and maximum 50 years;

Possibility to transfer capital and profit abroad;

Financial operations in hard currency;

Possibility to change the origin of merchandise;

Possibility to keep in stock the merchandise using warehouses in the Curtici Arad Free Zone until the market provides the anticipated profit (keeping merchandise in stock is time unlimited);

Keeping wares in stock is not subject to import rights or to measures of commercial politics on import, as wares are not considered to be on Romania's customs territory;

Well-educated and inexpensive labour force.

What does Curtici Arad Free Trade Zone mean?

The Romanian Govemment Decision 449 issued on the 8th of June 1999 established the Curtici Arad Free Zone, which consists of the two following locations:

Platform 1

In the proximity of Curtici city, at the Hungarian border

Platform 2

In the western part of Arad, near the International Airport from Arad and the Cargo Terminal.

In comparison with other Romanian free zones, the Curtici Arad Free Zone is the only one located on a European motorway near four customs centers. It is also the only free zone that can be accessed through three of four types of access: railway, motorway and airway.

The Curtici Arad Free Zone is the only free zone located in the western part of Romania, the other free zones are located in the eastern and southeastern Romania, next to the Danube and the Black Sea harbours.

Land concession and lease within Curtici Arad Free Zone shall be accomplished by public auction.

Should you be interested in the opportunity of extending your activities towards the European markets, the Curtici Arad Free Zone from Romania represents a means of increasing the volume of your business transactions:

- the Free Zone is defined as an enclosure where non-Europeans goods are considered to be outside the EU customs area
- customs duties are paid only when goods are realesed for free circulation
- there is no limit to the length of time goods may remain in the Free Zone
- there are no duties to be paid for goods which are exported outside the European Union

Acces

The advantageous geographical position as well as the location on an European motorway corridor and the fact that the Curtici Arad Free Trade Zone can be reached by three ways of acces: highway, railway and airway.

The railway...

which links Romania to Western Europe, through Hungary;

The highway...

which links the town of Curtici to the city of Arad and therefore provides easy and quick access in the Free Zone;

The International Airport from Arad...

which has a 2000 m long and 45 m wide runway and a capacity of about 27 tones allowing transport of persons or merchandise under safety conditions.

Activities

Investors can carry on in the Curtici Arad Free Zone all activities permitted by the law such as:

- Packing an assembling of goods;
- Production an forwarding of goods;
- Selling and purchasing of goods;
- Storage, loading, unloading, stowing, lashing, tying and untying of goods;
- Transhipment and transit of goods as well as use of railway infractructure;

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