The Study of the Growth of Tissue Cultures under a Layer of Nanotextiles

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Abstract— Nowadays nanotextiles are very popular due to their unique properties (antibacterial, very light weight, thin, solid, high porosity, transparency, good mechanical properties, etc.). These characteristics bring new possibilities of classification in the various fields of human activity. For example, the filtration of air and water through the nanofiber membranes whose structure is similar to the construction of tissue that supports the growth of cells in their natural environment. Carbon nanofibers have their application in treating the effects of myocardial infarction. Nanotextiles consist of nanofibers with a diameter in the range from 50 to 500 nm. Production of such a fabric is much more complex than classical woven fabric. This material is not possible hold by any device. Production is carried out using the electrospinning. The nanotextile produced spinning method was used on the samples of spruce embryos and concluded (with samples) in the plastic Petri's dishes. Spruces embryos were selected for their rapid growth, their biggest increase is till the fifteenth day then they are growth-stabilized. The aim of this paper is to determine the influence of the nanotextiles to the tissue cultures and whether the embryos will be able to growth under this structure. The samples were periodically removed from the magnetic field and moved in an isolated box throughout the outdoor environment into the room with NMR tomograph for obtaining the images of individual tissue cultures. After fifteen days the last measurement was carried out and the results of all measurements were evaluated using the programs Marevisi and Matlab. Observed parameters of individual samples were processed into graphs.

1. INTRODUCTION

Nanotextile is the collective name for textile fibers (nanofibers) their diameter is in the order of a few nanometers (50–500 nm). Nowadays nanotextiles are very popular due to their excellent mechanical properties in relation to their weight, in particular, are very thin with high porosity. The most important and most used property is an antibacterial character mainly used in health care. These characteristics bring new possibilities of application in the various fields of human activity. For example, the filtration of air and water through the nanofiber membranes whose structure is similar to the construction of tissue that supports the growth of cells in their natural environment. Carbon nanofibers have their application in treating the effects of myocardial infarction. In the construction industry are used for thermal and acoustic insulation [1].

Production of such a fabric is much more complex than classical woven fabric. This material is not possible hold by any device. Production is carried out using the electrostatic spinning of polymer solutions in a strong magnetic field (electrospinning). The Nanospider technology uses two electrodes between which there is a strong electrostatic field. The first electrode has a cylindrical shape and by constant rotation creates a thin layer of polymer. By the electrostatic forces is on the second electrode pull out a thin layer [2].

In measurements were used two materials: the Chitosan on matrix of polyethylene and the Polyamide on matrix of viscose. Chitosan is a polysacharide occurring in shells of crustaceans, which is non-toxic and compatible with living tissue. It is used in a health care for faster healing of wounds or for production of artificial skin. Another use is in cosmetics, food industry, or for the treatment of wastewater. The second material Polyamide is made of petroleum. This material is very flexible and has high tensile strength. It is able to resist moisture very well but has little resistance to light and weather conditions [3]. Illustrative photography of nanotextiles made of polyamide is shown in Figure 1.

2. EXPERIMENTAL MEASUREMENETS

Nanotextiles made by Nanospider technology were inserted to the samples of tissue cultures of early spruce embryos, which were grown in the plastic Petri's dishes with the diameter of 50 mm. In each dish there was placed a cluster of plant tissue culture with a sample of nanotextile. The spruce embryos were selected for their rapid growth. The largest increase is till the fifteenth day then the growth is stabilized. The dishes of samples were placed in a dark place without the action of external lighting, at a constant temperature and humidity. All samples in the plastic Petri's dishes were divided into two main groups. At the first group of samples were applied thin layer nanotextiles with a circular shape (different diameters).The second group served as the controls and comparative samples. Distributions of all dishes with the samples are listed in the Table 1.

Table 1: Distribution of all dishes with the samples.

Nanotextiles	**Dishes with nanotextiles**			**Control dishes**
	Dishes 1–3	**Dishes 4–5**	**Dishes 6–7**	**Dishes 8–10**
Size	Diameter 50 mm	Diameter 30 mm	Diameter 50 mm	-
Type	Chitosan S PEO		PA 612	
Fiber diameter	100–350 nm		100–250 nm	
Basis weight	0,89 gsm		0,86 gsm	

All dishes were periodically withdrawn from the constant environment and moved in an isolated box through the outside environment into the room with nuclear magnetic resonance tomograph (NMR) to obtain images of the tissue culture. The measurement of nuclear magnetic resonance is gentle for the tissue culture, by which the cuts of images plant are acquired, without any deformation or destruction of the plant tissue culture [4]. The images from the NMR tomograph were obtained by spin echo method with parameters: $T_E = 18,35\,\text{ms}$, $T_R = 1\,\text{s}$. Individuals times were chosen to achieve the best image contrast. The size of the resulting images are 128×128 pixels and the size of operating point is 30×30 mm. Individual slices have a width of 2 mm and are spaced 2 mm. After the fifteenth day the last measurement in the NMR tomograph was done and all acquired images were processed according to the following diagram. A more detailed description of the image processing is given in the article [4].

After loading the NMR cuts in the program Marevisi, the images were reconstructed using the inverse Fourier transform to the resulting image. In the picture there were executed selections of individual clusters and subsequently were obtained information about the sizes of clusters in pixels. In Table 2 are given the total sizes (in pixels) of clusters of tissue cultures from all measuring days obtained by NMR methods. All is plotted in Figure 2. To assessment of cluster growth are all sizes expressed as a percentage and sorted from the lowest value (Table 3). The control samples are

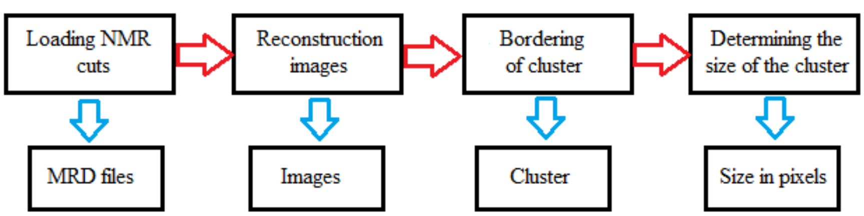

Figure 1: Diagram of evaluation of NMR images.

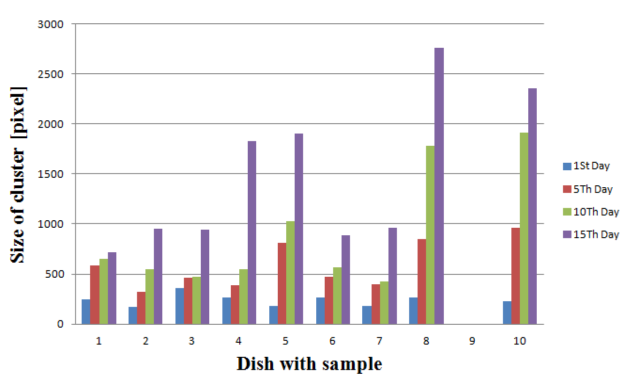

Figure 2: The comparison of the sizes of growth of all tissue cultures from all measurements.

Figure 3: Illustrative photography of nanotextiles.

Table 2: Data from measurements of tissue cultures.

Dish	**1st day**	**5th day**	**10th day**	**15th day**
	Size [pixel]	**Size [pixel]**	**Size [pixel]**	**Size [pixel]**
1	245	583	654	718
2	167	324	546	953
3	359	461	471	945
4	268	387	548	1831
5	184	810	1028	1908
6	263	475	569	889
7	184	396	423	965
8	263	853	1786	2765
9	154	0	0	0
10	229	958	1913	2358

Table 3: Cluster sizes sorted by percentage in two days.

5th day		**10th day**		**15th day**	
Dish	**Size [%]**	**Dish**	**Size [%]**	**Dish**	**Size [%]**
9	0	9	0	9	0
3	12,841	3	13,120	3	26,323
4	14,440	4	20,448	1	29,306
6	18,061	6	21,635	6	33,802
2	19,401	7	22,990	7	52,446
7	21,522	1	26,694	2	57,066
1	23,796	2	32,695	4	68,321
8	32,433	5	55,870	10	102,970
10	41,834	8	67,909	5	103,696
5	44,022	10	83,537	8	105,133

marked by red color. From Table 3 it can be seen that the majority of the control samples are in the lower part of the table, it means that the size has increased faster than for the other samples. Sample with No. 9 could not be further processed, due to necrosis of the sample. We can only assume that the dishes were poorly sealed and then an outdoor environment got to the inside.

During the last day of measurement the largest increase was recognized in samples No. 4 and No. 5, these are the samples in which nanotextiles made of the polysacharide was placed. While in the samples No. 6 and No. 7, (with nanotextiles made of polyamide) the mold appeared during the growth the tissue culture. It is possible that during the samples transport through the outdoor environments to the area with NMR tomograph these were influenced by outside light and temperature, because nanotextiles of this type is susceptible to the surrounding environment.

3. CONCLUSIONS

The tissue culture grew along with the sample of nanotextiles Chitosan or Polyamide. The best rated on the end measurements were the samples with Chitosan, which had the fastest growth compared to other samples. In other samples grew a mold that could get in by bowls leakage, or the tissue culture respond to nanotextiles. Sample No. 9 was eliminated during the first few days due to necrosis of tissue culture plates inside. Based on this measurement was designed by additional measurements that will be deal by removing the mold that arise Petri's dishes during the growth of tissue cultures. Because insertion the nanotextiles at different intervals are needed to eliminate the effects of molds. The mold is highly undesirable and cause necrosis or destruction of samples.

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