THE FUNDAMENTALS OF MUSHRROM FEEDING AND FARMING TECHNOLOGY DEVELOPMENTS

Nikodem SAKSON

Introduction

The changes in technology that ensure greater technical and economic efficiency are the conditions for an industry is the development in any given production. In recent years a clear standstill can be observed in the production of mushrooms. It is a result of a crisis in the satellite model for mushroom production in Europe. It is particularly evident in the Netherlands and even more so in Poland. It stems from the fact that in the satellite system it is difficult to create innovations without the help from the government, which cannot be commercialised directly and develop the mushroom production based on these innovations. The division of production at individual stages into sectors that function independently does not create conditions for development through innovation.

The exhaustion of the current system’s capacity to generate innovation based on current theoretical assumptions (a paradigm) has also its merits and it can be described as a controlled process of composting with the involvement of mushrooms (in oxygen conditions). The basic reason for this is the lack of new ideas for the development in technology in the production of mushroom substrate. This technology would ensure its stable yield and the opportunity to increase the use of substrate. The stagnation in mushroom farming cannot be disregarded, it does not offer strains of higher and better quality mushroom yield taking into account the current condition for substrate production technology and a more effective navigation of mushroom behaviour while cropping.

It does not mean there is no need for innovations. The economic situation of producers is constantly getting worse. The mushroom producers constantly need to aim at lowering the production costs. The decrease in profitability results from ever increasing production costs, however the price offered by stronger and stronger business retailers involved in mushroom trade is unchanged. Unless a more efficient solution is found to this problem, in the current situation the industry is threatened by the loss of profitability in a few years to come.

What conditions will decide upon the mushroom technology development in the nearest future?

1. The industrial development of mushroom production in the closed cycle with an introduction of an individual developmental policy and the use of your own funds on research and development and the capacity to generate innovations yourself.
2. The change in theoretical assumptions (the paradigm) into a new described as a control process for mushroom feeding or a different competitive process.
3. The method: a repetitive method to control the development process – the control of changes in the mushroom farming technology applied in an entrepreneurship and the evaluation of proposed changes. This method involves a repetitive mushroom farming technology development process through gaining theoretical knowledge of mushrooms, using it to build models of solutions and based on them – the creation of new effective technologies. The need for new technologies can in return stimulate the development of scientific research.

**Why is the technology development not noted? The limitations of current attitudes.**

It is not only the satellite system in its current form that is a limiting factor for the mushroom technology production development, but also the technologies used for substrate production. The limitation in the increase in yield is merely the composting process. The substrate prepared in the hot composting phase has a yield generating potential for the mushroom resulting from its sheer essence of its course which requires a necessary carbon to nitrogen proportion such as 30:1 and continuous access to oxygen. These determine the correct course. This means that the amount of nutrients available for mushrooms depends on the result of this process and the quantity of the substrate used and not the actual needs and capacity for mushroom cropping. The possible change in the C/N proportion interferes with the composting process, which leads to substrate production with a significantly lower yield generating potential. Apart from that, the technologies used nowadays do not allow for a full control of the substrate production process. This creates its significant inconsistency. It is also accompanied by the lack of knowledge on how to possibly standardise substrate prior to mycelium cropping so it will have a repetitive production potential. Looking from this perspective, the production of standard substrate is virtually unprofitable due to large inconsistency in raw materials as well as the costs of eliminating the influence of atmospheric conditions. Also, the knowledge on the composting process is still small or it is not transferable in practical work. Although it is true that the increase in yield can be achieved by using big doses of substrate as is done by the Americans (120kg/m2 of Phase II substrate allows for a yield on the level of 38kg/m2). This practice may lead to bigger yield but it usually means the decreased level of its use. Considering current substrate prices and energy costs, the increase in the amount of substrate is not profitable.

The situation on the supplements market is also not favourable. The supplements used so far are by definition products designed to enrich the substrate. Its aim is to supplement nutrients in the substrate in relation to the accepted standard. However the lack of suitable methods of identification results in the fact that the supplements are applied routinely regardless of the substrate characteristics. Nutrients, mainly protein, are produced in two different types depending on the type of substrate for which they are used. The difference is in the dose if formalin used. The higher dosage (6000ppm) is used for supplements in Phase II substrate and the lower (3000ppm) in Phase III substrate. The available literature indicates that the effectiveness of using the supplements in Phase II is significantly lower.

When analysing the composition of supplements, the knowledge about them nowadays and the production practice, a conclusion can be drawn that they have not fulfilled their role or only to a limited extent. It results from the fact that when they were used for the first time about 30 years ago the achieved yield was the effect of the fact that the substrates compared to today’s standards were poor and the yield low. Currently the substrates produced now are much richer which makes their effectiveness nowadays relatively small. They cannot be used in higher dosage than up to 1.75% of the substrate mass in Phase III. This results in high increase in temperature in substrate that accompanies larger and larger dosage of supplements above their recommended share in the substrate. This increase may lead to overheating of the substrate and a substantial decrease in yield. The question whether we can interfere with the composition of substrate if it is fully colonised by the mushroom mycelium is a separate issue. In this situation we need to ask a fundamental question – what is the sense of using protein supplements? The primary assumption supplementation refers to making a change to the substrate composition and should be carried out until the start of the pasteurisation and growing process. However from the moment the mycelium colonises the substrate we should use a term such as feeding. In this situation it is easy to explain the low effectiveness of the use of protein supplements. Their role is to change the C/N ratio by the increase in nitrogen share which can be obtained from HP soya or other protein balanced to the value of 46-48% regardless of the mushroom digestibility. The impact of protein diet on the development of green competitor mould should not be disregarded. It can be assumed that the presence of the extra protein from the supplement and the increase in substrate temperature may favour the growth of green mould. It is a different species from the mushrooms and the main way to reduce its growth in substrate should be an energetic diet easily absorbable by the mushrooms.

The main characteristic of the supplements used nowadays is the focus on using soya. Even when making changes in the supplement composition which was caused by the price increase and the GMO problem, the introduced new components should ensure that protein at an accepted level would be present in its composition. As a substitute meat and bone meals were temporarily introduced as well as cruciferous plant meal. The use of bone and meat meals to produce food was questioned between 2012/2013. No other solutions were explored in spite of the fact that in “The Mushroom Cultivation (1988)” you can find a long list of other products that can fulfil the role of supplements and which come from plants found in Europe such as corn, potato, wheat, sunflower, sugar beet.

The next factor is the availability period for the mycelium in the process of mushroom feeding. Supplements by definition are to work with delay, which is why they are treated with formaldehyde. The same effect can be achieved by heat treatment and carboxylic acid salt. However their actual mycelium digestive period is short; from the application of casing till the end of shock. Consequently, the impact on yield in the first and second flush is limited.

However the main cause of dissatisfaction with the currently used technologies is the lack of progress when it comes to yield. The average higher yield rarely exceed 32kg/m2 and it is only provided that the yield in the first flush is high and usually a higher than usual fill rate of substrate is used which is more than 85kg/m2 of substrate in Phase III. Although there are technical conditions available to achieve yield in the amount of 20 – 25kg/m2 in each flush, then in every subsequent flush it is usually lower. For example, the yield of 30kg/m2 is divided into flushes of 15, 10 and 5kg/m2. This means that the substrate use is between 30-40%, and the desired maximum is 50%. The fact that in subsequent flush the achieved yield can be about 5kg/m2 means that the amount of nutrients absorbed during the enzymatic decay – the growth of mycelium are too small to achieve higher yield. There is a lack of biomass whose amount in the substrate does not exceed 2% of its dry mass. This creates a need to provide extra nutrients into the substrate that will be responsible for the yield increase especially in the second and third flush.

The significant part of the substrate is still removed beyond the system of its production, regardless of the level of its use. As waste it should be considered as a part of the mushroom diet. The substrate that is not used after the cultivation is finished, especially after two flushes, seems to be a very interesting diet because of its composition and more importantly its selectiveness for the mushroom.

The analysed limitations do not allow for further increase in yield and the effectiveness of substrate use when considering ever growing substrate as well as mushroom production costs. The further development may ensure a new attitude for the mushroom yield navigation process.

**The change of the paradigm**

The current attitude towards mushroom production can be defined as a controlled composting process with the use of mushroom. There is a suggestion to change this into a new definition which would involve a controlled process of mushroom feeding. With the adoption of this definition the mushroom is in the focal point of the production process. This means that the feeding, growth and development control methods is dependent on the mushroom needs as well as the amount of planned yield, range and the qualities of fruiting bodies that are going to be achieved in the process of cultivation. The activities carried out during production and ensuring the increase in yield and better quality of fruiting bodies are at the essence of the changing attitudes.

1. The use of supplements containing carbohydrates as an ingredient for the energy increase necessary for the mushroom survival as saprophyte mushroom.
2. Mushroom feeding through the use of nutrients in the casing.
3. The use of nutrients in a liquid form.
4. The initiation and control of the mushroom feeding cycle process in flushes.
5. The counteraction for the limitation of pin growth through the change in the cultivation conditions.

An important cultivation activity that is directed to the change of attitudes are some promising effects of compost use after the cultivation is finished, the compost is treated as a valuable source of food for the mushroom.