OYSTER MUSHROOMS CULTIVATION ON WATER LILIES

Waterschap Aa en Maas

Interreg North-West Europe
Carbon Connects
European Regional Development Fund

VERBRUGGEN PADDESTOELEN

VAN DE CROMMERT
PROJECTS &
INNOVATIONS

Contents

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Introduction

A large part of the management area of the Aa en Maas water board consists of high sandy soils. Due to climate change, this area is struggling with drought. Long drought periods and peak precipitation occur more frequently. The water authority wants to use measures for drought relief and water storage to set up the best possible water management for entrepreneurs, residents and nature.

Part of the project is a farm-scale test, in which bulrush is used as an alternative substrate for organic oyster mushroom cultivation, partly replacing wheat straw. The consequences for the production process and the yields are examined. The company Verbruggen Paddestoelen, with branches in Erp and Uden, is an important project partner in order to close the small cycle in North Brabant as a potential customer.

Purpose

Within this exploratory trial, the main aim is to investigate the effects of the bulrush on the oyster mushroom fungus. In other words, do oyster mushrooms grow on a substrate made of bulrush. The reason for this is that earlier tests by the WUR show that oyster mushrooms do not always thrive on substrates of water plants. The hypothesis is that these plants have developed a natural defence against fungi because they are in the water.

In addition to this test of principle, it is important to look at the extent to which contaminants accumulate in both the bulrush and the oyster mushrooms. Both organisms are known for the fact that contaminants such as heavy metals accumulate in the product.

Implementation

In order to be able to perform a good comparison test with existing substrates, the bulrush should be delivered sufficiently dry to Verbruggen Paddestoelen. The ideal moisture content is between 15 - 20%. Subsequently, a substrate is made from the lisbon fibre based on the expertise of Verbruggen Mushrooms. This substrate is pasteurised in the existing plant and grown in a climate cell together with a standard biological substrate.

During this process, the steps are recorded and it is possible to evaluate how the substrate compares to other substrates. Because the trial is carried out on a small scale, no statement can yet be made about the final product efficiency of the bulrush substrate.
In addition, an estimate can be made of the purchase price for the bulrush in relation to the reference wheat straw on the basis of these processes.

Research questions

Ultimately, this exploratory project will answer the following research questions:

1. Does an oyster mushroom fungus (Pleurotus) develop on a substrate of dry irrigated fibre?
2. Are oyster mushrooms grown on islet substrate suitable for human consumption?
3. What yield price for the bulrush can be realised based on the first product yields?
4. Based on this exploratory study, what are useful next steps?

Project report

In order to test the oyster mushroom substrate made from bulrush, it is important that in the first instance the material is delivered sufficiently dry. In this way, remaining plant juices and other moisture have no negative effect on the development of the oyster mushroom fungus. Unfortunately, it was not possible to supply the bulrush fibre sufficiently dry. A first test showed that the product had a moisture content of approximately 80%. The main reason for this was the large amount of snow and ice that was still present in the product.

After consultation with Aa and Maas, it was decided to dry the bulrush in two batches. The first batch of product was sent without further processing to Bouwgroep Dijkstra Draisma, who use the bulrush fibre as alternative insulation in house construction. The second batch of bulrush was first reduced in size and then dried. Part of this bulrush was delivered to Kompetenzcentrum 3N, which is investigating whether the fibre is suitable as a substitute for peat in potting soil. The remainder is used by Verbruggen Paddestoelen as oyster mushroom substrate.

Below is a schematic representation:

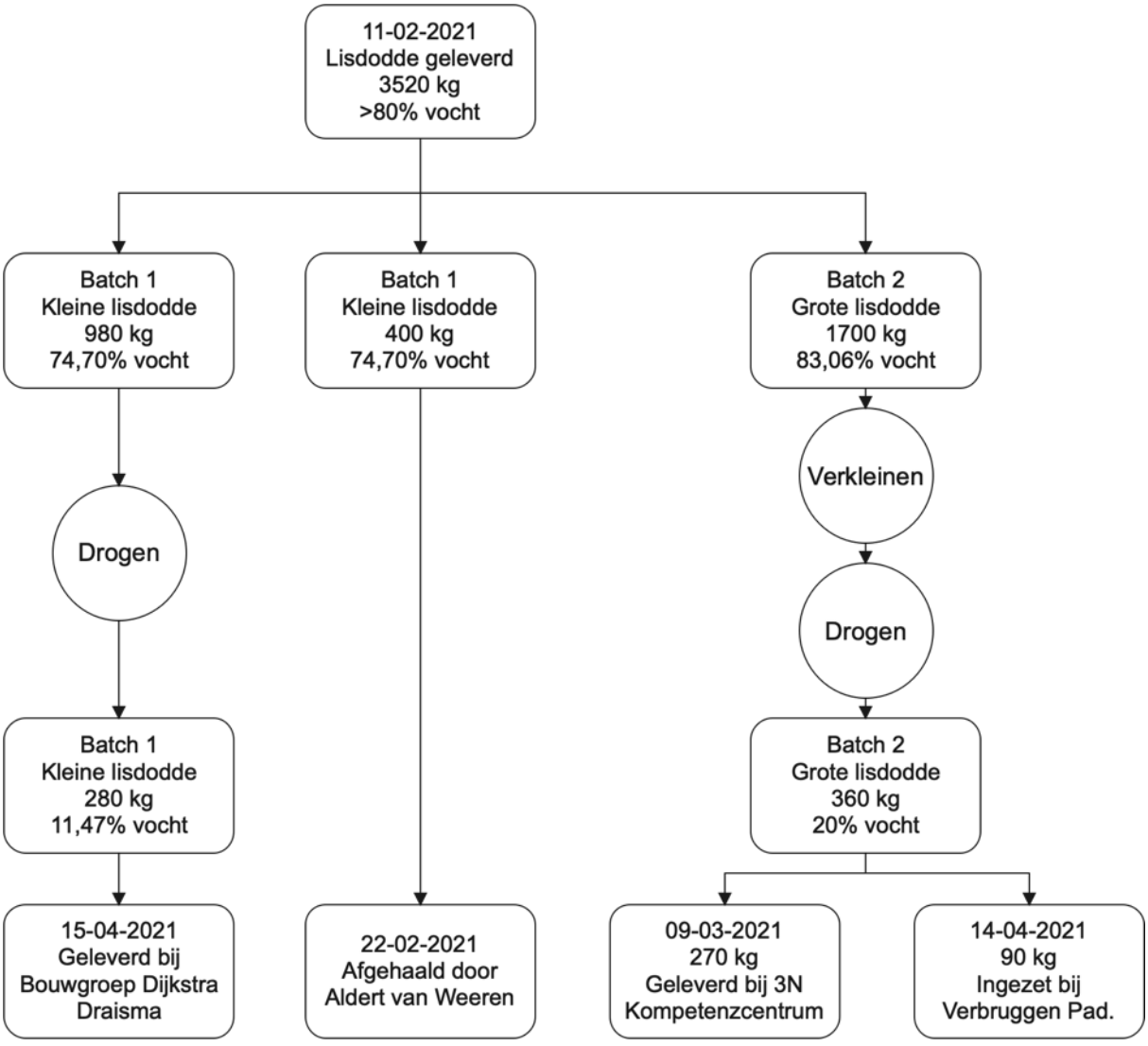

Figure 1 - Schematic representation of product flow

Pre-treatment

Drying

In order to get the bulrush sufficiently dry for further processing, a drying installation was used in which the bulrush was dried using sustainable heat. The delivered material consisted of two batches, which were also dried separately. The last batch has been reduced in size before drying, more about this in the next paragraph.

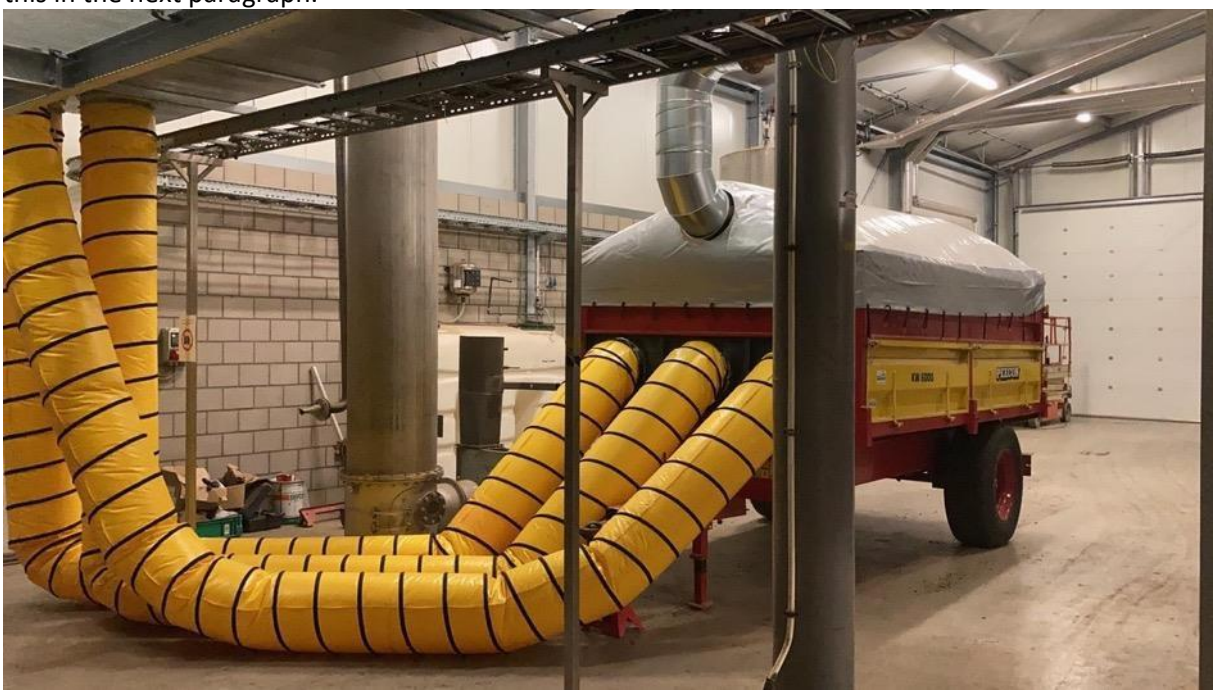

Figure 2 - Mobile drying container with sustainably generated heat

Figure 3 - Leakage of snow

Reduce

During the sampling, it appeared that the product after reduction had a nicer structure than the dry, non-reduced product. Below are two pictures to illustrate this. On the left picture the bulrush shredded in its dry state; a lot of dust and no homogeneous mixture. On the picture on the right, the bulrush shredded when still wet; a nice homogenous mixture with a loose structure.

Finally, the hammer mill that is normally used to shred wheat straw was also used to shred the bulrush.

Figure 4 - Dry reduced bulrush Figure 5 - Wet reduced bulrush

Figure 6 - Downsizing on an industrial scale

Substrate production, cultivation and harvesting of oyster mushrooms

To be able to make the right quality oyster mushroom substrate, some steps are necessary, mainly realising the right moisture content and the effective pasteurisation of the mixture by means of temperature. Below a process description by means of pictures.

Step 1 - Moisture levels

A sample of the material is taken beforehand and the required moisture is added on the basis of this sample. A homogeneous mixture is then created in a mixing installation, where it is important that the material actually absorbs the moisture. After this step, the mixture is packed in small ventilated bags to ensure a smooth pasteurisation process.

Figure 7 - Bulldog fibre at the right moisture level

Step 2 - The pasteurisation process

The bags are placed in a separate cart in the pasteurisation tunnel, separately from the other substrate. In this way, we can be sure that both flows are not mixed up. By controlling the climate in the tunnels in this way, a situation is created in which the substrate is pasteurised.

Figure 8 - The bulrush mixture in the pasteurisation tunnel

Step 3 - Inoculation of the substrate

After the pasteurisation step, the sterile substrate is inoculated with the oyster mushroom fungus. This mould then has a head start on the other spores present in the substrate, and will therefore develop best under the right conditions. Immediately after grafting, the substrate is packed in a package, on which the oyster mushrooms will grow later.

Figure 9 - The bulrush substrate in the stock hopper and producing the packets

From the 90 kilograms of dry bulrush fibre at the beginning, 220 kilograms of substrate was eventually made, divided into 18 packages. The package weight is slightly lower than for a straw substrate, but this can be explained by the different structure of the material.

Step 4 - Growing the substrate

In this phase, the substrate is placed in a cultivation cell and the right climate is created to allow the fungi to develop properly. In this case, the 18 packages of bulrush were placed in a standard cell, and underwent the same treatment as the packages on standard straw substrate.

Figure 10 - Packages in standard cell during the growth phase

Step 5 - Harvesting the oyster mushrooms

About 18 days after the parcels were placed in the cell, the first budding took place. Another 5 days later, the first oyster mushrooms were picked from the parcels. This development is similar to the parcels with standard straw substrate. At first glance, the yields of the oyster mushrooms seem to be roughly the same as those of the standard substrate, but because only a very small trial was done, no significant statement can be made about this.

Figure 11 - Budding and further development

Figure 12 - Ready for harvesting

Sampling and accumulation of harmful substances

Because both bulrush and mushrooms have the characteristic of accumulating harmful substances, it was decided to take a sample of the material at various stages of the process. In this way, it can be determined whether the cultivated oyster mushrooms may be sold for human consumption.

Sampling of bulrush

From the field, two samples of isopod were delivered to Verbruggen Paddestoelen. It was decided to analyse both samples for pesticides and heavy metals. The table below shows the results of this analysis. It can be seen that no pesticides were detected in the material and that the values for heavy metals are below the maximum residue limit (MRL).

	Greater Bulrush (mg/kg)	**Lesser broad-leaved daffodil (mg/kg)**	**MRL EU (mg/kg)**
Pesticide (LC-MSMS)	-	-	
Heavy metals (ICP-MS)			
Arsenic	<0,02	0,12	
Cadmium	0,031	0,039	
Chrome	0,44	1,1	
Copper	3,1	4,0	20,0
Mercury	<0,01	<0,01	0,05
Lead	1,2	1,8	
Nickel	0,35	0,58	
Zinc	15	14	

Sampling oyster mushrooms

Based on the sampling of the bulrush, it was decided to analyse the oyster mushrooms for heavy metals only. The table below shows the results:

	Oyster mushrooms on bulrush (mg/kg)	**MRL EU (mg/kg)**
Arsenic	0,19	
Cadmium	0,012	0,2
Chrome	<0,02	
Copper	0,72	20
Mercury	<0,01	0,05
Lead	<0,01	0,3
Nickel	<0,05	
Zinc	5	

None of the measured values exceeds the applicable MRL. It can even be seen that the oyster mushrooms have a lower value compared to the pure bulrush. To make a definitive statement on this, additional research is necessary. This sampling shows that the oyster mushrooms in any case meet the applicable requirements and are therefore suitable for human consumption.

Results

The aim of the project was to be able to answer the following research questions;

1. Does an oyster mushroom fungus (Pleurotus) develop on a substrate of dry bulrush fibres?
2. Are oyster mushrooms grown on islet substrate suitable for human consumption?
3. What yield price for the bulrush can be realised based on the first product yields?
4. Based on this exploratory study, what are useful next steps?

Does an oyster mushroom fungus (Pleurotus) develop on a substrate of dry bulrush fibres?

This project shows that an oyster mushroom fungus can develop on a substrate made of dry bulrush fibres. In this experiment, the bulrush fibres were first dried to a moisture content of 20%, so for this situation this question can be answered in the affirmative. However, it is hypothesised that with a wet substrate, the remaining plant sap has a negative result on the development of oyster mushroom fungus.

Are oyster mushrooms grown on islet substrate suitable for human consumption?

The chemical analysis of the oyster mushrooms shows that the oyster mushrooms from this trial are suitable for human consumption. The analyses show that there is no undesirable accumulation of heavy metals.

What yield price for the bulrush can be realised based on the first product yields?

Assuming that the substrate based on bulrush has the same yield as the standard straw substrate, this also automatically means that the dried bulrush fibre can be purchased for the same price as straw. In practice this means that the reference prices below can be used. Condition for this is that there are no contaminants in the product, and that no chlormequat and mepiquat is used during the cultivation.

Reference prices and specifications		
Wheat straw supplied OOS*	115	[€/tonne]
Wheat straw delivered IS**	75	[€/tonne]
moisture content wheat straw	15	[%]
density on delivery	185	[kg/m3]

* OOS = out of season (October to March)
** IS = in season (April to September)

Based on this exploratory study, what are useful next steps?

Within the scope of oyster mushroom cultivation on a liana substrate, there are in principle several follow-up steps to be defined. This research shows that it is possible to grow oyster mushrooms on dry islet fibre. However, it is also known that the drying costs are so high that the reference prices that can be paid are not sufficient to cover these costs.

A possible next step could therefore be to set up research to determine what the maximum moisture content could be for successful cultivation. This would be done using the existing harvesting and processing techniques. If, for example, a maximum moisture content of 30% would still yield sufficient results, the crop could be harvested during a frost period. At that moment, with few costs, a yield could be obtained from the plot.

Another approach is to develop a technique in which the bulrush is delivered wet, but processed in such a way that it can still be processed. This requires a different pasteurisation technique, which is currently still in the development phase. Oil samphire could be one of the raw materials to test this technique on a larger scale.

Conclusions and recommendation

Oyster mushrooms can be grown on a substrate of bulrush, provided that it meets the stipulated condition of a maximum of 20% moisture. To be able to make a statement at higher moisture levels, more extensive research is necessary.

Why is it interesting to look at bulrush in oyster mushroom substrate; with the help of this application, a guaranteed market can be developed and the basis for markets with a higher gross yield of the product can be laid. In this way, a start can be made on the cultivation of bulrush in areas with an increased water level.