Biobaserede vækstsubstrater til planteproduktion (BioSubstrate)

Afrapportering af projektleverancer fra arbejdspakke 4 og 5 i GUDP-projektet, 2019-2021.

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Leverancer fra arbejdspakke 4

M4.1 Screening af første-runde vækstmedier afsluttet og de mest lovende kombinationer af biomasse og processering udvalgt

The first-round screening of 25 new substrates using both lab and greenhouse assay was investigated in 2019. In total, 25 new substrates developed from a variety of biomasses and residual products from bio-based productions were used for the first-round screening (Figure 2). The substrates were sampled, weighed and mixed with distilled water to obtain 100% extract. The 100% extract was diluted with distilled water to yield 66% and 33% extract. In vitro germination and root elongation for the lettuce seeds incubated in 100%, 66% and 33% extract was determined (Figure 1).

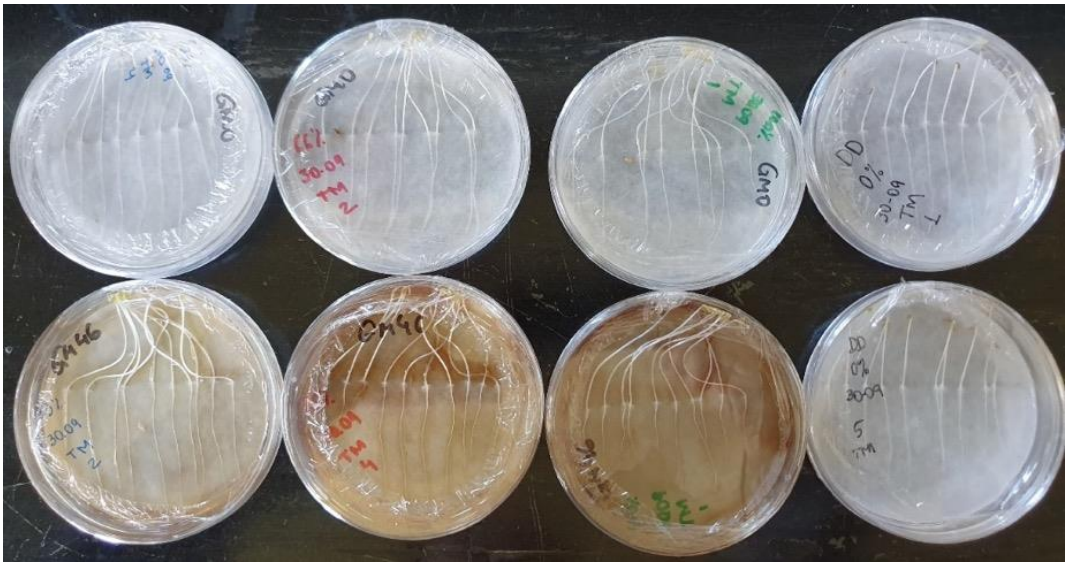

Figure 1. In vitro assay for screening for phytotoxic compounds. The extract was obtained by mixing 2:1 parts of distilled water and substrates. The mix was further diluted. Lettuce seeds were incubated in four different concentrations 100%, 66%, 33% and 0%.

Meanwhile, a pot trial was conducted. The 25 substrates were mixed with Pindstrup 1 (control) to form the 66% and 33% original substrates. In total, 75 substrates were used to incubate the lettuce, Chinese cabbage and cress to test the plant growth. The pH and electrical conductivity and nutrient composition of the 25 substrates was detected by Eurofins Agro, Wageningen, The Netherlands. Even though the problem of delayed seed germination and root elongation and decreased biomass accumulation were shown in the majority of the newly developed substrates, we successfully found three potentially good candidates with no detrimental effects as compared with control in both lab and greenhouse test. The substrates No.2, No.3 and No.4 made from willow chips with 66.67% control showed as good seed germination and biomass accumulation as control. This indicated the possibility of willow chips to partially replace peat. We also found that a positive effect of dilution was observed regarding both lab and greenhouse assay.

Figure 2. Pictures of the different tested new biosubstrates.

M4.2: Screening af anden runde vækstmedier afsluttet

In the second round of screening for new biomasses, a total of 28 new materials were developed from a variety of biomasses and residual products through different processing methods. The commercial sphagnum peat medium, Pindstrup 1 (Pindstrup Mosebrug A/S, Ryomgaard, Denmark), was used as control. In order to test their performance, each new material was tested as a stand-alone medium (peat-free) or with partial peat replacement (Figure 3). The following

three mixture ratios were tested: 100% new material (100%), (2) 66.67% new material + 33.33% control (v/v) (66%), and (3) 33.33% new material + 66.67% control (v/v) (33%).

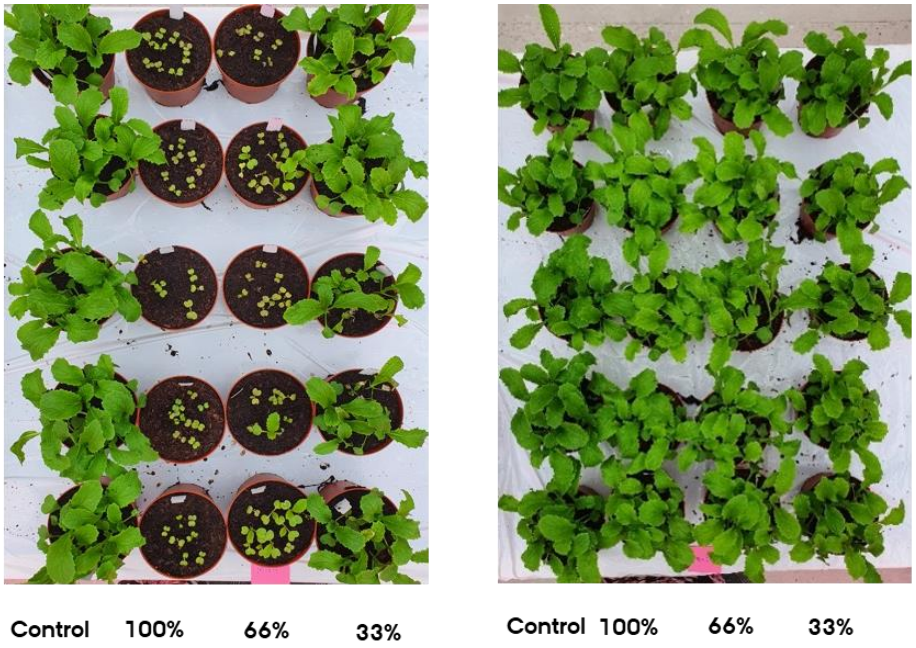

Figure 3. Example of two different tested biosubstrates. The new substrates were tested against control (peat-based substrate), as stand-alone (100% GM) or as partial replacement for peat in dilutions of 66% or 33% with peat.

Different sources of Nitrogen fertilization were also tested for materials with a high C:N ratio (both organic and inorganic). The stand-alone material nutrient composition, pH and EC was analysed by Eurofins Agro, Wageningen, The Netherlands. At the end of the screening trials, different types of materials showed the potential to partially replace peat: willow compost, biogas fibre, bark fibre and a blend of willow compost and extruded wood fibres (Figure 4). We could show at the screening experiments that different biomasses could replace between 33 to 66% of peat in growing media blends in trials with Chinese cabbage as a species.

Figure 4. Photos from different pot trials showing the performance of the different biosubstrates as a stand-alone or as partial replacement of peat.

M4.3 Vækstmedie(r) til demonstration i jordbær fastlagt

Based on our first-round screening, we selected the most promising substrates for testing in the strawberries cultivation. Overall, different blends made out of composted willow and wood fibre were tested.

Crops were cultivated simultaneously at the facilities of the Department of Food Science of Aarhus University and at Hunsballe Grønt.

Six different growing media were tested against control and the aim of the trial was to replace a minimum of 50% of peat in the blends.

M4.4: Vækstmedier til kontrollerede dyrkningsforsøg og demonstration i krydderurter og småplante-produktion fastlagt

Based on the second-round screening, we selected the most promising substrates for testing in on herbs and cutting cultivation. The new substrates biomasses originated from different

blends made out of composted willow and wood fibre. The blends tested were designed to replace 70% of peat in the cultivation.

M4.5: Kort rapport om fysisk og kemisk karakterisering

Biomasses, which showed promising results during the screening trials, were tested in the demonstration trials. Wood fibre and willow compost were tested either in blends or as stand-alone growing media. The different blends were tested for their physical and chemical characteristics and compared with the commercial growing media during the growth of strawberries. The crop was chosen to evaluate the performance of the new media during a round year crop. The plants of strawberries were transplanted during early summer of 2020 and kept until summer of 2021. Two seasons production were evaluated. The substrate volume added to the pot was recorded at the beginning and end of the cultivation. Electrical conductivity (EC), pH were monitored for changes during the growing season, by collecting the leached irrigation water from 3 different pots of each growing media. Chemical analysis were done for each of the growing media by Eurofins Agro, Wageningen, The Netherlands at the beginning of the season. Six different growing media were tested against control (commercial strawberry growing media); two stand-alone (1- willow composted with 20% of chicken manure, 2- willow composted with grass (50/50% volume)); and 4 blends (3-50/50% of willow composted with 20% of chicken manure and control, 4-50/50% of willow composted with grass mixed with control, 5- 50/50% willow composted with grass mixed with peat; 6- 50/50% of wood fibres mixed with peat). Evaporation curves and bulk change analysis were also conducted.

Regarding the chemical characteristics at the start of the cultivation, pH and EC varied among the tested growing media. In general, the stand-alone growing media presented a high pH level (above 7.0) and moderate high values of EC. The addition of peat (50%) reduced pH and EC in the blend of willow composted with grass (5) compared to the stand-alone (3), presenting values similar to control. The blend of wood fibre and peat (6) presented similar values to control regarding both pH and EC. The blend with commercial control growing media and the different composts presented moderate high pH (above 6.3) and moderate high EC (0.8 mS/cm) (Figure 5). During cultivation however, EC and pH tended to stabilise at the same level for the all the growing media tested after about 45 days.

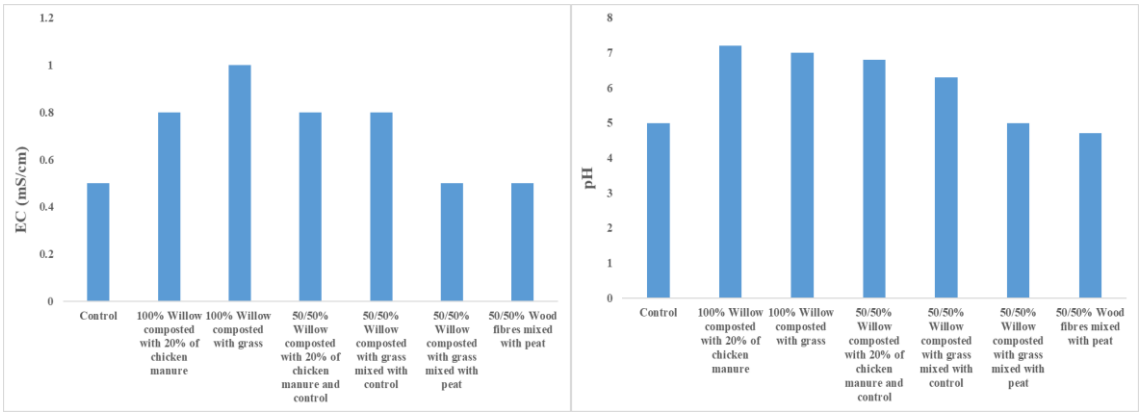

Figure 5. Difference in Electrical conductivity (EC) and pH among the tested substrates.

Regarding physical characteristics of the growing media, at the beginning of the cultivation evaporation curves were done to understand water-holding capacity. Overall, blends behave in a similar way as control meaning that evaporation rate did not differ, while the two stand-alone growing media presented a much higher water holding capacity, meaning that the evaporation was slower compared to control. When we looked at changes in the bulk density similar result were observed, while the blends behave similar to control, the stand-alone growing media willow composted with chicken manure presented a high degree of compaction. At the end of the cultivation, a higher degree of compaction/shrinking was also observed for the stand-alone willow composted with 20% chicken manure, while the grass and willow compost and the blends between the two stand-alone and control (3 and 4) showed moderated shrinking when compared to control. The two remaining tested blends (5 and 6) presented a lower shrinking degree than control (Figure 6).

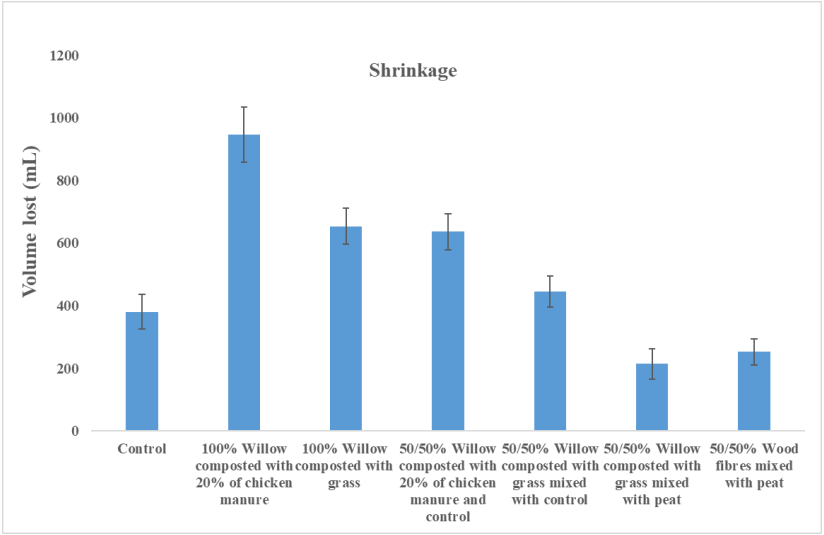

Figure 6. Volume reduction for each tested substrate after a year of strawberry cultivation.

Leverancer fra arbejdspakke 5

M5.1: Resultater fra dyrkningsforsøg dessimineret
M5.2: Resultater fra demonstration i jordbær formidlet
M5.3: Resultater fra demonstration i krydderurter formidlet
M5.4: Resultater fra demonstration i småplanteproduktion formidlet

New biomasses, which showed promising results during the screening trials, were tested in the demonstration trials in order to ensure a fast transfer of the knowledge developed during the project. Different crops were grown with the new biomasses as stand-alone (peat-free) or as a blend with peat. Overall, different composts made out of willow and wood fibre were tested. The blends tested were aimed to replace between 50 to 70% of peat in the cultivation. Crops were grown simultaneously at the facilities of the Department of Food Science of Aarhus University and at the partner nurseries of the project. Strawberry was chosen to evaluate the performance of the new media during a long-term crop; basil was chosen to evaluate the performance of the new media under organic cultivation and; geranium and salvie were chosen to as conventional horticultural crops.

In the strawberry trial, six different growing media were tested against control and the aim of the trial was to replace a minimum of 50% of peat in the blends. Growing media with 100% of the new material (peat-free) did not performed well during this trial, with a reduction in the yield of average 90% in the first year and 40% in the second year. However all the blends tested with a replacement of 50% of peat yield as much berries as the commercial growing media used as control. All blends containing 50% of new biomasses (willow composted with 20% of chicken manure, willow composted with grass, and wood fibre) yield similar number and weight of berries as control, showing that the new material selected in this project has the potential to replace 50% of peat in a commercial production of strawberry (Figure 7).

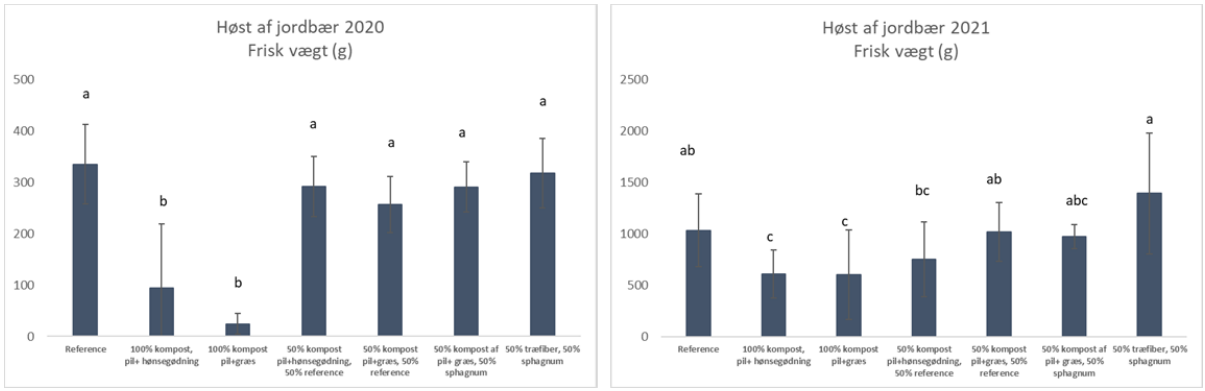

Figure 7. Total harvest of strawberries in 2020 (left) and 2021 (right).

For the organic herbs trial, basil was cultivate in six different growing media consisting of 3 stand-alone (peat-free) and 3 blends containing 30% of peat. In this trial we aimed to replace 70% of peat in the cultivation of herbs. The biomass used in this trial was willow processed in different ways. The stand-alone tested were willow composted with grass; a blend of willow composted with grass and willow fibres and traditional willow compost. The blends consisted of the three above mentioned growing media mixed with peat in a proportion of 70:30%. The stand-alone media performed the worst in this trial with a reduction in basil biomass accumulation between 40% to 70% when compared to control. Out of the six tested new media, two blends yield fresh biomass similar to the commercial control (the mix of willow composted with grass and peat and; the mix willow composted with grass, willow wood fibre and peat). The new materials selected in this project showed the potential to replace up to 70% of peat in a commercial production of basil (Figure 8).

Figure 8. Basil plants grown in different types of substrates.

For the demonstration trial of conventional pot plants, two species were tested: geranium and salvie. Similar to the herbs demonstration, we aimed to replace 70% of peat in the growing media blend. Therefore, seven different new growing media were tested, consisting of three stand-alone (same used in the herbs trials) and four blends containing 70% of the new material and 30% of peat. Likewise to basil and strawberry trial, the stand-alone (peat-free) growing media did not performed well, reducing biomass accumulation in geranium and salvie between 50 to 60% and 40 to 70%, respectively. However, all blends tested (replacing 70% of peat) performed similarly to control in geranium showing a similar biomass accumulation (*Figure 9*). For salvie, two different blends yield similar to control (a mix of willow composted with grass, wood fibre and peat). In pot plants demonstration trial, we also could show that the new biomasses screened in this project have the potential to replace 70% of peat in a commercial production setup.

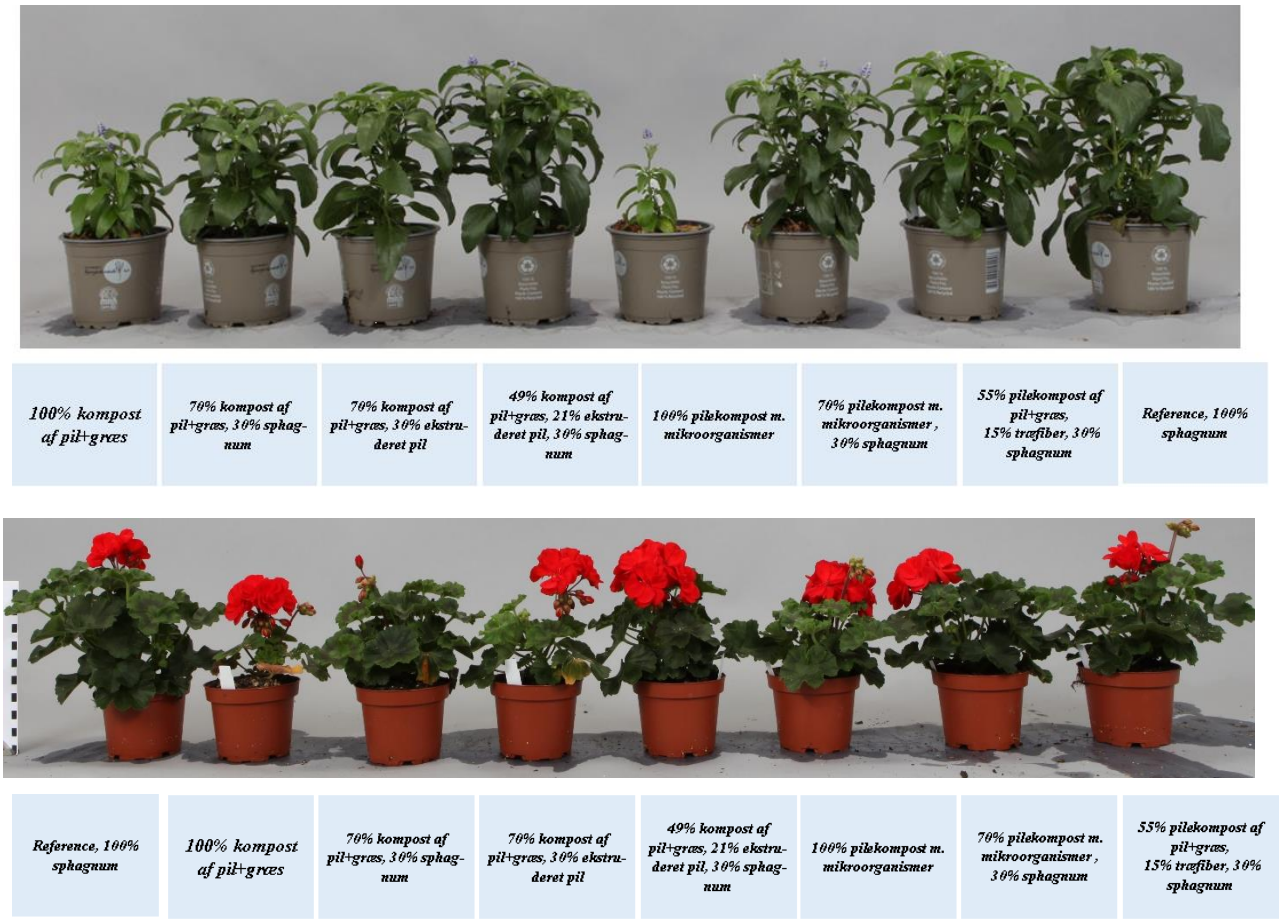

Figure 9. Salvie (top) and geranium (bottom) plants grown in different types of substrates.