# DELIVERABLE REPORT

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| **Grant Agreement number:** | 289843 |
| **Project acronym:** | GRATITUDE |
| **Project title:** | Gains from Losses of Root and Tuber Crops |
| **Funding Scheme:** | Seventh Framework Programme |
| **Date of latest version of Annex I against which the assessment will be made:** | 2011-11-15 |
| **Deliverable Number:** | D4.1 |
| **Deliverable Title:** | Development of methods for growing mushrooms from the waste from cassava peel |
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## 1. Summary

Cassava and yam are important food security crops for approximately 700 million people in the world. Post-harvest losses however are significant and come in the three forms: (a) physical; (b) economic through discounting or processing into low value products and (c) from bio-wastes. This GRATITUDE project aims to reduce these losses to enhance the role that these crops play in food and income security. There are 3 impact pathways: (a) reduction of physical losses – focusing on fresh yams storage, (b) value added processing reducing physical and economic losses in yam and cassava and (c) improved utilisation of wastes (peels, liquid waste, spent brewery waste) producing products for human consumption including snack foods, mushrooms and animal feed. The work has been divided into 7 work packages. This report focuses on work package 4.

The general objective of WP4 is to generate value added products from the wastes arising from cassava and yam value chains. The work package requires technical knowledge and expertise that would result in practical applications to increase food security at the low level of technology and at a higher level, increase business opportunities and reduce the damage done to the environment by providing new solutions to use the wastes. The aim of this work package is to expand/open new market opportunities for new products and added valued products generated from the waste of cassava and yam. Methods would be developed to utilize cassava and yam peels/leaves for mushroom production.

## 2. Key Findings

- Vegetative growth of eight MES strains on prepared substrate media
  - Best growth of five MES strains (*P. ostreatus* MES 11797, 03416, 03364, 03216 and *P. florida* MES 03772) after seven days of incubation occurred on both cassava peel and yam peel agar.
  - The morphological characteristics exhibited by the MES strains on both cassava peel and yam peel agar was rhizormorphic in nature.
- Substrate formulation experiments
  - A combination of composted cassava and composted/fresh sawdust in a 1:1 ratio supported the best total fruit body yields for the cassava strains used.
  - Supplementation of cassava sticks with sawdust either composted/fresh improved the yield of EM-1 on cassava sticks
  - Supplementation of cassava sticks with composted cassava peels decreased cassava sticks' ability to support EM-1 fructification.

## 3. Deliverable Objectives

To develop methods for growing mushrooms from the waste from cassava peel

## 4. Background

Large volumes of agricultural wastes which are mainly ligno-cellulosic in nature are available in most farming communities. These are either disposed of by burning or are left to rot on farms thus posing a hazard to the environment and human health. One way of combating this menace is to use these wastes as substrates for cultivating mushrooms. The cultivation of mushrooms converts these organic materials into edible biomass which is generally accepted as food of high quality, flavour and nutritive value. Apart from mushrooms utilizing these substrates, the spent substrate after production can also be used as feed for animals and fertiliser for growing crops. The substrate that is mainly used in the cultivation of the oyster mushroom in Ghana is composted sawdust of *Triplochiton scleroxylon* locally known as "wawa" with cotton waste and banana leaves being used for the oil-palm mushroom. Due to the problem of deforestation, it is important that substrates other than sawdust are developed for the cultivation of mushrooms. Agricultural wastes and residues like root and tuber peels, straw and stover from wild grasses, rice, maize, millet, sorghum and its products are potential substrates for cultivating mushrooms.

Earlier studies on the use of cassava for growth of mushrooms recorded very low yields due to the methods use. Thus this project seeks to use other substrate treatments and determine the efficiency of using cassava wastes (peels and sticks) as substrates for growing the oyster mushroom using the plastic bag method in Ghana.

# 5. Methodology

***5.1 Mushroom cultures used***

***5.1.1 Control mushroom cultures***

Cultures of *Pleurotus ostreatus* (Jacq.ex.Fr.) Kummer strain EM -1 originally from Mauritius and maintained on Malt Extract Agar slants were used to prepare sorghum grain spawn (Oei, 1991).

***5.1.2 MES mushroom cultures***

Sixteen mushroom cultures received from Plant Research International, Wageningen comprising of 8 strains of *Pleurotus ostreatus* species, 4 strains of *Lentinula edodes*, and a strain each of *P. citrinopileatus*, *P. eous*, *P. florida* and *P. eryngii* were cultured on both Potatoe Dextrose Agar and Malt Extract Agar. Daily mycelial growth rates were recorded till full colonization on the Petri plates. These were subsequently used for experiments on mycelia growth rates on cassava peel agar, yam peel agar, cassava sticks agar and sawdust agar.

***5.2 Compost preparation, bagging and incubation***

In the period under review, three substrate formulation experiments were carried out:

1) Freshly milled dried cassava (*Manihot esculenta*) from a single variety of cassava (*Afisiafi*-local name) was used in various formulations with sawdust of *Triplochiton scleroxylon* in fresh and composted forms in the preparation of the compost bags

2) A repeat experiment involving a mixture of cassava strains *Afisiafi* and *Bankye Hemaa* (local names) was also set up

3) Freshly dried and milled cassava sticks

were used for preparation of bags.

In the first two experiments compost was prepared by the outdoor single-phase solid waste fermentation and mixtures used are as described by Obodai *et al*. (2002). The mixtures were stacked into a heap of about 0.5m high and 0.5m wide at the base and left to compost for

28 days with regular turning every 4 days. Every fourth day before turning, samples of the compost were adjusted to approximately 68 - 70% (Buswell, 1984).

On day 28 various treatments were used with sawdust of *Triplochiton scleroxylon* in 1:1, 1:3 and 3:1 ratios. The control included only sawdust and cassava treatments. At bagging rice bran (12%) and lime (0.5%) were added to each treatment. The mixtures were bagged, sterilized, incubated and mushrooms harvested as described by Obodai *et al*., (2002).

***Data Analysis***

Data analysis on triplicates was done using GenStat Discovery Pro ($4^{th}$ Edition).

# 6. Results

***6.1 Vegetative growth of eight strains of mushroom cultures on prepared media***

Eight of the sixteen strains received grew well on both PDA and MEA. These strains (*P. ostreatus*-MES 11797, 03416, 03364, 03216, *P. eryngii*-MES 12060, *P. florida*–MES 03772 and *Lentinula edodes* - MES 02008, 02052) were then sub cultured on four prepared media and the best growth of five of these strains after seven days of incubation occurred on cassava peel and yam peel agar (Fig 1 and 2) whilst the other three strains. Morphological characteristics of the mycelia growth exhibited by the strains on both cassava and yam peel agar were rhizormorphic. Plate 1, 2 and 3 shows these on three of the strains.

***6.2 Substrate formulation experiments***

Various substrate formulations involving 1) single strain of cassava variety 2) mixed strain of cassava varieties and 3) cassava sticks were used to assess the fruit body yields of *P. ostreatus* strain EM -1.

***6.2.1 Single strain variety***

In Fig 3 the total fruit body yield showed a significantly lower yield for the combination of cassava and fresh sawdust in a 1:1 ratio (C1) (Fig 3) than for all the other treatments. Although composted sawdust had a higher fruit body yield (491g) than all the other treatments there were no significant differences (P>0.05) between the treatments with the exception of C1. This is an indication that all treatments A1, B1, D1, E1 are comparable in their suitability to support EM-1 fructification (Fig 3). However, fermented sawdust appeared to be better suited for EM-1 fructification compared to the fresh substrate.

#### *6.2.2 Mixed cassava strains*

Figure 4 shows the total yield obtained from each treatment within the cropping period in the study. The highest total yield was obtained from the control treatment (B; 100% composted sawdust) while the lowest total yield was obtained from 100% mixture of cassava strains (A). There was no significant difference (P>0.05) between the total yields obtained from treatments D and F (25% composted cassava + 75% composted sawdust and 50% composted cassava + 50% fresh sawdust respectively), which had total yields comparable to that obtained from the control treatment. Total yields obtained from treatments C and E (25% composted cassava + 75% fresh sawdust and 50% composted cassava + 50% composted sawdust respectively) also did not differ from each other but were significantly higher than that obtained from treatment G (100 % fresh sawdust). On the whole, total yields obtained from treatments A, C, E and G were significantly lower than that obtained from the control treatment. Thus, treatments D and F are comparable in their abilities to support EM-1 fructification (Fig 4), whereas treatment A is least suitable for EM-1 cultivation.

#### *6.2.3 Cassava sticks*

The significantly lowest total yield obtained after the cropping period of 8 weeks was in ascending order D2 (50 % cassava sticks + 50 % composted cassava peels)> treatment A2 (100 % cassava sticks only). Treatments B2 and C2 (50 % cassava sticks + 50 % fresh sawdust and 50 % cassava sticks + 50 % composted sawdust respectively) gave the highest total yields with no significant differences between the total yields (Fig 5). Thus, supplementation of cassava sticks with sawdust, either fermented or not, improved the yield of EM-1 on cassava sticks whereas supplementation of cassava sticks with fermented cassava peels decreased cassava sticks' ability to support EM-1 fruitification.

## 7. Conclusions

Mushrooms grown on unmilled and uncomposted cassava peels resulted in very low yields, this necessitated the present study. Results have clearly indicated that ~~mushrooms grown on~~ a 1:1 ratio of cassava to sawdust of *Triplochiton scleroxylon* whether the cassava varieties are mixed or single are a possible alternative substrate to use in the cultivation of mushrooms.

# 8. References


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# Annex 1

Fig 1: Vegetative growth of four *P. ostreatus* MES strains grown on four prepared media at 7 days of incubation

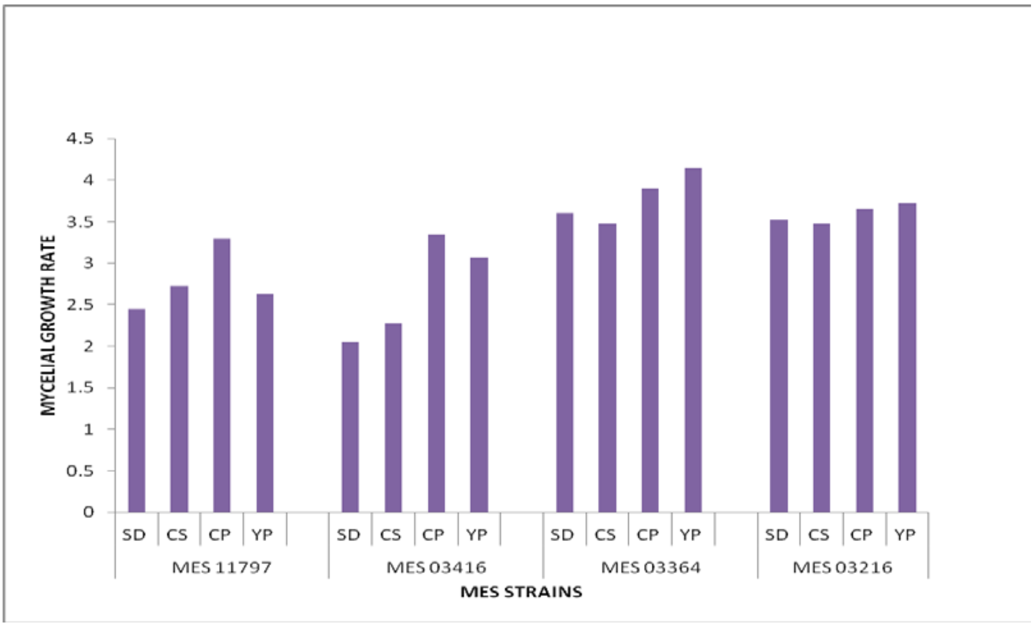



Fig 2: Vegetative growth rate of four MES strains grown on four prepared media

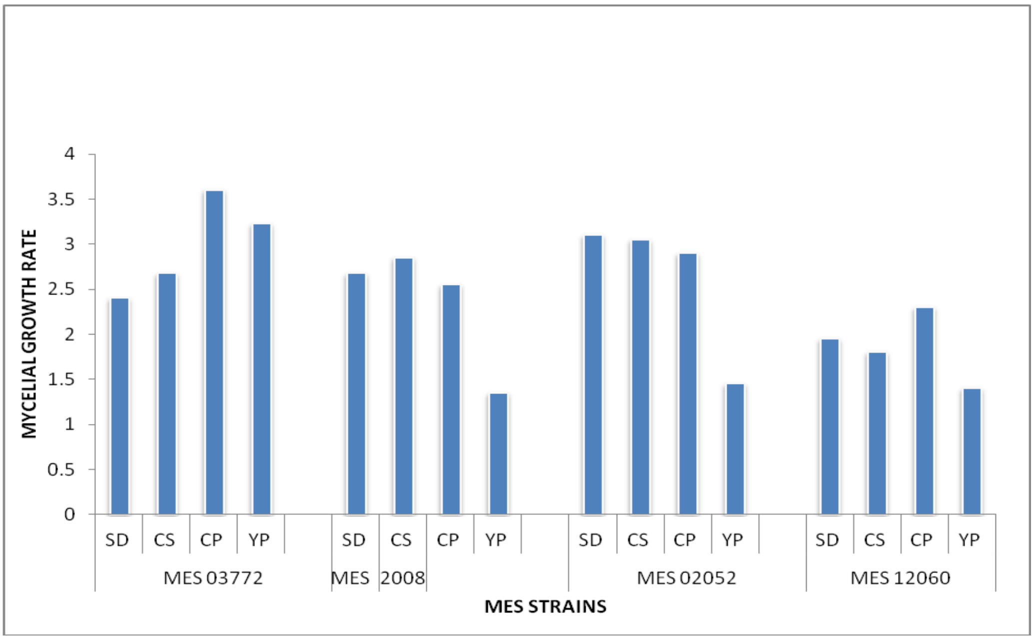



Plate 1: Vegetative growth of *P. ostreatus* - MES 03364 on cassava peel agar (left) and yam peel agar (right) on day 5

Plate 2: Vegetative growth of *Lentinula edodes* MES 02008 on cassava peel agar (left) and yam peel agar (right) on day 5

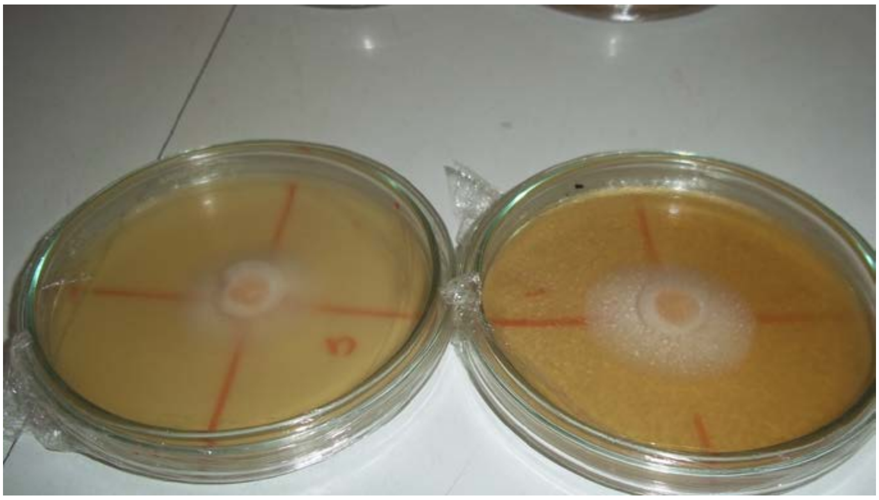
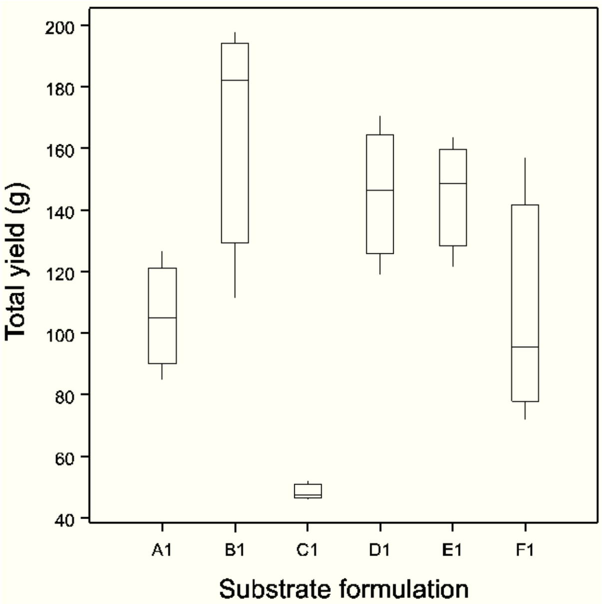


Plate 3: Vegetative growth of *P. florida* -MES 03772 on cassava peel agar (left) and yam peel agar on day 5

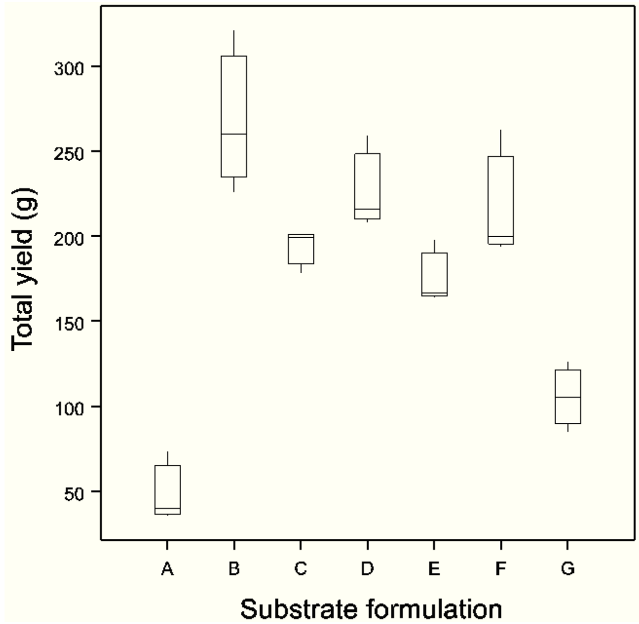
**Fig 3: Box plot of total yield obtained within cropping period from all treatments (Single strain cassava experiment)**




**Key**

A1 100% fresh sawdust
B1 100 % composted sawdust
C1 50 % uncomposted cassava + 50 % fresh sawdust
D1 50 % composted cassava + 50 % fresh sawdust
E1 25 % composted cassava + 75 % fresh sawdust
F1 25 % uncomposted cassava + 75 % fresh sawdust

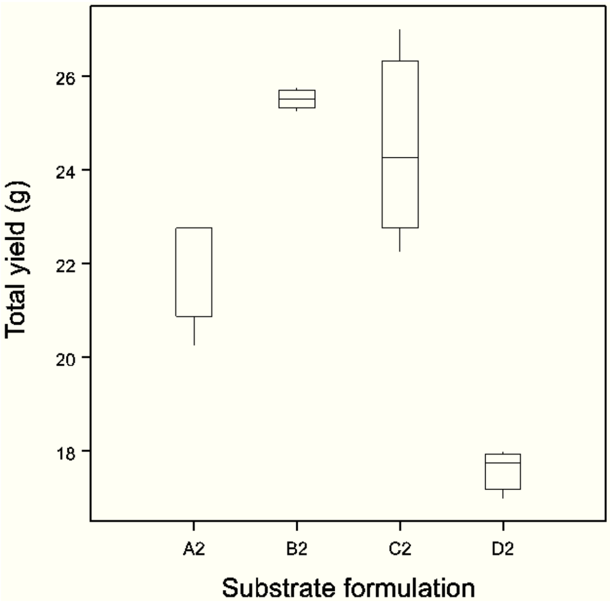
**Fig 4: Box plot of total yield obtained within cropping period from all treatments (Mixed strain cassava experiment)**




**Key**

A 100% mixture of cassava strains
B 100 % composted sawdust
C 25 % composted cassava + 75 % fresh sawdust
D 50 % composted cassava + 50 % fresh sawdust
E1 25 % composted cassava + 75 % fresh sawdust
F1 25 % uncomposted cassava + 75 % fresh sawdust

**Fig 5: Box plot of total yield obtained within cropping period from all treatments (Cassava sticks experiment)**




**Key**

A2 100 % cassava sticks only
B2 50 % cassava sticks + 50 % fresh sawdust
C2 50 % cassava sticks + 50 % composted sawdust
D2 50 % cassava sticks + 50 % composted cassava peels