

COUNCIL FOR SCIENTIFIC AND INDUSTRIAL RESEARCH



FOOD RESEARCH INSTITUTE

COLLABORATIVE RESEARCH REPORT

By

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**CHARACTERIZATION, CONSERVATION AND DOMESTICATION OF INDIGENOUS
EDIBLE AND MEDICINAL MUSHROOMS ON AGRICULTURAL RESIDUES**

**A collaborative project with Embrapa Recursos Genéticos e Biotecnologia - Parque Estação
Biológica (EMBRAPA, BRAZIL) (2012-2015)**

SPONSORS: Africa-Brazil Agricultural Innovation Marketplace (MKTplace)

PRINCIPAL INVESTIGATOR: ...Dr Mary Obodai

**PARTICIPATING SCIENTISTS: ... Dr. Arailde Fontes Urben (EMBRAPA), Dr Vinicius Reis
de Figueirêdo (Brazil), Dr Edison de Souza (Brazil), Ms. Matilda Dzomeku (CSIR-FRI),
Ms. Deborah Narh (CSIR-FRI)**

PARTICIPATING TECHNOLOGIST: Mr Richard Takli and Miss Juanita Prempeh

BACKGROUND INFORMATION and JUSTIFICATION:

Many forests in the tropics and sub-tropics are endowed with abundant genetic resources of edible and medicinal mushrooms. Most of these mushrooms remain unidentified, underutilized and understudied. For centuries now, mushrooms have not only been used as foods and therapeutics in folk medicine but in the present-day has found clinical uses. There is a growing interest in mushrooms on their dietetic, pharmacological, production of secondary metabolites and their bioactive properties. They have attracted much interest as functional foods because of properties they exhibit such as being anti-tumoral and anti-viral among others. Statistics in Ghana show that the country's total forest cover which stood at 8.2 million hectares at the turn of the 20th century has decreased to about 1.6 million hectares and it is estimated that its forest resource in the next 23 years will be totally lost if correct measures are not put in place. In view of this alarming situation in terms of the rate of desertification, the rationale for the project is to characterize the mushroom germplasm in some forests in Ghana with the view of conserving these mushrooms under threat some of which will serve as raw materials for the nutraceutical and functional food industries. Also, the project will create jobs for the youth and the unemployed in the communities surrounding these forests by engaging them in mushroom farming using agricultural residues, thus ensuring both food and income security.

OBJECTIVES:

- To document indigenous knowledge of edible and medicinal mushrooms in four regions of Ghana
- To characterize by phenotypic methods mushrooms collected from four forests in these regions
- To determine the biochemical composition of these mushrooms in order to ascertain their biochemical components
- To cultivate five selected cultivable species on agricultural residues using the Juncao technology and plastic bag methods
- To transfer mushroom cultivation technology to the youth through workshops

FIRST REPORT (2012-2013)

ACTIVITIES CARRIED OUT DURING THE PERIOD

- The first activity carried out under this project in 2012, was the inception project meeting held at FORUM, 2012 in Brasilia, Brazil from 1-3 August. Dr Mary Obodai (PI) met Dr Arailde Urben Fortes Co-PI) for the first time (Figure 1) at this meeting. The project objectives, timelines and budgets were finalised.



Figure 1: Project partners at FORUM 2012

- The first activity carried out in 2013, was the administering of 817 questionnaires in six villages in and around the Atiwa and Wli Agumatsa forests in the Eastern and Volta regions of Ghana respectively. Some of the questions asked were their perceptions about mushrooms, any uses they know of, how they came about that information etc. The results of this survey has being analyzed and a manuscript titled '**A comparative study on the indigenous knowledge of macrofungi in the Eastern and Volta regions of Ghana**' submitted to Journal of Ethnobiology and Ethnomedicine.
- The second activity in the year was the visit to Ghana of three scientists from Brazil: Drs Arailde Fontes Urben, Edison de Souza and Vinicius Figueiredo from 10th to 24th May. A Trainer of Trainers workshop in Juncao technology and Germplasm collection in two regions of Ghana were carried out. A report of the workshop has been prepared and submitted- CSIR-FRI/RE/OM/2013/020.

- The third activity was mycological collections of macrofungi in the forests. Four forests were visited during this period namely: Atiwa Forest Reserve and Apapem Forest in the Eastern Region, Gbedi Gborgame Afadzato Range and Wli Agumatsa Waterfalls of the Volta region. These trips were carried out from 1^{7th}-1^{8th} and 2^{1st}-2^{2nd} May. A report to the forests: ‘Report Of Mushroom Diversity In Ghana: Case Study In The Volta And Eastern Regions’ has been submitted under CSIR-FRI/RE/OM/2013/019.
- The fourth activity carried out was domestication trials on five cultivable mushrooms namely: *Pleurotus sajor-caju* strain PSCW, *Auricularia polytricha* strain APA, *Lentinus squarrosullus* strain sqw, *Pcynosporus sanguinesis* and *Pleurotus tuber-regium* strain SAA13. These were cultivated on mixed sawdust of *Triplochiton scleroxylon* and *Chlorophora excelsa* and *Pleurotus tuber-regium* strain SAA13 on plantain leaves (Dzomeku, 2009). Yields of various flushes including proximate and mineral composition after flushes on sawdust were carried out. A technical report titled ‘Domestication of an indigenous Ghanaian edible mushroom-*Pleurotus sajor-caju*: variations in the proximate, and mineral contents of the wild and cultivated species’ has been submitted- CSIR-FRI/RE/OM/2015/014.
- Two members of the team: Dr Mary Obodai and Mr Richard Takli travelled to Manaus in Brazil to attend the VII International Symposium on Mushrooms in Brazil/VI National Symposium on Edible Mushrooms from 12-15th October. At this symposium a joint poster was presented on “Preliminary investigations of *Favolus brasiliensis* (Fr.) Fr., Aphyllophorales in Ghana” (Figure 2).



Figure 2: Photograph during the poster session. From right: Dr Vinicius Reis F, Dr Mary Obodai, Mr Richard Takli

- A total of forty two participants comprising of 39 from the Mushroom Growers and Exporters Association of Ghana (MUGREAG) and three new entrants were trained in the JUNCAO technology (use of grasses, elephant grass-*Pennisetum purpurem* and thatch-*Imperata cylindrica*) for the production of edible and medicinal mushrooms. This was carried out under the SDF-COTVET:MUGREAG:CSIR-FRI consultancy programme. These trainings were carried out on 16th-20th and 24th-27th September, 21st-25th October and 4th-8th November (Figure 3). CSIR CSIR-FRI/EL/NMDL/2015/002.



Figure 3: First batch of participants inoculating bags using the Juncao technology

REPORT FOR 2014-2015

ACTIVITIES CARRIED OUT DURING THE PERIOD

- The nutritional and antioxidant activities of five cultivated mushrooms (*Pleurotus ostreatus* strain EM1, *P. sajor-caju* strain PscW, *Lentinus squarrosullus* strain LsF, *Lentinus squarrosullus* strain SqW, *Auricularia auricula* strain ApA) and two wild mushrooms (*Termitomyces robustus* strain TrA and *Pleurotus tuber-regium* strain PtA) were sent to Mountain Research Centre (CIMO), ESA, Polytechnic Institute of Bragança, Campus de Santa Apolónia, apartado, Portugal for analysis. A paper was published from this research: Mary Obodai, Isabel C.F.R. Ferreira, Ângela Fernandes, Lillian Barros, Deborah L. Narh Mensah Matilda Dzomeku, Arailde F. Urben, Juanita Prempeh & Richard K. Takli (2014). Evaluation of the Chemical and Antioxidant Properties of Wild and Cultivated Mushrooms of Ghana. *Molecules* 19 (12) 19532-19548.
- A total of 761 questionnaires were administered on the indigenous knowledge of edible and medicinal mushrooms in communities around the Ayum forest in the Brong Ahafo region and Bia Forest Reserve in the Western region. A manuscript on these results titled '**Ethnoknowledge and ethnomedicinal uses of mushrooms among dwellers in forest fringe communities in the Brong-Ahafo and Western regions of Ghana**' is ready for submission to the Journal of Ethnobiology and Ethnomedicine.
- A second paper published: Narh Mensah DL, Obodai, M. (2014). Morphological characteristics of mycelia growth of two strains of the indigenous medicinal mushroom, *Lentinus squarrosulus* Mont.(Singer), on solid media. *African Journal of Agricultural Research*. 9(23):1753-1760. A poster of mushrooms from Wli was prepared and submitted to Wli Agumatsa forest reserve.
- Test trials began on the use of the newly constructed grass cutting machine (Figure 4) for cultivation of mushrooms using the JUNCAO technology



Figure 4: Grass cutting machine fabricated during the project

- The PI – Dr Mary Obodai attended the final project meeting which concluded the project. This was held at FORUM, 2015 in Brasilia, Brazil from 15th-18th September where she presented a poster on the project (Figure 5).



Figure 5: Dr Obodai presenting the poster to some participants at FORUM, 2015.

MAJOR FINDINGS FROM PROJECT

- A total of about 1500 questionnaires were administered in four regions of Ghana, namely: Eastern, Volta, Brong Ahafo and Western
- Sixty macrofungi were collected from the four forests visited out of which 51 were identified. Six new species of mushrooms were recorded for the first time in Ghana, namely *Pleurotus sajor caju*, *P. albidus*, *Tremella mesenterica*, *Oudemansiella canarii*, *Pycnosporus sanguineensis* and *Favolus brasiliensis*. These mushrooms have been photographed in situ, dried and are currently being stored in a refurbished Research Lab.
- Diversity of mushrooms available for the market: *Pleurotus sajor-caju* strain PSCW-1, *Lentinus squarrosullus* strain sqw-10 and *Pleurotus tuber-regium* are new cultures in the National Mycelium Bank which is kept in CSIR-Food Research Institute. Experiments carried out on *Pleurotus sajor-caju* strain PSCW-1 showed that the yields are comparable to that of *P. ostreatus* strain EM1 which is currently on the market. Shelf-life studies will be conducted and then this variety will be released on the local market.
- Seven of the mushrooms studied showed high levels of antioxidants and other phytochemical components with the potential to be used as functional foods or as nutraceutical sources
- Grass cutting machine has been fabricated and ready to be used in trainings in the Institute.
- Juncao technology (use of grass) is now available for extensive technology transfer to the villages. Two user friendly hand-outs on this technology have been developed to be used for training

POTENTIAL IMPACT OF PROJECT:

- The use of the Juncao technology, adapted by Embrapa Genetic Resources and Biotechnology and modified to suit growing conditions in Ghana, in addition to the sawdust plastic bag method will be used as important techniques for the cultivation of mushrooms in Ghana and beyond.

- To date a total of 96 persons have been trained. There is a system in place for more farmers to be trained using the Juncao and Plastic bag methods
- The cultivation of three species (*Pleurotus sajor-caju* strain pscw-1, *Lentinus squarrosullus* strain sqw-10 and *Pleurotus tuber-regium*) obtained on this project will be taught during training programmes and then will be cultivated by the youth and the unemployed and this will eventually give them a means of income.
- The mushroom cultivation using agricultural residues is an important strategy for biotransformation, where organic waste can be transformed into nutraceuticals and food. As a future perspective, the marketing of these mushrooms and their benefits to human health could be used by the food and pharmaceutical industries due to their rich nutritional and medicinal properties.

PUBLICATIONS FROM PROJECT

- Mary Obodai , Isabel C.F.R. Ferreira, Ângela Fernandes, Lillian Barros, Deborah L. Narh Mensah Matilda Dzomeku, Arailde F. Urben, Juanita Prempeh & Richard K. Takli (2014). Evaluation of the Chemical and Antioxidant Properties of Wild and Cultivated Mushrooms of Ghana. *Molecules* 19 (12) 19532-19548
- Narh Mensah DL & Obodai, M. (2014). Morphological characteristics of mycelia growth of two strains of the indigenous medicinal mushroom, *Lentinus squarrosulus* Mont.(Singer), on solid media. *African Journal of Agricultural Research*. 9(23):1753-1760.
- Figueirêdo, V.R., Urben, A.F., Souza, E., Obodai, M., Dzomeku, M., Takli, R. (2013). First record of *Favolus brasiliensis*, Aphyllophorales, in Ghana (Africa). VII International Symposium on Mushrooms in Brazil and VI National Symposium on Edible Mushrooms, organized by The National Institute for Amazon Research, Manaus, Brazil from 12th to 15th October, 2013 (Poster presentation)
- Domestication of an indigenous Ghanaian edible mushroom-*Pleurotus sajor-caju*: variations in the proximate, and mineral contents of the wild and cultivated species (CSIR-FRI Technical report)
- Mushroom cultivation using the Juncao technology: A handout for mushroom

farmers

- Deborah Louisa Narh Mensah; Lynda Hagan; Matilda Dzomeku; Juanita Prempeh; Richard Kwamla Takli; Mary Obodai (2015) Ethnoknowledge and ethnomedicinal uses of mushrooms among dwellers in forest fringe communities in the Brong-Ahafo and Western regions of Ghana (Ready for submission to Journal of Ethnobiology and Ethnomedicine).
- Dzomeku Matilda, Hagan Lynda, Takli, Richard Komla and Obodai, Mary (2015) A comparative study on the indigenous knowledge of macrofungi in the Eastern and Volta regions of Ghana (submitted to Journal of Ethnobiology and Ethnomedicine)

WAY FORWARD

- There are over 100 forests in Ghana. In this project only four forests were visited. The next step is to explore more forests and identify more mushrooms.
- During this project six new mushrooms were recorded for the first time in Ghana. There is the need to unearth the mushroom diversity hidden in forests.
- There is also the need not only to phenotypically characterize the mushrooms but to characterize them further using molecular methods.
- The next step in the identification of mushrooms will be to establish the relationship between species and strains from different localities.
- Multiplication of spawns of the domesticated mushrooms will be carried out and released onto the market after shelf life studies.