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ENERGY USE EFFICIENCY OF OYSTER MUSHROOM PRODUCTION IN A SELECTED TRIBAL VILLAGE

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Abstract- The aim of this study was to determine energy consumption pattern and efficiency for oyster mushroom production in a tribal village in Uttar Simlabari, Alipurduar district, State of West Bengal, India. The data used in this study were collected by direct interviewing the mushroom growers of the adopted tribal village. Results revealed that average yield and total energy consumption were 0.79 and 1.1 kg per bags and 253.46 and 266.15 MJ/20 bags of rice and wheat straw, respectively. In terms of energy consumption, highest consumption was recorded in substrate followed by water for sprinkling spawn, fuel wood, human labour and plastic in both rice and wheat straw. The total energy output was higher in case of wheat substrates. However, farmers prefer on rice substrate due to availability of rice straw.

Keywords- Energy, Oyster Mushroom, Different Substrates, Tribal community, India

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Introduction

Cultivation of oyster mushroom in recent times is gaining importance in tropical and subtropical regions due to its simple way of cultivation and high biological efficiency. Tribal farmers are characterized by small and fragmented land holdings, low productivity of crops and livestock, unemployment, poor income and low risk bearing ability [1]. Most of tribal families don't have their own land and hence become difficult for them to generate income and employment. They are largely dependents on daily wages as agricultural workers and sustain upon local bio-resources. Introduction of mushroom cultivation along with existing farming system can be an alternative source of income for the poor and land less farmers. This may help many unemployed youth and tribal farmers to get decent livelihood. The Oyster mushroom (*Pleurotus ostreatus*), is one of the most widely cultured species due to high biological efficiency, very good taste, high nutritional and medicinal values. It has also been found to exhibit strong anti-inflammatory and immune-modulatory properties due to their chemical composition. Mushrooms are good sources of protein, vitamins and minerals. These are known to have a broad range of uses both as food and medicine [2].

Oyster mushroom can be grown on various substrates including paddy straw, wheat straw, maize stalk cobs, vegetable plant residues, bagasse etc. [3] and this has been reported to influence their growth, yield and composition [4]. Although considerable information are available on the energy consumption during oyster mushroom production such as white button mushroom [5], kiwi [6], apple [7,8], grapes [9], sunflower [10,11], oilseed [12], greenhouse vegetable production [13,14] and sugar beet [15], but there is paucity of information on energy consumption in oyster mushroom production. The aims of this study is to determine the total amount of energy required for oyster mushroom production using rice and wheat as substrate.

Materials and Methods

The study was conducted in 2014-2015 in a tribal dominated village of Uttar Simlabari, in the district of Alipurduar. It has a population of about 1572 persons living in around 284 households. About 90% cultivated area is non-irrigated and depends on rainfall and hill torrents for its moisture requirements. The study site is located between 26°16′ and 27°0′ North latitude and 88° 53′ East longitude. Data were collected from the farmers by using an interview schedule and focus group discussion among mushroom growers. Information related to input energy use in oyster mushroom production were collected as mentioned in the [Table-2]. For analysis of the data, energy equivalents of the inputs and outputs was calculated using the standard accepted conversion factors as indicated in [Table-1].

Mushroom production is a continuous process involving different operational steps, each of which must be carefully and aseptically performed. During the production cycle, mushrooms were harvested in a series of breaks or flushes that occur at approximately 7 or 8 days interval. After two flushes, mushroom production slowly declines and produces fewer mushrooms in each time. The inputs of mushroom production were human labour, rice and wheat straw, plastic bags, spawn (seed) and water for soaking and sprinkling. Based on energy equivalent of inputs and output, average energy output in oyster mushroom production were calculated [Table-2]. Further, using the estimated values of energy inputs and output [Table-2], energy use efficiency and energy productivity were calculated as describe by [4].

$$Energy\ use\ efficiency = \frac{Energy\ output\ (MJ/kg)}{Energy\ input\ (MJ/kg)}$$

$$Energy\ productivity\ (kg/MJ) = \frac{Mushroom\ yield}{Energy\ input}$$

The energy use efficiency gives an indication of how much energy is produced per unit of energy utilized. The energy productivity provides quantitative data on how much oyster mushroom is obtained per unit of input energy.

Result and Discussion

The inputs used and their energy use equivalent values are presented in [Table-2]. Total energy used in various farm operations during mushroom production was 253.46 MJ/ 20 bags in rice and 266.15 MJ/ 20 bags for wheat straw. Mushroom,

seed consumes around 27.62% and 28.18% of total energy inputs followed by energy used for water sprinkling 25.35% and 26.44% for rice and wheat respectively during a production cycle. Human energy was mainly consumed for straw cutting, boiling, filling of bags, water for irrigation and harvesting.

Table-1 *Energy equivalents of inputs and output in mushroom production*

Energy source		Energy equivalent (MJ)	Reference
(Input)	**Labour**(h)		
	Women	1.57	Singh et al., 1994 and Yılmaz et al., 2005 (16,23)
	Spawn(Seed) (kg.)	25	Ozkan et al., 2007 (9)
	Plastic (kg.)	45	Walters et al., 2000 (17)
	Fuel wood (kg.)	7.2	www.victoria.ac.nz/architecture/centres/cbpr/.../pdfs/ee-**coefficients**.pdf(18)
	Water for sprinkling (L)	1.02	Ozkan et al., 2007 (9)
	Substrate		
	Rice straw (kg.)	14	http://www.bioenergyconsult.com (19)
	Wheat straw (kg.)	12.5	Ozkan et al., 2004 (20)
Output	Oyster mushroom(kg)	1.4	Mattila et al., 2002 (21)
	Mushroom Compost :Wheat(kg)	4.6	McCahey et al., 2003 (22)
	Mushroom Compost :Rice(kg)	5	http://www.bioenergyconsult.com (19)

Table- 2 *The amount of energy input for oyster mushroom production on different substrates for one cycle operation (MJ/ 20 bags).*

Input	Substrate	
	Rice Straw	Wheat straw
Human labour (Women)	19.70	21.27
Seed (Spawn)	50.00	50.00
Plastic	13.50	13.50
Fuelwood	36.00	36.00
Water for irrigation	64.26	70.38
Substrate	70.00	75.00
Total Input energy	**253.46**	**266.15**

The energy input and output, yield, energy use efficiency and energy productivity of mushroom production are shown in [Table-3]. Energy use efficiency (energy ratio) was estimated as 0.40 and 0.43 in case of rice and wheat straw, respectively. Leila *et al.,*(2015) evaluated different substrates used for production of oyster mushroom and found that palm fibers bed consume less energy (176.29 MJ/m^2) compare to baggasse (454.04 MJ/m^2) and wheat straw (205.95 MJ/m^2). They also reported highest energy productivity when palm fibers bed supplemented with the poultry manure (0.099 MJ/m^2) was used followed by rapeseed meal (0.097 MJ/m^2). In the present study, energy productivity of mushroom production were 0.11 MJ/ kg and 0.13 MJ/kg, against rice straw and wheat straw respectively.

Table-3 *Energy input-output ratio in Mushroom production*

Item	Production	
	Rice straw	Wheat Straw
Yield(kg)	0.79	1.1
Energy Input	253.46	266.15
Energy output (Mushroom and compost)*	102.12	113.6
Energy use efficiency	0.40	0.43
Energy productivity	0.11	0.13

* for 20 bags

In the present study, average yield of mushroom harvested was 0.79 kg and 1.1 kg for rice and wheat straw during one cycle and total energy output was 102.12 and 113.6 MJ/20 bags. The percentage share of the various sources of energy is shown in [Fig-1]. It is evident that substrate exhibit the highest share of 27.62% and 28.18% for rice and wheat respectively followed by water for irrigation (25.35% and 26.44% respectively). This shows that in the case of substrate and water for soaking and sprinkling, energy consumption is the highest. On the contrary, plastic bag requires relatively less energy *i.e.* 5.33% and 5.07% for both rice and wheat substrates, respectively.

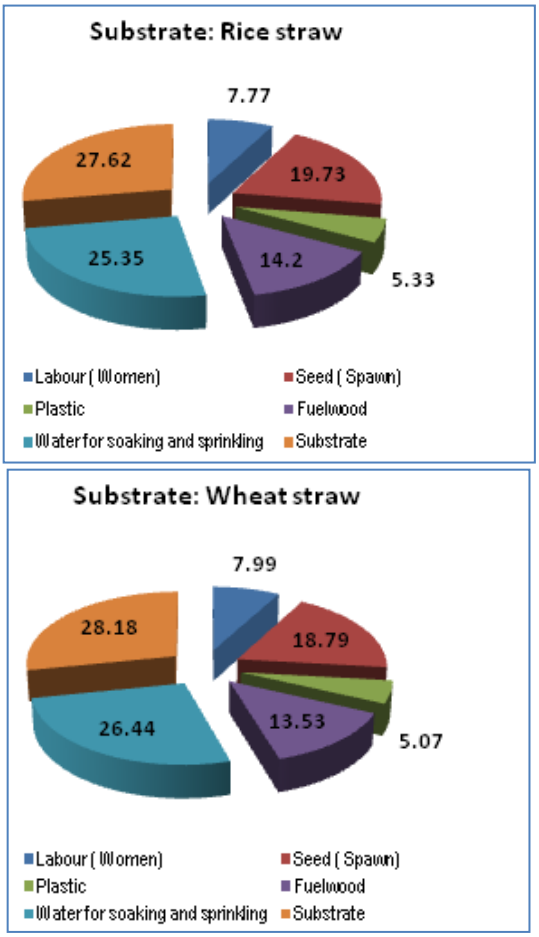

Fig-1 The share of input energy for production of oyster mushrooms on rice and wheat substrate (%)

Conclusion

In the present study it was found that wheat straw shows better performance compare to rice straw substrate in terms of energy utilization and energy efficiency. Hence, there is tremendous scope exist to encourage the tribal farmer for utilization of wheat straw in mushroom production. The tribal people of that region generally prefer rice as the staple food as compared to wheat for their daily consumption. Hence, the availability of wheat straw is limited in those areas owing to existing agroclimatic condition and local demand. Suitable technological intervention supported with proper extension mechanism can facilitate better utilization of resources as well as exploration of more indigenous substrate for utilization in the mushroom production.

Conflict of Interest: None declared

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