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Research article

EFFICACY OF AN EDIBLE TROPICAL FUNGUS, *CALOCYBE INDICA* IN THE BIO-TRANSFORMATION OF SOME LINGO-CELLULOSIC AGRO- INDUSTRIAL WASTES TO PROTEIN RICH FOODS

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ABSTRACT: A study was undertaken to utilize cotton wastes and sunflower stalks either alone or in combination with paddy straw (1:3, 1:1, 3:1, v/v) for sporophore production of milky mushroom, Calocybe indica. As single substrate, cotton wastes and sunflower stalks were not ideal for mushroom cultivation. However, the biological efficiency of the fungus could be improved when these were used in various combinations with paddy straw. There was also faster substrate colonization and primordial initiation and higher number of fruiting bodies. Cotton wastes + paddy straw (1:3) sustained the highest mushroom yield (73.2 % BE) which was statistically at par with paddy straw (71.3 % BE).

Keywords: Cotton waste, sunflower stalks, mushroom, Calocybe indica, yield

INTRODUCTION

It is estimated that around 200 billion tons of organic matter are generated annually through the process of photosynthesis [18]. A majority of this organic matter and many agro-industrial wastes furnish large volumes of solid wastes, residues and by-products which pose serious environmental pollution [7, 8]. In fact the physiochemical properties of such lingo-cellulosic materials offer great scope for their enormous biotechnological importance. Global efforts are being made involving innovative technologies and disposal methods for the utilization of these lingo-cellulosic into more profitable materials by solid state fermentation [2, 17]. Among various methods, mushroom cultivation is the most economical and relatively short biological process for the biotransformation of such materials into protein rich food [4, 10]. Cotton wastes and sunflower stalks are examples of agro-industrial wastes which are of limited/no economic use. Cotton waste is a by-product of the textile industry. In recent years, cotton wastes have become popular as substrates for straw mushroom [1] and oyster mushroom [6] cultivation. The sunflower stalks left after collection of pods do not have any productive use except as a source of fuel. Literature is almost unavailable on the utilization of cotton wastes and sunflower stalks for production of milky mushroom, *Calocybe indica*. Therefore, in the present study, an attempt was made for biotransformation of these two important agro-wastes into protein rich food by the edible basidiomycetes, *C. indica vis-à-vis* the commonly used paddy straw substrate.

MATERIALS AND METHODS

Cotton wastes collected from spinning mills and well dried sunflower stalks were used in the study as substrates for cultivation of milky mushroom, *Calocybe indica*. Well dried paddy straw (var. CR-1014) and sunflower stalks were chopped into 3-5cm pieces and soaked in water for 9 hours. Shredded cotton wastes were also dipped in water fort the same period. After draining of excess water the wet materials were sterilized by steam for one hour.

A moisture content of 50-60 % was maintained in the substrate before spawning. Cotton wastes and sunflower stalks were used alone and in different combinations with paddy straw (1:3, 1:1, 3:1, v/v). Cultivation of milky mushroom was followed in high density cylindrical poly bags (60 cm X 40 cm, 100 gauge) with multi-layered spawning as per the method of Pani and Das [12].Each of the treatments was replicated thrice. During the entire cropping period, 30-35 C temperature, 80-90 % relative humidity, sufficient natural light and controlled ventilation were allowed. Mushrooms were harvested from two flushes and fresh weights were immediately recorded. Biological efficiency (BE) of the fungus was calculated as the fresh weight of harvested mushrooms from the dry weight of substrate and was expressed as a per cent. Data pertaining to yield were statistically analyzed.

RESULTS AND DISCUSSION

Cotton wastes and sunflower stalks as single substrates were not ideal substrates for *Calocybe* cultivation (Table 1 and 2). However, the biological efficiency of the fungus could be improved when these substrates were used in various combinations with paddy straw (3:1, 1:1 and 1:3, v/v) for sporophore production. There was also faster substrate colonization and primordial initiation and higher number of fruiting bodies. It was revealed (Table 1) that the combination of cotton wastes and paddy straw in (1:3) has resulted in the highest mushroom yield (73.2 % BE) which was statistically *at par* with paddy straw (71.3 % BE) . The superiority of cotton stalks over paddy straw for oyster mushroom cultivation was reported by Patil and Jadav [13] and Pani and Das [11], the former attributing the higher N and P content in the form of lignin protein complex for this unique ability. Excellent performance of cotton wastes as substrate for mushroom cultivation has been reported in other edible fungi [3,9,14]. In the present study, cotton waste alone, though rich in cellulose, could not sustain any sporophore production ostensibly due to poor physical make up. Disadvantage of using cotton waste as single substrate included poor and insufficient drainage, over wetness leading to reduced ventilation and rotting of fungal hyphae. When cotton waste was mixed with paddy straw, there was reduction in the compactness and improvement in its physical structure resulting in relatively higher mushroom yield.

Table 1: Effect of cotton waste and paddy straw on production of *C. indica*

S Substrates	Substrate colonization (days)	Fruiting initiation (days)	Sporophore No.	Yield (g)	Avg. wt. of sporophore (g)	BE (%)
Cotton waste + Paddy straw (1:0)	Partial	39	-	-	-	-
Cotton waste + Paddy straw (3:1)	Partial	37	1	103.0	103.3	10.3
Cotton waste + Paddy straw (1:1)	19	29	5	613.3	122.6	61.3
Cotton waste + Paddy straw (1:3)	14	29	6	732.6	122.1	73.2
Cotton waste + Paddy straw (0:1)	15	30	6	713.3	118.8	71.3

CD (0.05) 38.10

Each of the observation was the average of three replications.

When sunflower stem was used alone as well as in combination with paddy straw (3:1), the substrates could not be completely colonized by the mushroom mycelia (Table 2). There were no mature sporophores in pure sunflower stalks because the emerging primordia withered during the cropping period. However, when 25 % of sunflower stalks were substituted by paddy straw, the partial fungal growth in substrate could produce three fruiting bodies in 33 days with 21.6 % BE.

Sunflower stem + paddy straw in equal proportion sustained 40.3 % BE while satisfactory mushroom production (62.6. % BE) could be obtained from sunflower stalk + paddy straw (1:3).The poor yield potential of sunflower stem might have been due to its higher lignin content in the cell wall [16] and reduced water retention capacity leading to poor hydrolysis of available nutrients. Lignin surrounds the cellulose and forms a physical barrier restricting microbial enzyme attacks [5, 15].

Table 2: Effect sunflower stalk and paddy straw on production of *C. indica*

Substrates	Substrate colonization (days)	Fruiting initiation (days)	Sporophore No.	Yield (g)	Avg. wt. of sporophore (g)	BE (%)
Sunflower stalk + Paddy straw (1:0)	Partial	35	-	-	-	-
Sunflower stalk + Paddy straw (3:1)	Partial	33	3	216.6	72.2	21.6
Sunflower stalk + Paddy straw (1:1)	18	31	4	403.3	100.8	40.3
Sunflower stalk + Paddy straw (1:3)	18	31	4	626.0	156.5	62.6
Sunflower stalk + Paddy straw (0:1)	15	30	6	713.3	118.8	71.3

CD (0.05 37.18

Each of the observation was the average of three replications.

It was concluded from the study that one-fourth of paddy straw could be substituted by sunflower stalks and cotton wastes to produce satisfactory (62.6 % BE) to high (73.2 % BE) mushroom yield, respectively. As single substrate, cotton waste and sunflower stalks can be used for milky mushroom production by further augmenting the physical structure and nutritional supplementation. This will pave the way for developing an alternate substrate to paddy straw, the production of which has declined in recent times by introduction of short statured high yielding paddy varieties.

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