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Effect of different substrates and casing materials on growth and yield of *Calocybe indica* (P&C) in North Bengal, India

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Abstract: Cultivation of *Calocybe indica* was undertaken with locally available substrates viz. paddy straw, maize stalk waste, bamboo leaves and young coconut fibre alone and various combinations with paddy straw + maize stalk (1:1 v/v), paddy straw+ saw dust (1:1 v/v), and paddy straw+ saw dust (1:2 v/v)and different casing materials such as vermicompost, soil+ sand (1:1v/v), dried saw dust, hard paper (wet condition) and combination of tea waste +soil+ sand, saw dust +sand (1:1 v/v), tea waste+ sand (1:1 v/v) in paddy straw cultivating condition. Among the substrates, paddy straw was the best with 196.12 % biological efficiency (BE) followed by different substrate combinations but the bamboo leaves alone was recorded as substrate with lowest potential (84%) for cultivation. As casing material the spent mushroom compost (SMC) of *Agaricus bisporus* resulted in the highest biological efficiency (207%) followed by soil+ sand (196%), sand +saw dust (163%) but combination of tea waste+ soil + sand was inferior (151%). Saw dust gave the lowest (96.8%) biological efficiency. In conclusion the maximum biological efficiency of *C. indica* can be obtained by using paddy straw as a substrate encased with spent compost of button mushroom.

Keywords: Biological efficiency, *Calocybe indica*, Casing, Coconut fibre, Spent mushroom compost, Vermicompost

INTRODUCTION

Mushroom cultivation and consumption is getting popular day by day due to their high nutritional and medicinal values. Due to high content of vitamin, protein and minerals, mushrooms are considered as poor man's proteins (Velusamy *et al.*, 2014a). Milky mushroom is suitable for hot humid climate and can be cultivated almost throughout the year in India except few places (Pani, 2010). Mild tropical humid climate with the temperature in a range of 25-35°C and relative humidity around 80-90 percent persists during summer season in North Bengal region of West Bengal. This mushroom requires a temperature range of 30-35°C and a relative humidity of 70-80%, which is conducive to the environmental conditions of North Bengal. Therefore, cultivation of *Calocybe indica* (P and C) stands to be the best option during summer season. First attempt for cultivation of *C. indica* was made by Purkayastha and Nayak in 1979. But till today it is cultivated only in few parts of the country (Navathe *et al.*, 2014; Rawal and Doshi 2014). Commercial cultivation of this mushroom is still in its infancy in India. There is need to introduce the cultivation technology of this mushroom into new agro climatic zones of the country as the biological efficiency of this mushroom is much greater than that of oyster mushroom. Its robust size, sustainable yield, attractive color, delicacy, long shelf-life, and lucrative market value have attracted the attention of both mushroom consumers and prospective growers. *C. indica* is rich in protein, fiber, carbohydrates, and vitamins and contains essential amino acids. This mushroom can be grown in different lignocellulosic substrate (Bokaria *et al.*, 2014, Velusamy *et al.*, 2014a). Huge quantities of lignocellulosic residues such as rice straw, wheat straw, mustard straw, maize stalk, waste cotton, water hyacinth, sugar-cane bagasse are generated annually through activities of the agricultural, forest, and food-processing industries in North Bengal. Therefore, the present investigation was undertaken to determine the best substrates and casing materials for the commercial cultivation of *Calocybe indica* in North Bengal.

MATERIALS AND METHODS

Inoculum and spawn preparation: The pure mycelial culture of *C. indica* was obtained from Directorate of Mushroom Research, Solan, HP, India and maintained at 25° C in PDA and MEA media. Pure culture was stored at 15° C. The preparation of mycelial inoculum in petri dishes and its conservation in test tube slants was performed according to Singh (Singh *et al.*, 2009). Spawn was prepared by boiling wheat grains for 15 minutes followed by draining and cooling and calcium carbonate (5g/kg) and gypsum (25g/kg) were added, mixed well and then transferred into 65 to 75 cm clear double polypropylene bags, with a mean thickness of 0.6 mm, and its upper portion was plugged with non

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absorbent cotton plug and were covered with paper. The grain filled bags were sterilized in autoclave at 15 lb pressure (121^{o} C) for 40 min and allowed to cool at room temperature. The mycelial inoculum discs (5 mm) of 10 days old were aseptically inoculated in the spawn bags and incubated at 25± 2^{o} C in shaded chamber for mycelial growth.

Mushroom bag preparation: The locally available lignocellulosic substrates such as paddy straw, maize stalk waste, bamboo leaves, saw dust and young coconut fibre were selected for mushroom bag preparation. Experiments were conducted in a completely randomized design with six treatments in substrate level and nine treatments in casing level with six replicates in each treatment. Polyethylene bags of 60 × 30 cm size were used and cylindrical mushroom beds were prepared following layer method of spawning. Beds were prepared in which each bed contain 3 kg of substrate (wet weight basis). A moisture content of about 60% was allotted in the wetted substrate prior to spawning. The substrates were pasteurized using boiled water at 100^{o} C for 30 minutes and dried up to 60% moisture. The inoculated bag was perforated (12 no's) with sterilized teasing needles. The bags were incubated in dark room to complete the spawn run and maintained at temperature of 29-34^{o}C with relative humidity of 85-90 %. After 12-14 days, when the beds were fully colonized by the vegetative mycelium of mushroom fungus, the upper surface of each bag was opened and the surface was applied with casing soil to a thickness of 2-3 cm over the spawn run substrate. The beds were uniformly and regularly sprayed with water to keep the surface of substrate moist. Watering was done after and before casing layer placement. After 2-3 weeks, the primordial initiation was observed in all substrate levels. Within one week the pin head becomes mushroom fruit body and mature mushrooms were harvested. From one bed twice or thrice mushrooms were harvested in 9±3 day's interval. No remnants of harvested sporophores were allowed to remain in the substrate. After each harvest, the casing soil was slightly ruffled. The different casing materials like alkaline (garden) soil, sand, saw dust, tea waste alone and various combinations were applied to the mushroom beds and recorded its bioefficiency.

Yield and bioefficiency: Total weight of all the fruiting bodies harvested from all the four pickings were measured as total yield of mushroom. The bioefficiency (yield of mushroom per kg substrate on dry wt. basis) was calculated by the following formula (Elaiya and Ganesh, 2013).

$$\text{BE (\%)} = \frac{\text{Fresh weight of total Harvested Mushroom} \times 100}{\text{Dry weight of Substrate}}$$

Biochemical analysis of fruit body grown on different substrate combination: Protein contents in fruit body grown on different substrate were determined followed by protocol proposed by Lowry *et al.*(1951). Carbohydrate content of different parts of fruit body grown in different substrates was measured. Ethanol (95%) was used for extract reparation in both total sugar and reducing sugar. Total sugar was estimated at 630nm using Anthrone's reagent. Reducing sugar estimation was done using 2 ml of alkaline copper tartrate in 2ml of ethanolic extract of sample. Determination of reducing sugar content using arseno molybdate was carried out at 620 nm following Nelson-Somogyi Method as described by Plummer (1978).

RESULTS AND DISCUSSION

Spawn run: Locally available substrates such as paddy straw, maize stalk saw dust, bamboo leaves etc. were investigated for their suitability to cultivation of *C. indica*. Minimum period for substrate colonization (14 days) was recorded in paddy straw while it was maximum (26 days) in bamboo leaves. Bamboo leaves contain high amounts of phenolic substances and complex lignin compounds as compared to other substrates (Sahoo *et al*., 2009). This might be the probable reason for delayed colonization in this substrate. Mycelium colonization of *C. indica* in mushroom beds containing different substrates such as paddy straw, maize stalk, saw dust was initiated on day 2 and fully colonization on day 10 (Table 1). This study was also supported by the finding of Pani (2011) and Bokari *et al*., (2014) where they used different substrate and casing materials for cultivation of *C. indica* that affect spawn run and colonization period in the substrate.

Days for pin head formation: The pin head of *C. indica* was observed on day 28 in mushroom bed containing paddy straw whereas maize stalk along with paddy straw took 29 days to initiate the pin head. The pin head was developed into matured fruit bodies on day 30 in mushroom bed containing paddy straw whereas bamboo leaves took 41.67 days.

Days for 1st harvest: Overall 33-45 days were required for first harvest. Significantly minimum 35.3 days was required for first harvest in the paddy straw substrate encased with soil+sand casing.

Total number of fruit bodies: The highest number of fruit body (23 fruit bodies) was harvested in the treatment with paddy straw substrate encased with SMC where 16 fruit bodies were harvested in paddy straw + maize stalk, 12 in paddy straw+saw dust (1:1 v/v), 10 in paddy straw+saw dust (1:2 v/v), 7 in maize stalk and 4 in bamboo leaves. The casing materials and thickness play important roles in fruit body development and fruiting period as recorded by Pani (2012).

Size of fruit-body: The average size of sporophore (i.e. length of stalk X diameter of pileus) was recorded in each harvesting time. The recorded data revealed that the sporophore size was significantly higher in paddy straw followed by the substrate combination of paddy straw + maize stalk, paddy straw + saw dust, maize stalk and bamboo leaves, minimum size observed in bamboo leaves. Maximum diameter of stalk was observed in paddy straw (3.2cm) followed by the combination of paddy straw + maize stalk (2.7 cm), maize stalk (2.2 cm) and in paddy straw + saw dust (1:1 v/v) (2.4cm). The minimum diameter of stalk was observed as 2.3cm in paddy straw + saw dust (1:2 v/v), 2.1 cm in bamboo leaves. The effect of casing materials on stalk diameter was also found. The stalk with parallel diameter in base to top was observed only in paddy straw encased with coconut young fibre. But in other treatments it was found that the diameter of stalk base is more than the top portion.

Effect of substrate on biological yield: Among the six substrate combinations, paddy straw was most suitable for the maximum production of fruit bodies (1961.90 g) with the bioefficiency of 196.19 % harvested in 3 intervals. Next to the paddy straw alone, the combination of paddy straw with maize stalk (1:1 v/v) and saw dust (1:1 v/v) should results with a production of 1.743 g and 1.773 gm harvested in 3 intervals (flashes) respectively. Cultivation of *C. indica* on the substrate combination of paddy straw with maize stalk and paddy straw with saw dust, the recorded bioefficiency was slightly less than paddy straw alone but higher than young coconut fibre (994.4 gm) and bamboo leaves alone (839.9gm). Comparison of the biological efficiency of *C. indica* on all the substrates revealed that maximum biological efficiency was on paddy straw (196.1%) which was followed by paddy straw + saw dust (177.37%), paddy straw + maize 1:1 (174.33%), maize stalk (161.16%) and bamboo leaves (84.93%). This study was supported by the experiment of Amin *et al*., (2010). He also used different substrates for cultivation of *C. indica* to see the effect of substrates on yield and biological efficiency.

Effect of substrates on biological efficiency: Five locally available substrates such as paddy straw, maize stalk, saw dust, bamboo leaves, young coconut fibre waste and their different combinations were used to ascertain the best suitable substrate for cultivation of *C. indica* in North Bengal region. From the data presented in Table 1 it is revealed that minimum period was required to colonize the substrate in paddy straw + maize stalk waste (1:1 v/v) (13 days) followed by paddy straw alone (14.33 days), paddy straw+ saw dust (1:2 v/v) (14.67 days), paddy straw+ saw dust (1:1 v/v) (15.33 days), maize stalk alone (17.66 days), bamboo leaves (20.67 days) and young coconut fibre waste (18.33) respectively. Maximum period (20.50 days) was required for partial colonization in bamboo leaves. Early emergence of pin heads occurred on paddy straw (32.5days) followed by paddy straw+ maize stalk (1:1 v/v) combination (35.67 days). They were followed by paddy straw +saw dust (1:1 v/v) 36.23 days, paddy straw +saw dust (1:2) 36.32 days, maize stalk (36.66 days), young coconut fibre (38.33 days) . Delayed pin head formation was recorded only in bamboo leaves where pin heads were appeared 41.35 days after spawning. The overall spawn run period ranged between 14-20 days and pinhead initiation period between 32 to 41days. Maximum number of fruiting bodies (6/flush) was recorded on paddy straw followed by paddy straw + maize stalk waste (1:1) (5.67/flush) paddy straw + saw dust (1:1), maize stalk, young coconut fibre and bamboo leaves respectively. Maximum biological efficiency of *C. indica* in three flushes was recorded on paddy straw (196.1%) which was subsequently followed by paddy straw+ saw dust in 1:1 ratio (177%), paddy straw +maize stalk in 1:1ratio (174.33%), maize stalk 161.16%, paddy straw + saw dust (1:2) 135.2%, young coconut fibre (99.44%) and bamboo leaves (83.93%) respectively. The reason for low biological efficiency on bamboo leaves may be attributed to unavailability of necessary cellulosic compound in required amounts for fruit body formation. Paddy straw was the best suitable substrate in respect of spawn run period, pinhead formation time, average weight of fruit body and biological efficiency. Proportionate amounts of lignin, cellulose and hemicellulose in paddy straw might have played the crucial role in performance of the mushroom study. Superiority of paddy straw as compared to many other substrates such as sugarcane bagasse, ground nut haulms, soybean hay, black gram hay, sunflower stalk, cotton waste, sesamum stalk, coir pith and wheat straw for cultivation of *C. indica* has been reported by many workers (Yadav 2006; Chaubey *et al*., 2010; Pani 2010; Saranya *et al*., 2011). The data in the table 1 indicate that the biological efficiency on bamboo leaves was quite low as compared to paddy straw and other substrate combination. It is clear from the results of this experiment that in respect of time required from spawning to pinhead appearance, biological efficiency and average weight of fruit body, paddy straw was the best substrate for cultivation of *C. indica* in North Bengal region.

Effect of casing material on biological efficiency: In this experiment, paddy straw based bag was encased separately with seven different casing materials viz., sand + soil (1:1v/v), vermicompost, tea waste + sand (1:1 v/v), saw dust + sand (1/1 v/v), tea waste + soil+ sand (1:1:1 v/v/v) and wet hard paper and saw dust alone,, young coconut fibre and spent mushroom compost (SMC) of *A. bisporus* to assess their effect on the biological efficiency of *C. indica*. From data illustrated in Table 2, it is revealed that among the nine treatments maximum biological efficiency was obtained on paddy straw encased with the SMC followed by the combination of sand+soil (196.19%), YCF (194.11), saw dust + sand (163.29%), wet hard paper (130%), tea waste + soil +sand (151.77%) and tea waste + sand, 144.57%, and vermicompost130.70%, and saw dust alone showed the lowest biological efficiency 96.94%. Kalha *et al.,*

(2011) and Kumar *et al*., (2012) reported that the various supplement and biofertilizer in casing layer have the effect on the yield of *C. indica.* The thickness of casing layer also affected the yield and bioefficiency as recorded by Subramanian and Shanmugasundaram, (2015).

Effect of different substrates on protein content of fruit body: Quantification of protein content of the different mushroom samples grown in different substrate did not show significant differences (Fig.3). Among the substrates the highest protein content of the pileus of fruit body was observed as 135.67 mg/gt and 134.33 mg/gt in paddy straw and young coconut fibre grown samples respectively. The maximum protein content of stipe of fruit body was observed in sample grown in paddy straw followed by paddy straw + maize stalk, maize stalk (56.67mg/gt), YCF (52.68 mg/gt), paddy straw + saw dust (1:2) 46.35 mg/gt and the minimum protein content was found in both paddy straw + saw dust (1:2) and bamboo leaves as 45.67mg/gt. The protein content was always found to be high in pileus compared to stipe. Velusamy *et al.* (2014b) reported the same result about protein content of pileus than stalk of fruit body. The chemical constituents of fruit body grown in different substrate varies as reported by Shin *et al*., (2007) and Pani (2010). Pushpa *et al.,* (2010) suggested that this mushroom is protein and fibrous rich with low fat content and may be used as protein supplementary diet.

Effect of different substrates on carbohydrate content of fruit body: No significant difference in carbohydrate content was found in mature spophores of *C. indica* grown in six different substrate combinations. Carbohydrate content (mg/gt) of *C. indica* grown in different substrate is represented in fig.4. The study revealed that the carbohydrate content of pileus is lesser than the stipe of the fruit body (Alam *et al.,* 2008). Among the substrates, the lowest total sugar content was found in stipe of fruit body grown in paddy straw and maize stalk combination as 26.30 mg/gt where others substrate based fruit body showed average. total sugar content of 32.62 mg/gt. On the other hand in case of pileus the lowest total sugar content was found in bamboo leaves (21.67 mg/gt) where maximum total sugar content (24.33 mg/gt) was found in YCF growing fruit body followed by paddy straw (23.67mg/gt) paddy straw + saw dust (23.67 mg/gt) and maize stalk singly (23.67mg/gt) and paddy straw +

Fig.1. *Effect of substrates on biological efficiency of C. indica, A. paddy straw B. paddy straw+ maize stalk, C. paddy straw + saw dust (1:1), D. Saw dust alone, E. Paddy straw + saw dust (1:2). F. Bamboo leaves G. Young coconut fibre waste (YCF).*

Table1. Effect of substrates on biological efficiency of *C. indica* substrate.

Substrates	Colonization days	Days for pin head appearance	No. of pin head	No. of sporocarp in 1st flush	Wet of each sporophore	Yield/bag			Total yield/bag	BE (%)
						1st flush	2nd flush	3rd flush		
Paddy straw	14.33±0.49	32.5±1.12	36.83±3.37	6.67±0.61	230.67±9.42	1258.56±60.39	420.67±17.4	280.67±18.41	1961.01	196.1
Maize stalk	17.67±0.56	36.5±1.73	22.17±1.62	4.33±0.56	197.5±10.25	1130.83±47.36	253.33±11.45	227.5±13.89	1611.6	161.16
Paddy straw + Maize stalk (1:1)	13.33±0.56	35.67±1.20	32.83±2.43	5.33±0.61	208.83±8.03	1250±18.07	290±15.25	203.33±8.53	1743.3	174.33
Paddy straw + saw dust(1:1)	15.33±.067	36.17±1.35	26.50±2.32	5.17±0.31	198.83±8.22	1135.83±36.29	375±17.27	262.83±20.69	1773.66	177.37
paddy straw + saw dust (1:2)	14.67±0.67	36.33±0.98	22.67±2.34	4.670.56	194.67±10.34	736.17±24.11	321.67±11.3	294.17±22.89	1352.01	135.2
Bamboo leaves	20.50±2.35	41.67±1.90	12.33±0.99	3.5±0.43	145.5±19.56	311.84±9.88	280.83±17.34	246.67±20.76	839.33	83.93
Young coconut fibre	18.33±2.36	38.33±1.35	16.35±1.62	4.33±0.86	149.83±10.25	444.17±36.33	310.15±15.56	240.17±8.89	994.49	99.44

* Values are average of the 6 replicate experiments, ±Standard Error

Table 2. Influence of different casing material on bioefficiency of *C. indica* casing materials.

Substrates	days for primordial initiation	No. of pin head	No. of sporophores /bag in 1st flush	Production/bag			Total yield/ bag	BE (%)
				1st flush	2nd flush	3rd flush		
Vermicompost	16.67±1.20	40.14±1.90	5.14±0.69	586.57±23.33	400.71±22.96	320.71±17.75	1307.99	130.70
Soil+ sand	15.67±0.33	42.28±2.09	6.29±0.52	825.71±45.75	635.43±23.63	500.85±21.24	1961.99	196.19
Tea waste	18.33±0.88	23.71±2.23	4.71±0.47	591.57±21.50	510.71±27.39	415.43±23.88	1517.71	151.77
Hard paper	11.34±0.89	41.29±3.12	4.57±0.65	603.28±16.69	495.28±17.33	465.14±81.92	1563.7	156.37
Saw dust	18.67±0.34	29.15±3.29	4.43±0.43	528.29±29.53	230.71±16.96	210.43±33.42	969.43	96.94
Saw dust+ sand	18.34±1.2	31.57±1.75	4.51±0.48	621.57±27.18	520.57±26.83	490.85±28.31	1632.99	163.29
Tea waste + sand	17.34±0.88	39.43±2.12	4.71±0.42	556.57±30.48	500.85±17.01	391.29±29.20	1448.71	144.87
Young coconut fibre	18.67±0.89	26.28±3.12	8.43±.52	820.28±21.56	610.54±24.5	510.24±22.67	1941.06	194.11
SMC	10.34±0.89	24.71±1.86	9.51±0.68	930.57±16.48	640.71±17.38	500.14±23.88	2071.42	207.14

*Values are average of the 7 replicate experiments, ± Standard Error

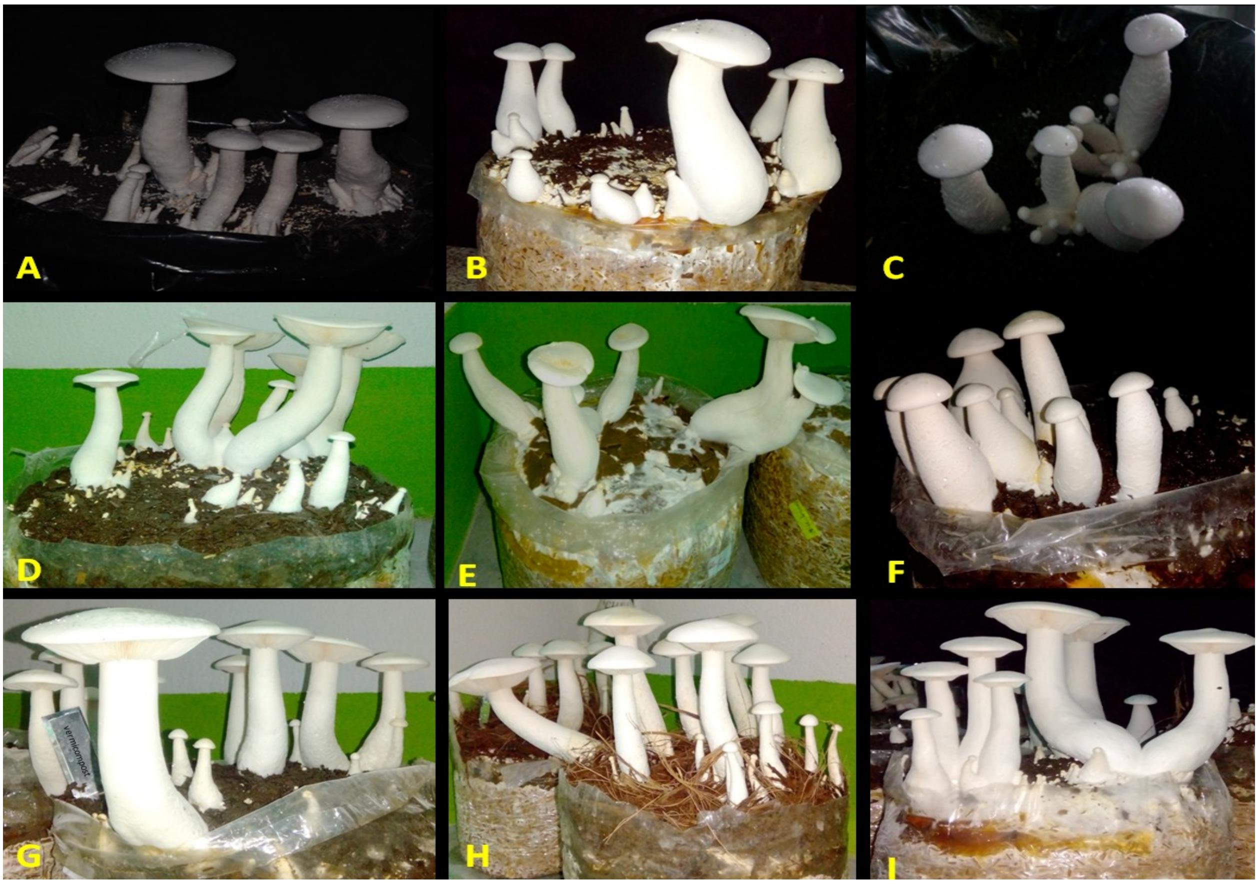

Fig. 2. *Effect of casing on biological efficiency of C. indica A. sand+soil B. Sand+soil+ tea waste; C. saw dust, D. Saw dust+ Sand, E. Hard wet paper, F. Sand+ tea waste, G. vermicompost, H. Young Coconut fibre waste (YCF). I. SMC of Agaricus bisporus.*

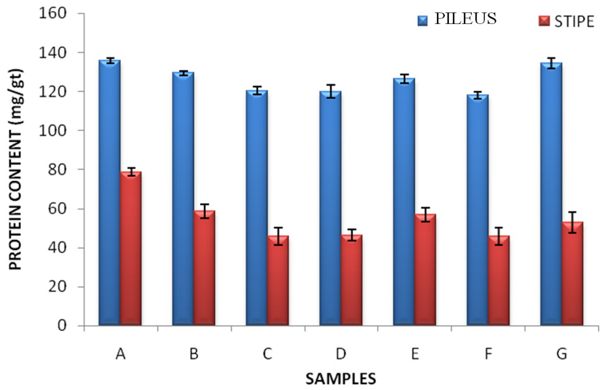

Fig. 3. *Effect of different substrates on protein content of fruit body; A. paddy straw, B. Paddy straw + maize stalk, C. Paddy straw + saw dust (1:1), D. Paddy straw + saw dust (1:2), E. Maize stalk , F. Bamboo leaves, G. Young coconut fibre.*

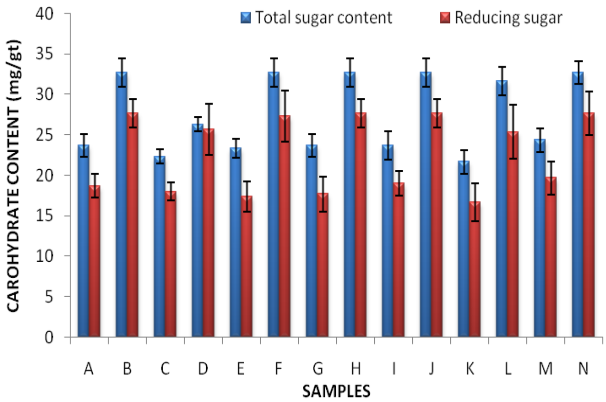

Fig. 4. *Effect of different substrates on carbohydrate content (mg/gt) of fruit body; A. Pileus-paddy straw, B. Stipe- paddy straw, C. Pileus-paddy straw + maize stalk (1:1 v/v), D. Stipe-paddy straw + maize stalk (1:1v/v), E. Pileus--paddy straw + saw dust (1:1 v/v), F. Stipe-paddy straw + saw dust (1:1 v/v), G. Pileus- paddy straw + saw dust (1:2 v/v), H. Stipe- paddy straw + Saw dust (1:2 v/v), I. Pileus-maize stalk, J. Stipe-maize stalk, K. Pileus-bamboo leaves, L. Stipe-bamboo leaves, M. Pileus-Young coconut fibre. N. Stipe-Young coconut fibre.*

maize stalk (22.33 mg/gt). Sharma *et al.* (2013), reported that the organic supplements also effect on the non-enzymatic antioxidants and mineral expression in *C. indica*. Fruit body of *C. indica* contain lesser carbohydrate than protein in pileus as reported by Alam *et al.* (2008).

Effect of casing materials on protein content of fruit body: Similar to previous result protein content in different mushroom samples grown in paddy straw based compost encased with different casing materials was also not significantly different (Fig. 5). The highest protein content (mg/gt) was found in the mushroom sample encased with spent mushroom substrate fol-

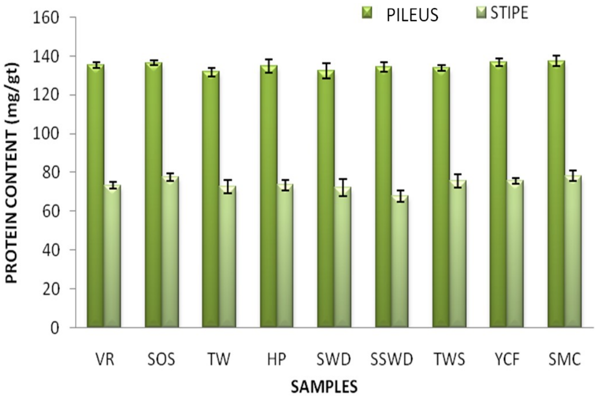

Fig.5. *Effect of different casing materials on Protein content of fruit body; VR - vermicompost, SOS-Soil+ Sand, TW-Tea waste, HP-Hard paper, SWD-Saw dust, SSWD - Sand+ saw dust, TWS-Tea waste, YCF-Young coconut fibre, SMC-Spent mushroom compost, SMC-Spent mushroom compost.*

paddy straw + saw dust (1:2) and bamboo leaves as 45.67mg/gt. The maximum protein content (78.33 mg/gt) of stipe of fruit body was observed in SMC casing material followed by SOS (77.67mg/gt), YCF (75.67 mg/gt), TWS (75.67), HP (73.67mg/gt), VR (73.33mg/gt), TW (72.67 mg/gt), SWD (72.33 mg/gt) and the minimum protein content was found in SSWD as 67.67 mg/gt. Maximum protein was observed in pileus of young fruit body compared to stipe by Alam *et al.,* (2008) and Velusamy *et al.,* (2014b).

Effect of casing materials on carbohydrate content of fruit body: No significant difference in carbohydrate content was found in mature spophores of *C. indica* grown in nine different casing material combinations. Carbohydrate content (mg/gt) of *C. indica* grown in different substrate is represented in fig.6. Among the casing materials, the maximum total sugar content (26.30 mg/gt) was found in stipe of fruit body

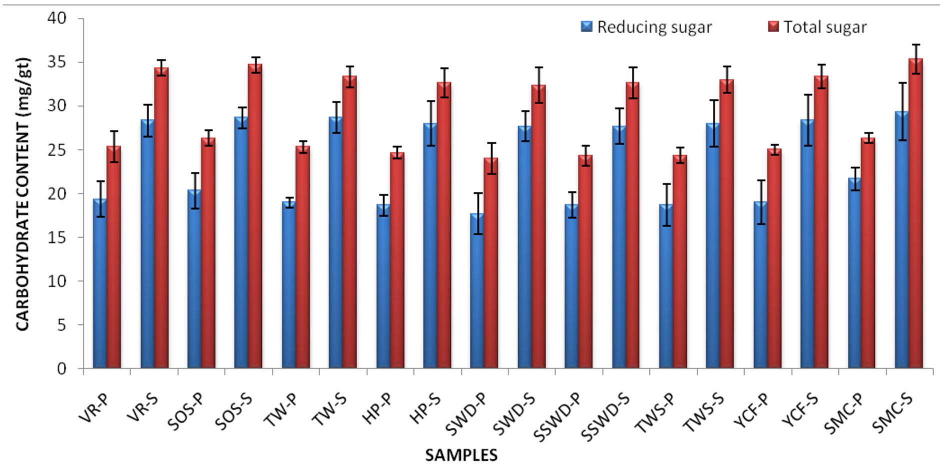

Fig. 6. *Effect of casing materials on carbohydrate content of fruit body; VR-P- vermicompost pileus, VR-S-Vermi stipe, SOS-P-soil+ sand pileus, SOS-S- soil + sand stipe, TW-P-tea waste pileus, TW-S- tea waste stipe, HP-P-Hard paper pileus, HP-S-Hard paper-Stipe, SWD-P-saw dust pileus, SWD-S-saw dust stipe, SSWD-P-sand+ saw dust pileus, SSWD-S- Sand + saw dust stipe, TWS-P-tea waste pileus, TWS-S- Tea waste Stipe, YCF-P-Young coconut pileus, YCF-S- Young coconut Stipe, SMC-P-Spent Mushroom Compost pileus, SMC-S- Spent Mushroom Stipe,*

lowed the sample grown in paddy straw encased with young coconut fibre, soil + sand, vermicompost, hard paper, sand + saw dust, tea waste + sand, saw dust. The lowest result found in the sample grown with tea waste. The protein content was always found to be high in pileus compared to stipe. It has been found that the various casing materials also have the effect in chemical constituent of fruit body of *C. indica*. Among all the casing materials the highest protein content of the pileus of fruit body was observed as 137.34 (mg/gt) in SMC followed by YCF (136.67 mg/gt), SOS (136.33 mg/gt), VR (135.34 mg/gt), HP (134.67 mg/gt), SSWD (134.33 mg/gt),TWS (133.67 mg/gt), SWD (132.34 mg/gt), TW (131.67mg/gt). The maximum protein content of stipe of fruit body was observed in sample grown in paddy straw followed by paddy straw + maize stalk, maize stalk (56.67mg/gt), YCF (52.68 mg/gt), paddy straw + saw dust (1:2) 46.35mg/gt and the minimum protein content was found in both grown in SMC followed by SOS (34.67), VR (34.33), YCF and TW (33.33 mg/gt), TWS (33mg/gt) , SSWD, HP (32.67mg/gt). On the other hand in case of pileus the lowest total sugar content was found in SWD (24 mg/gt) where maximum total sugar content was recorded in SMC and SOS (26.33 mg/gt). Maximum carbohydrate was obtained in stipe compared to pileus by Alam *et al.,* (2008) and Velusamy *et al.,* (2014b).

Conclusion

From the above results we can conclude that the paddy straw is the best substrate for cultivation of *C. indica* and the biological efficiency of *C. indica* can be increased up to 180-198% by using a combination of soil + sand as casing material in North Bengal condition. It was revealed that the casing material plays a decisive role in increasing biological efficiency of summer mushroom. The nutritional value of fruit body also depends on the substrate on which it is grown.

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