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Growth, Infestation and Yield of Oyster Mushroom (*Pleurotus ostreatus* (Jacq.) P Kumm on Local Substrates in the Cropping House in Kumba Municipality South West Region, Cameroon

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Abstract:
The farming of oyster mushroom is reported as an economically viable biotechnology process for conversion of different organic wastes. Due to insufficient knowledge on the use of different local substrate and combination for production of oyster mushroom, the main aim of this work is to contribute to knowledge on the effect of different substrate medium, on growth, infestation and yield of the oyster mushroom. This work was carried out at HTTTC Kumba, South West region of Cameroon. The species of mushroom used was the white oyster mushroom and was spawned on easily available substrates. The treatment combinations were: (Control (T0): corn husk, Treatment 1(T1): pig dung, Treatment 2(T2): cocoa pod husk, Treatment 3(T3): 75% corn husk +25% cocoa pod husk, Treatment 4 (T4): 50% corn husk +50% cocoa pod husk, Treatment 5(T5)+25% corn husk +75% cocoa pod husk, Treatment 6(T6):75% pig dung+25% corn husk ,Treatment 7(T7):50% pig dung+50% corn husk ,Treatment 8(T8):25% pig dung+75% corn husk ,Treatment 9(T9):10g corn husk+6g NPK Treatment 10(T10):10g corn husk+4g NPK and Treatment 11(T11):10g corn husk+2g NPK each of 1.5kg and replicated for 3 times. The experimental design used was Completely Randomized Design (CRD). All analyses were done at $\alpha = 0.05$ using Minitab version 17 statistical package. Results illustrated that the control T0 (corn husk) was noticed with the shortest spawn run of 20 days and was closely followed by T9(10gcorn husk□6g NPK) resulted with the shortest spawn run period 21 days. The shortest duration for pin head appearance wd (28 days), highest average number of fruiting bodies (34.67), highest diameter of fruiting bodies (9.32cm), average diameter of pileus (6.54cm), average width of stalk (2.6cm), average length of stalk(2.9cm), highest total length of mushroom(6.93cm), lowest number of fungi affected by diseases (green mould, brown blotch and die back), the highest number of fresh (35.4g/day) and dry mass yield (11.3g/day). In term of the best organic substrate the best substrate combination was T4 (50% cocoa pod husk + 50% corn husk).

Keywords: Substrate combination, Growth, Infestation and Yield of oyster mushroom.

INTRODUCTION

Human population growth, coupled with inadequate supply of food, diminishing quality of health, high rate of unemployment and increasing environmental degradation are some of the key underlying problems affecting the future well-being of humankind. The magnitude of these problems is said to increase as the world's population continues to grow (Chang, 2007; UN, 2017).

According to (UN,2020) the population of Cameroon is estimated to be 26,545,863, with a population density of 56 persons per Km^2 coupled with high unemployment rate of 25.6%, for the proportion of the population of the ages between 15 – 24. It is becoming glaring that Agriculture can play a prominent role in reducing poverty, raise income and improve food security for 80 percent of the world population (Eichenauer and Knack, 2018). This sector is highly neglected and under exploited by most communities and most of all the youths who are the back bones of most growing economy. This situation continues to be looming and poorly addressed.

Food insecurity has negatively affected livelihoods both in rural and urban communities especially in Asia and Sub-Saharan Africa. According to Food and Agriculture Organization (FAO, 2007) some communities are victims of food insecurity due to unsustainable dietary choices. Most attention on agricultural research in Asia and Sub-Saharan Africa and Cameroon in particular is centered towards cash crops for exportation such as coffee, cocoa and oil palm (FAO, 2007) as well as a number of studies on vegetables. Yet, little attention has been focusing toward mushroom production. In rural areas, women and children scramble for fresh mushroom after the first drop of rains due to its nutritional and medicinal benefits. Pharmaceutical reports have made known the importance of mushroom in patients suffering from diabetes, hypertension and other health issues (Devi et al., 2015). But the production still remands low and not available sometimes. The dependent on gathering or picking mushroom under forest floor, barks of trees and in savannas are becoming rudimentary and time consuming since inhabitants moved around in search for mushroom. It has been reported that smugglers and hunters take advantages of this activity to exploit other natural resources indiscriminately especially in forest ecosystem.

In line with the development goals and the Cameroon Vision 2035 plan, there is need to develop strategies that expand dietary choice circles as well as increase agricultural productivity for food security and incomes in order to improve livelihoods (Kollmair et al. 2002). This can be enhanced through introduction and utilization of high value crop like mushroom which represent one of the world's greatest untapped resources of nutrition and palatable food of the future.

Oyster mushroom is one of the most important and it is commercially cultivated for food, and its world production is on the rise. Mushrooms can be part of the solution to world's food shortage as well as health problems; due to high amount of proteins, they can be used to bridge the protein malnutrition gap. Mushrooms contain a high percentage of proteins, which is higher than any other vegetative protein, but it is low in calories (Mohd *et al*. 2013). Having low starch content, it is a good diet for people suffering from diabetes (Devi et al., 2015). They contain 19-35% protein, 0.6-3.1% fat content (Shirur, 2011), 70-90% moisture, 7.5-16.5% fiber content (8.7 %), 9.8 % ash content and 57.6 % carbohydrate content, while vitamins such as riboflavin (4.7mg) and niacin (108.7mg), thiamin (4.8 mg). Minerals like phosphorus (476 mg), ferrous (8.5 mg) calcium (98 mg) and sodium (61 mg) on 100 g dry weight bases are also found in mushrooms (Somashekhar et al. 2010). Also, they are endowed with bioactive compounds that are of medicinal value (Chang, 2004).

MATERIALS AND METHODS

Study Site

This study was carried out in Kumba Sub Division, Meme Division of the South West Region, Cameroon (Figure 2). The experimental house was the Cropping house of Kumba Njuki Farmer common initiative group (CIG). The experimental sites were located at altitude 211m from sea level, longitude 9° 26′ 48· 84″ E and latitude 4.39°, 10· 68″ N.

Kumba falls within the Cameroon Agro-ecological Zone IV characterized by mono modal rainfall. The climate of Kumba is typically Equatorial with two seasons, the dry season (November to March), and the rainy season (April to October) with an average annual rainfall ranging from 2500 to 4oomm per annum (IRAD- Barombi, 2012). The natural vegetation is equatorial forest and the mean annual relative humidity and temperature are between 70% to 84% and 24°C to 35°C respectively, characterized by hot days with high intensity of sunlight. Kumba has a loamy soil which is brownish yellow colouration, with high organic matter content suitable for agriculture, with crops such as banana, plantains, yams, coco yams, maize, vegetable crops and cocoa being the predominant crop grown in the area. The vegetation is predominantly evergreen forest, characterized by abundance of leguminous trees (Manimuthu*et al*.2015). This cropping house was constructed with wooden materials for the frame work, with dimensions 5m long, 4m wide and 3m high. It was built to have adequate light transmission, good air flow quality and ambient CO_2 levels. The walls were made from cement bricks to keep predators away. The sides were covered entirely with wire mesh and palm frond to prevent the entry of disease transmitting pests and to maintain the internal humidity and temperature. The cropping house has concrete floor to keep the entire cropping house clean and free from direct contact with soil. The experimental bags were placed on tables measuring 15cm x 15cm. Figure 1, presents the experimental setup in the mushroom cropping house.

Figure 1: Mushroom cropping house

Spawn Material

The species studied was the White Oyster Mushroom (*Pleurotus ostreatus*).White Oyster Mushroom spawn were obtained from the PDFC (Projet de Développement de la Filière de Champignon) Yaoundé, NPK was gotten from Farmer Store in kumba while Corn husk, pig dung cocoa pod husk, were gotten from agricultural and livestock cooperatives in Kumba.

Experimental Design

The experiment was carried out using a completely randomized design with 12 treatments and a control with 100% corn husk. The factor to be investigated was substrates. There are twelve levels of substrates comprising combinations of corn husk, pig dung, cocoa pod husk, poultry dung and NPK. The experimental units were replicated three times to give a total of thirty-six (36) experimental units (Figure, 3). Substrates were placed in perforated polythene bags. The bags in the cropping house were 15cm x 15cm apart, and were randomized for uniform micro environment distribution across treatments in the cropping house (Figure 1). Table 1, presents the different experimental treatment combinations.

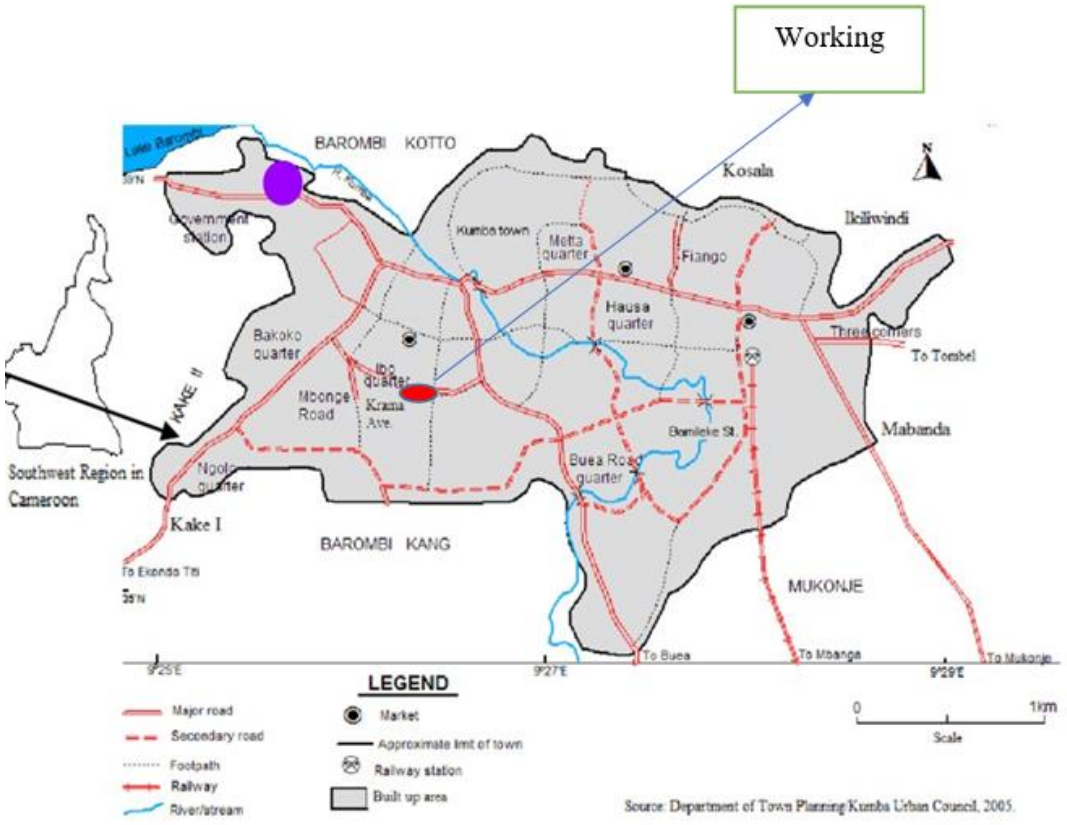

Figure 2: A map of Kumba showing the study site

Source: Divisional Delegation of Agriculture and Rural Development Meme Kumba (DDARD. 2014).

Table 1: Substrate combinations for the different treatments

SN	TREATMENT	TREATMENT COMBINATION
1	T0	Corn Husk
2	T1	Pig Dung
3	T2	Cocoa Pod Husk
4	T3	75%Corn Husk+25%Cocoa Pod Husk
5	T4	50% Corn Husk+50% Cocoa Pod Husk
6	T5	25% Corn Husk+75%Cocoa Pod Husk
7	T6	75% Pig Dung+25%Corn Husk
8	T7	50%Pig Dung+50%Corn Husk
9	T8	25%Pig Dung+75%Corn Husk
10	T9	10g Corn Husk+6g NPK
11	T10	10g Corn Husk+4g NPK

12	T11	10g Corn Husk+2g NPK

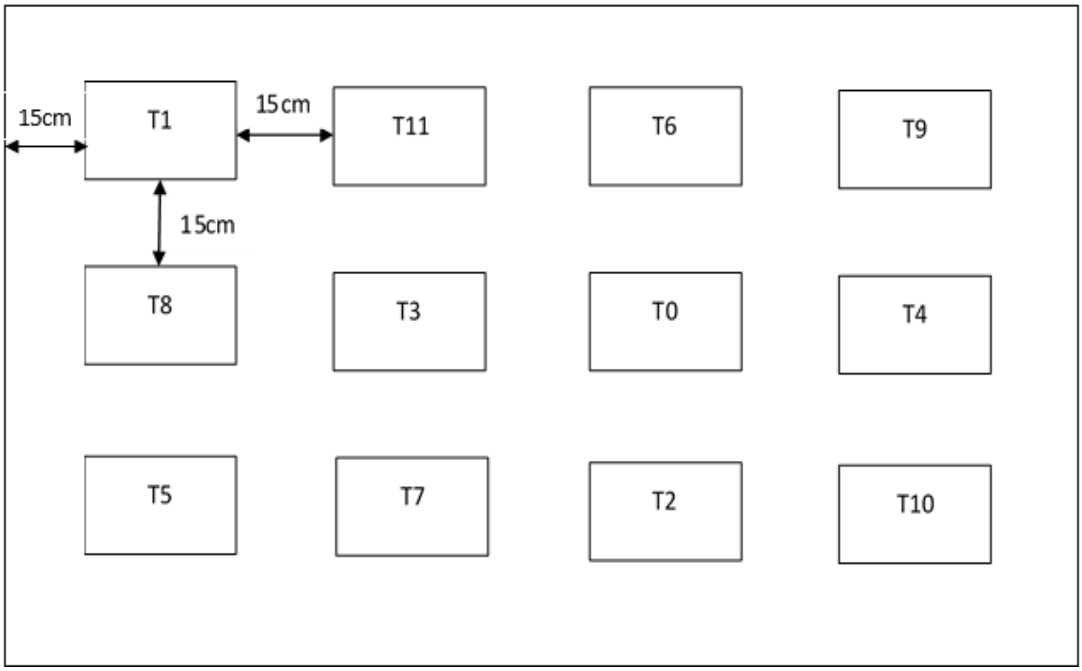

Figure 3: Experimental design

Agronomic Operations

Preparation of Substrate:

The principal components of the different substrates were prepared. Cocoa pod husk was chopped using a cutlass and crushed using a wooden mortal. The pig dung was sundried while the corn husk was chopped to fine particles. The different substrates were mixed at varying ratios as seen in Table 1. The materials were mixed in a clean basin using a wooden spoon. The prepared substrate mixtures were filled into heat-resistant polythene bags. The bags were gently pressed and were sealed by rubber bands on the same day. Each treatment had a net weight of 1.5 kg of dry material and 2.5 liter of water supplement. All bags were labelled as per the different treatments. Cotton wool was used to cover the opening on the bags to prevent entering of germs and for air penetration.

Sterilization:

The steam pasteurization method was used and the substrates were pasteurized for 6 hours. Three cement blocks were placed at the bottom of a metal barrel. Wooden frames, about 45 cm by 10 cm in size were placed on top of the cement blocks at the bottom of the metal barrel. The metal barrel was filled with water to 25 cm level. The bags were placed on top of the wooden frames. The top layer bags were turned up-side-down for effective sterilization. An opening was created in the lid of the barrel to monitor formation of steam. Substrates were heated until steam gets out of the opening in the lid, after which pasteurization continued for another six hours. The bags were then cooled for four hours and then transferred to the inoculation room.

Inoculation:

After sterilization, methylated spirit with an alcoholic concentration of 95% was used to sterilize the hands, spawn bottle as well as the neck of the bags. Two candles were lit and the bags were placed in-between the candles to prevent pathogenic infection when the bags were opened for

spawning. Approximately the same spawns were introduced into each bag and cotton wool was placed quickly at the open end of the bags. The bags were shaken gently for uniform distribution of the spawns.

Spawn Running:
The bags were arranged on the wooden shelves in the incubation room according to a Complete Randomized Design (CRD). Spaces of 15 cm were left between treatments for aeration. Formation of mycelia was monitored regularly by observing the development of white thread-like structures on the substrates. The rate of mycelia growth was observed until total colonization. Time to total colonization ranges from 21 to 45 days after spawning depending on the substrate type and combinations. The thickening of the mycelia in the bags (colonization of the bags) was an indication for the bags to be opened for fruiting bodies.

Cropping:
The bags were then transferred to the cropping house after full mycelia formation, where they were once again arranged according to the Complete Randomized Design on the shelves in the cropping room. Bags were then open slightly at the bottom of the polythene to enhance flushing. The cropping room was watered regularly to provide proper humidity for the growth of the mushroom. The cropping house was opened at the side with wire mesh to provide 50% shade for flushing.

Data Collection
Data collection started from 3 to 4 weeks after spawning (depending on the substrate), that is, following the time for total colonization of the substrate by the mycelium. The cottons at the top of the bags were removed while ensuring high humidity. Some of the parameters measured included: days to first emergence of pinhead, time to maturity, time for second flush, growth parameters etc.

Growth Parameters:
The following growth parameters were measured every day for three months.

Diameter of Pileus (cm):
This was measured in centimeter using meter ruler from on edge of the pileus, across the stipe to the opposite edge.

Stipe Height (cm):
The height of the mushroom was measured in centimeter using meter ruler from the base to the stipe of the pileus.

Number of Fruiting Bodies:
The number of fruiting bodies was counted for each treatment and the mean calculated.

Yield Parameters:
The total dry and fresh mass of the fruiting bodies harvested during the first, second and third flush was measured.

Infestation Parameters:

The number of fungi affected by brown blotch, green mould and Die back for each treatment was collected, counted and recorded.

Data Analysis

The parameters of growth, yield and disease were subjected to Two Way Analysis of Variance with interactions, using the General Linear Model Approach. This was done following tests for Normality and Homogeneity of variance. All analyses were done at $\alpha = 0.05$ using Minitab version 17 statistical package (Minitab Inc, PA, USA).

RESULTS

Growth Characteristics

Spawn Run Period:

The spawn run periods for the different treatment combinations were different. It was observed that To (corn husk) had the shortest spawn run period of 20 days, this was closely followed by T9 (10g corn husk+6g NPK) that had a spawn run period of 21 days during the first flush period. Treatment T3, had the highest spawn run periods of 31, 33 and 54 days in all the 3 different flushing periods.

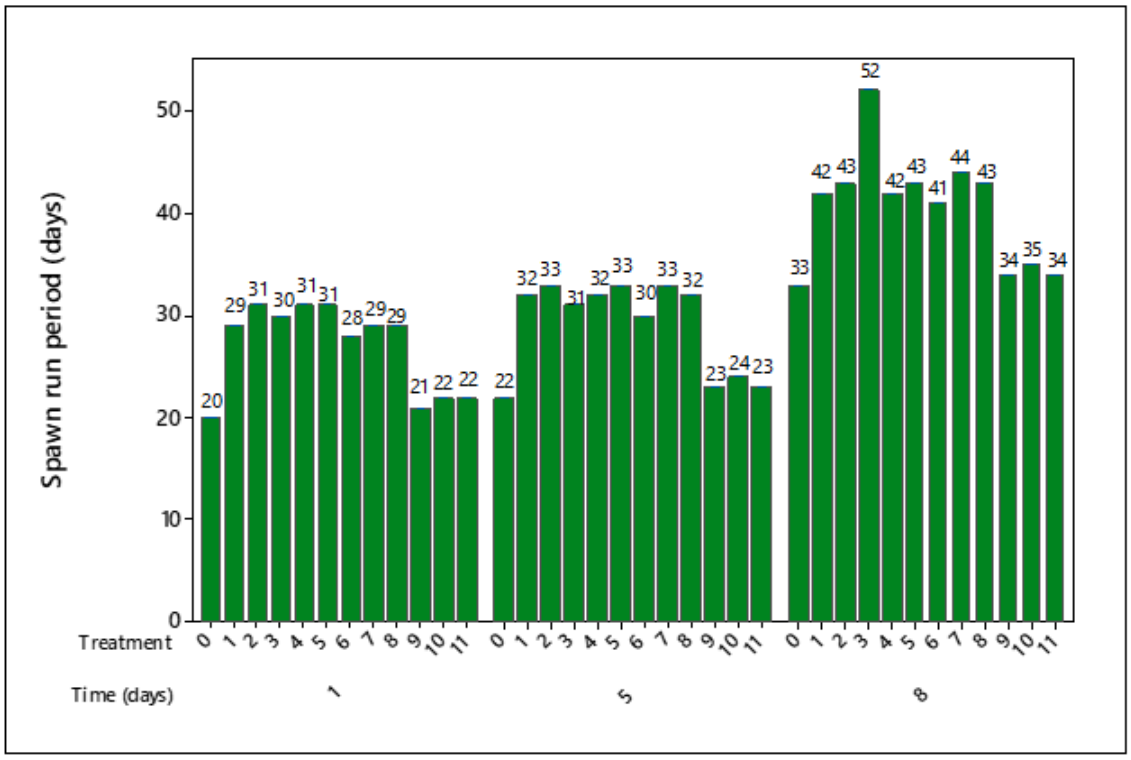

Figure 4: Effect of substrates on Spawn period characteristics of mushroom grown in Kumba

It was observed the appearance of pin head was fastest on Treatment To (corn husk). This was noticed on Day 26 and was closely followed by Treatment T9, with the appearance of pinhead observed on Day 28. Treatment T3 and T4 in all the three flushes were observed to record pin heads with the longest duration for initiation of pinhead (62 days) noted in the last pinhead flush.

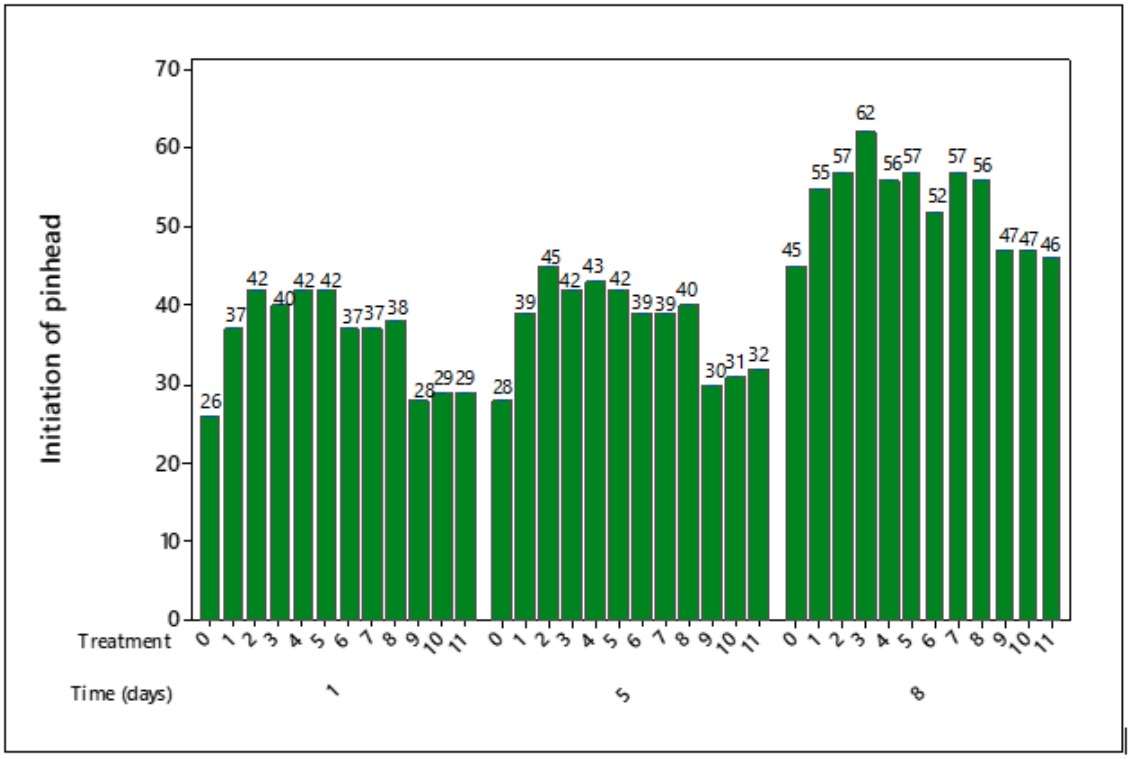

Figure 5: Effect of substrates on Initiation of Pinhead characteristics of mushroom grown in Kumba

Characteristic of Fruiting Body

The fruiting body characteristic were presented in Table 2. The average number of fruiting bodies ($p = 0.001$), diameter of fruiting body ($p = 0.001$) and average diameter of pileus ($p = 0.001$) were statistically different under the different treatments.

Table 2: Analysis of variance results on fruiting body characteristic of mushroom grown in Kumba

Factor	AVFB	DFB(CM)	AVDP(CM)
Treatment (S)	0.001	0.001	0.001
Time (T)	0.001	0.001	0.001
S * T	0.001	0.001	0.001

Values in the Table represent p-values, the level of significance. The treatment has a significant effect on the response variable for all p-values less than 0.05. AFB = Average number of fruiting bodies; DFB = diameter of fruiting bodies; AVDP = average diameter of pileus.

Fruiting body characteristics of mushroom grown in different substrates are presented on Figure 6. The highest diameter of fruiting body was recorded on mushroom grown under Treatment 9 (9.32 ± 0.20 cm). This was statistically similar to diameter of mushroom grown under treatments T8 (8.78 ± 0.20 cm), T10 (9.00 ± 0.20 cm) and T11 (8.73 ± 0.20 cm). The lowest diameter of mushroom fruiting bodies was recorded in those grown under treatments T0 (7.19 ± 0.32 cm) and T2 (7.38 ± 0.30 cm).

The highest average number of fruiting bodies was recorded in mushroom grown under treatment T9 (34.67 ± 1.16) while fruiting bodies were fewest in mushroom grown under

treatment To (24.64 ± 1.13). Similarly, the highest diameter of pileus (6.54 ± 0.29 cm) was recorded in fruiting bodies of mushroom grown under treatment T9 and the lowest (3.53 ± 0.30 cm) was recorded in mushroom grown under treatment To.

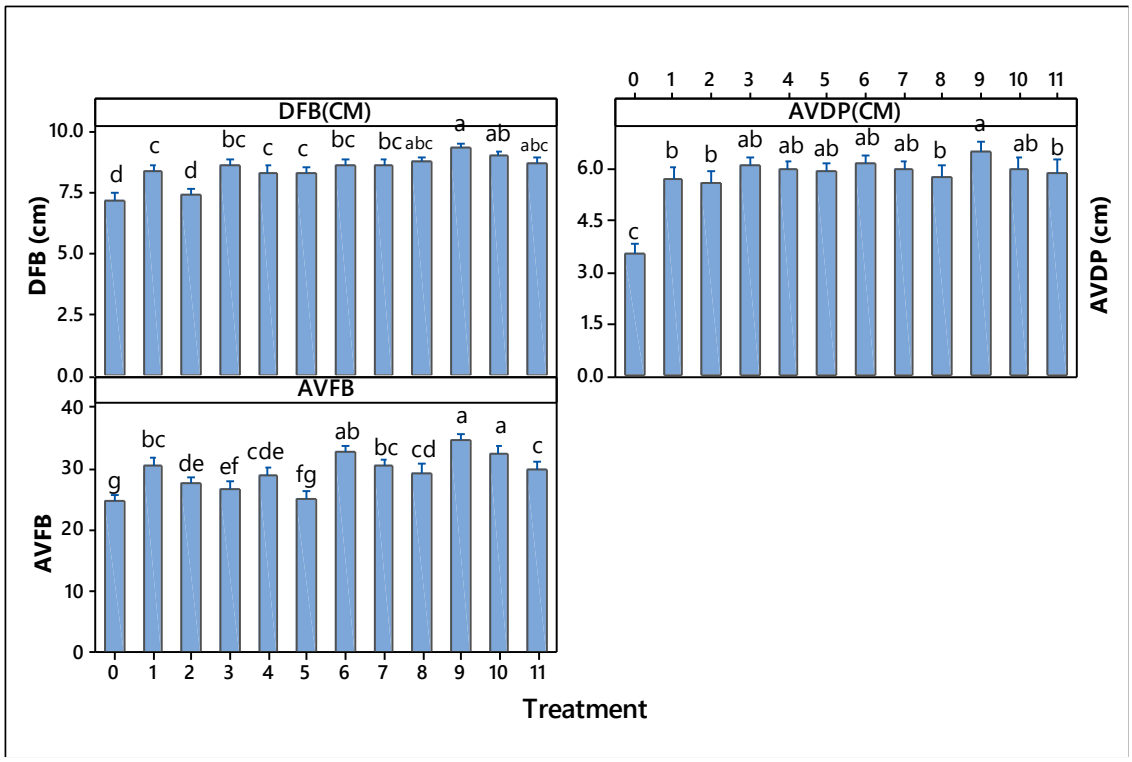

Figure 6: Effect of substrates on fruiting body characteristics of mushroom grown in Kumba

Bars represent means ± SE. Means separated through GLM ANOVA with Tukey HSD test at α = 0.05. Bars sharing a letter for each response variable are not significantly different. AVFB = Average number of fruiting bodies; DFB = diameter of fruiting bodies; AVDP = average diameter of pileus.

The Diameter of fruiting bodies, number of fruiting bodies and average diameter of mushroom pileus all decreased over time (Figure10). The diameter of fruiting bodies was highest at Week 3 (9.76 ± 0.07 cm) and lowest at Week 9 (6.91 ± 0.11 cm). The number of fruiting bodies was also highest on Week 3 (35.07 ± 0.37) and lowest on Week 9 (22.11 ± 0.34). The diameter of pileus likewise decreased from 7.39 ± 0.10 cm on Week 3 to 3.85 ± 0.10 cm on Week 9.

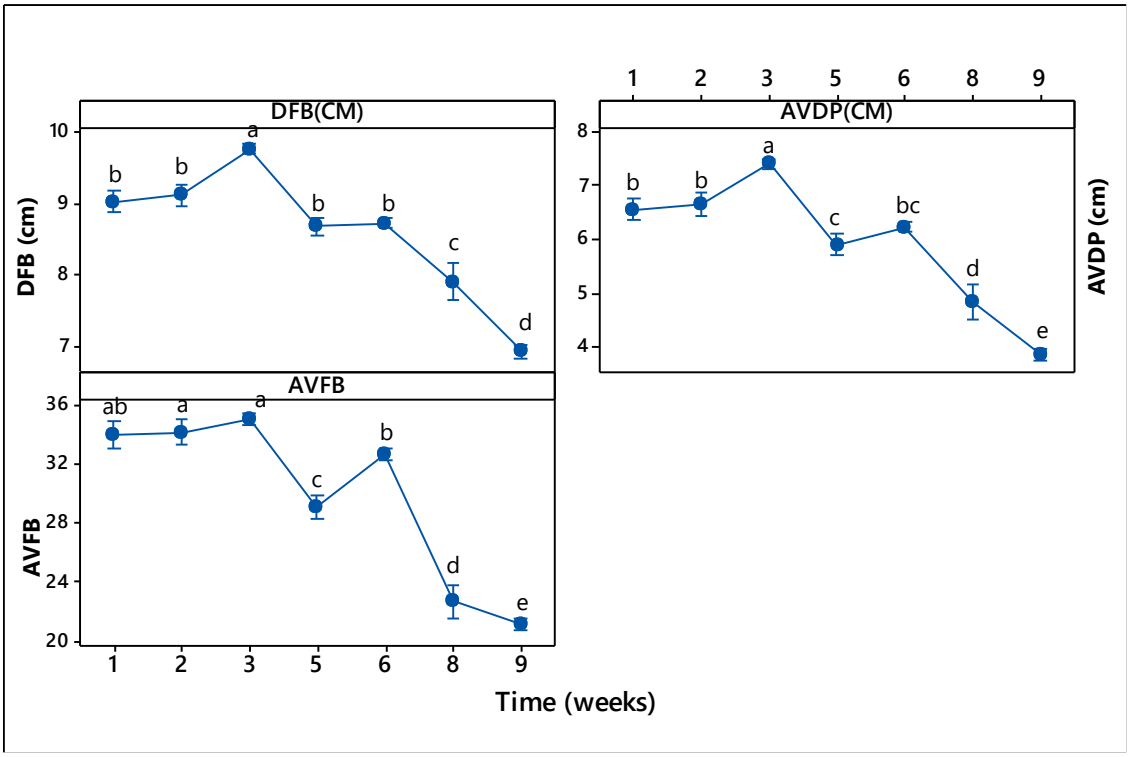

Figure 7: Changes in fruiting body characteristics of mushroom grown on different substrates over time in Kumba.

Values represent means ± SE. Means separated through GLM ANOVA with Tukey HSD test at α = 0.05. Means sharing a letter for each response variable are not significantly different. AVFB = Average number of fruiting bodies; DFB = diameter of fruiting bodies; AVDP = average diameter of pileus.

Morphological Characteristics of Oyster Mushroom on Different Substrates:

Analysis of variance results on morphological characteristics of Oyster Mushroom on different substrates, such as average length of stalk, average width of stalk and total length of mushroom are presented on Table 2. The average Length of Stalk (p = 0.000), Average Width of Stalk (p = 0.000) and Total length of Stalk (p = 0.000) were statistically different under the different treatments.

Table 3: Analysis of variance results on morphological characteristics of oyster mushroom grown in Kumba on different substrates

Factor	AVLS(CM)	AVWS(CM)	TLM
Treatment (S)	0.000	0.000	0.000
Time (T)	0.000	0.000	0.000
S * T	0.916	0.882	0.000

Values in the Table represent p-values, the level of significance. The treatment has a significant effect on the response variable for all p-values less than 0.05. AVLS = average length of stalk; AVWS = average width of stalk; TLM = total length of mushroom.

Average Length of Stalk of mushroom grown in different substrates are presented on Figure 11. The highest average length of stalk was recorded on mushroom grown under Treatment 9 (2.90 ± 0.16 cm). This was statistically similar to length of stalk of mushroom grown under treatments

T6 (2.60 ± 0.15 cm), T8 (2.54 ± 0.18 cm) and T3 (2.30 ± 0.12 cm). The lowest Average Length of Stalk of mushroom was recorded in those grown under treatments T2 (1.90 ± 0.15 cm) and To (1.91 ± 0.10 cm). The highest average width of stalk was recorded in mushroom grown under treatment T9 (2.60 ± 0.18 cm) while average width of stalk was lowest in mushroom grown under treatment To (1.83 ± 0.14 cm). Similarly, the highest total length of mushroom (6.98 ± 0.35 cm) was recorded in fruiting bodies of mushroom grown under treatment T9 and the lowest (4.86 ± 0.43 cm) was recorded in mushroom grown under treatment To.

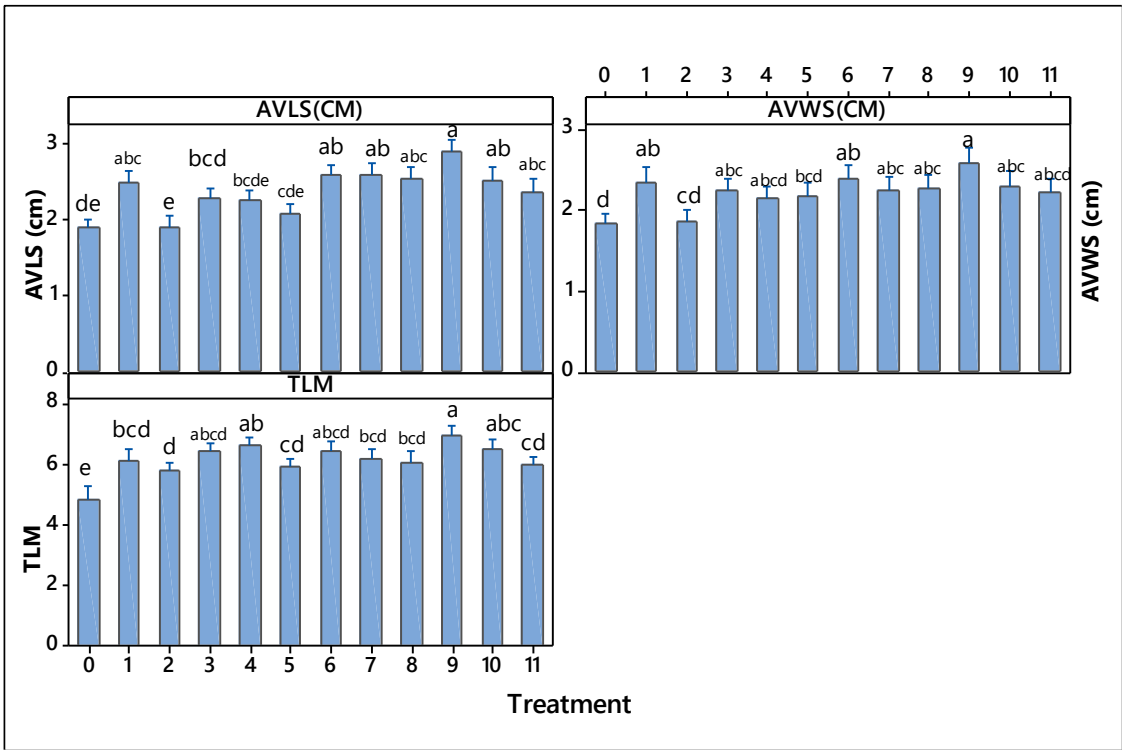

Figure 11: Effects of growth structures on different substrates on Average length of stalk, average width of stalk and total length of mushroom grown in Kumba.

Bars represent means ± SE. Means separated through GLM ANOVA with Tukey HSD test at α = 0.05. Bars sharing a letter for each response variable are not significantly different. AVLS = average length of stalk; AVWS = average width of stalk; TLM = total length of mushroom

The average length of stalk, total length of mushroom and average width of stalk all decreased over time (Figure12). The average length of stalk was highest on Week 3 (3.21 ± 0.06 cm) and lowest on Week 9 (1.50 ± 0.04 cm). The total length of mushroom was also highest on Week 3 (7.82 ± 0.07) and lowest on Week 9 (4.08 ± 0.09). The Average Width of Stalk likewise decreased from 3.16 ± 0.05 on Week 3 to 1.21 ± 0.03 on Week 9 (Figure 12).

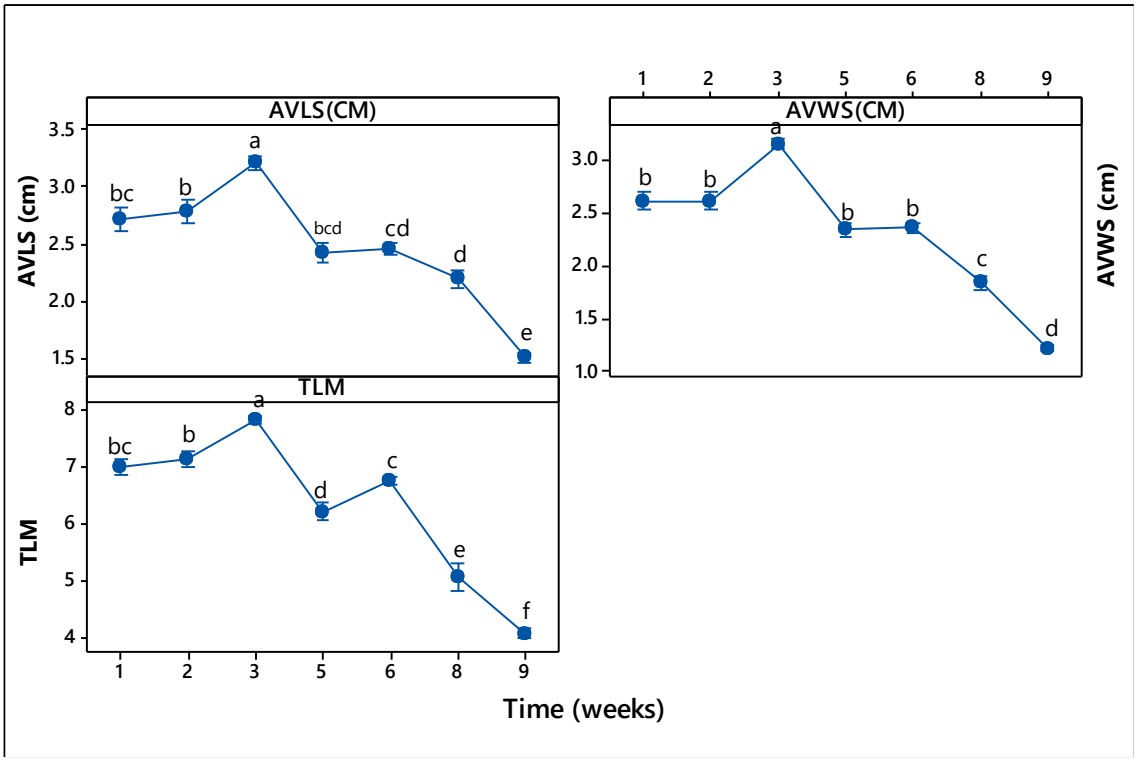

Figure 12: Changes in Average length of stalk, average width of stalk and total length of mushroom grown in Kumba over time.

Values represent means ± SE. Means separated through GLM ANOVA with Tukey HSD test at α = 0.05. Means sharing a letter for each response variable are not significantly different. AVLS = average length of stalk; AVWS = average width of stalk; TLM = total length of mushroom

Disease Infestation in Mushroom Grown on Different Substrates

The analysis of variance results on disease infestation in mushroom grown on different substrates are presented on Table 4. The average number of plants affected with Brown Blotch (p = 0.000), Average number of plants affect Die Back (p = 0.000) and Average Number of Plants affected with Green Mould (p = 0.000) were statistically different under the different treatments, as well as over time.

Table 0: Analysis of variance results on the effect of different substrates on disease incidence in mushroom in Kumba

Factor	AVNBB	AVNDB	AVNGM
Treatment (S)	0.000	0.000	0.000
Time (T)	0.000	0.000	0.000
S * T	0.000	0.000	0.000

Values in the Table represent p-values, the level of significance. The treatment has a significant effect on the response variable for all p-values less than 0.05. AVNBB = average number of plants affected by Brown Blotch; AVNDB = average number of plants affected by Die back; AVNGM = average number of plants affected by green mould.

The highest number of plants affected with Brown Blotch (1.38 ± 0.18) was recorded on Treatment T10. This was statistically similar to the number affected on TreatmentsT3, T5 and T9. The lowest

number of mushroom plants affected with Brown Blotch (0.38 ± 0.10) was recorded on Treatment T1. The highest mean number of mushrooms affected with Dieback (1.42 ± 0.13) was recorded on mushroom grown on Treatment T3. This was statistically similar to most of the treatments except T1, T2, T4 and T11. Statistically, the least mean number of mushrooms affected with Dieback was recorded on Treatment T1 (0.46 ± 0.10). With respect to infestation with Green Mould, the highest mean number of mushrooms affected was recorded on Treatment T9 (1.63 ± 0.16) while the least was recorded on Treatment T8 (0.33 ± 0.14).

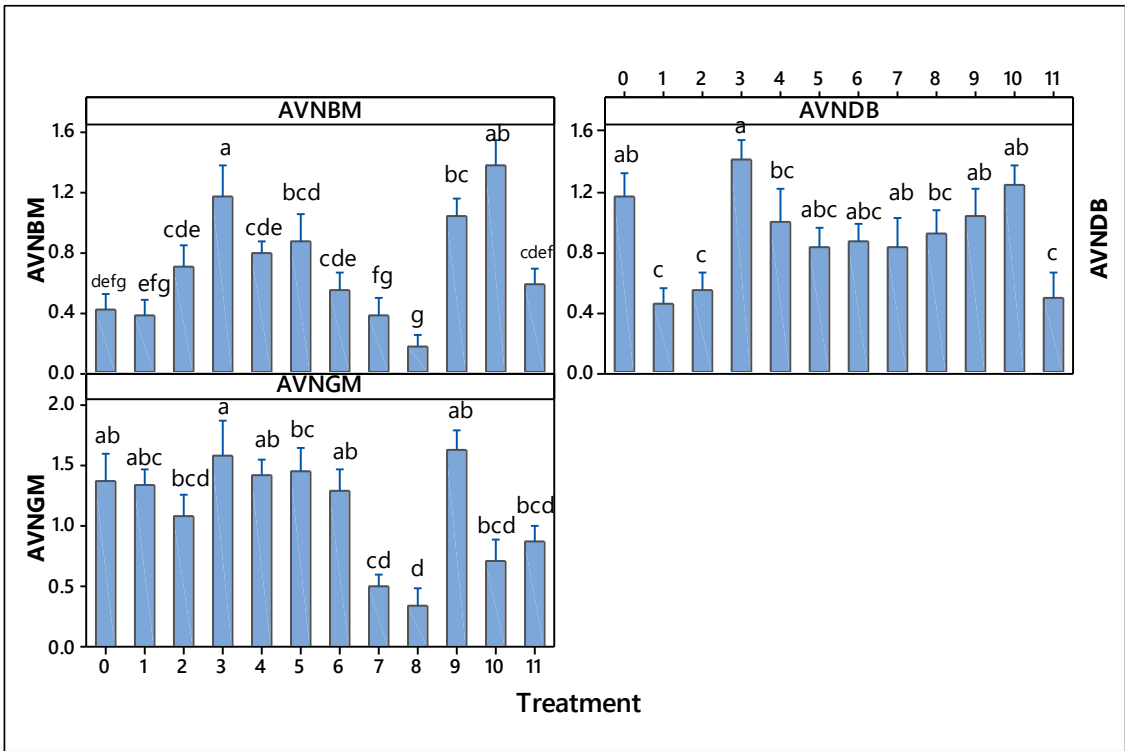

Figure 13: Effect of different substrates on disease incidence in mushroom grown in Kumba.

Bars represent means ± SE. Means separated through GLM ANOVA with Tukey HSD test at α = 0.05. Bars sharing a letter for each response variable are not significantly different. AVNBB = average number of plants affected by Brown Blotch; AVNDB = average number of plants affected by Die back; AVNGM = average number of plants affected by green mould.

Average Number of Mushroom affected by Brown Blotch, Die Back and Green Mould respectively, all decreased over time (Figure 14). The Average Number of mushrooms affected by Brown Blotch was highest at Week 3 (1.22 ± 0.09 cm) and lowest at Week 9 (0.60 ± 0.07cm). The Average Number of mushrooms affected by Green Mould was also highest on Week 3 (1.03 ± 0.12) and lowest on Week 9 (0.96 ± 0.09). Meanwhile the Average Number of mushrooms affected by Die Back decreased from 0.76 ± 0.09 on Week 3 to 0.45 ± 0.06 on Week 9.

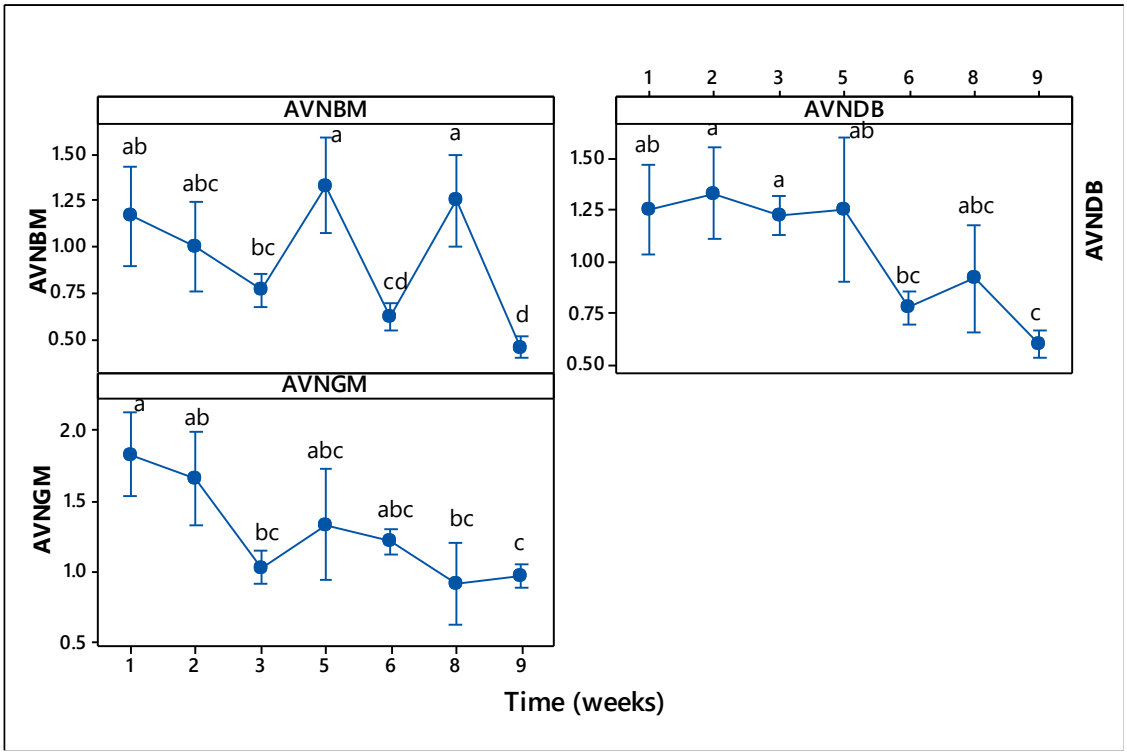

Figure 14: Effect of different substrates on disease incidence in mushroom grown in Kumba.

Values represent means ± SE. Means separated through GLM ANOVA with Tukey HSD test at α = 0.05. Means sharing a letter for each response variable are not significantly different. AVNBB = average number of plants affected by Brown Blotch; AVNDB = average number of plants affected by Die back; AVNGM = average number of plants affected by green mould.

Test Of Hypothesis 2: Different Substrates Have No Significant Effect on The Infestation of Oyster Mushroom.

Table 4 shows that different substrates have a significant effect on incidence of three major diseases of mushroom (p = 0.000 in all cases). Therefore, we reject the Null hypothesis and accept the alternate, that different substrates significantly influence disease infestation in Oyster mushroom during production.

Yield Characteristics of Oyster Mushroom Grown on Different Substrates

Analysis of variance results on Yield characteristics of mushroom grown on different substrates are presented on Table 5 The average total fresh yield (p = 0.000), and total dry mass (p = 0.000) were statistically different under the different treatments.

Table 5: Analysis of variance results on Total Fresh yield and total dry mass of mushroom grown on different substrates in Kumba

Factor	TFY (g)	TDY (g)
Treatment (S)	0.000	0.000
Time (T)	0.000	0.000
S * T	0.000	0.482

Values in the Table represent p-values, the level of significance. The treatment has a significant effect on the response variable for all p-values less than 0.05. TFY = total fresh yield, TDY = total dry mass

The highest fresh mass (35.42 ± 1.69 g) was recorded from Treatment T9 followed by fresh mass of 30.78 ± 1.84 g from Treatment T10. The least fresh mass of mushroom (25.20 ± 1.80 g) was recorded from treatment T0. With respect to Dry mass (Mushroom Biomass), the highest mean mass was recorded from Treatment T9 (11.33 ± 0.50 g) and the least (8.51 ± 0.46 g) was recorded from Treatment T0.

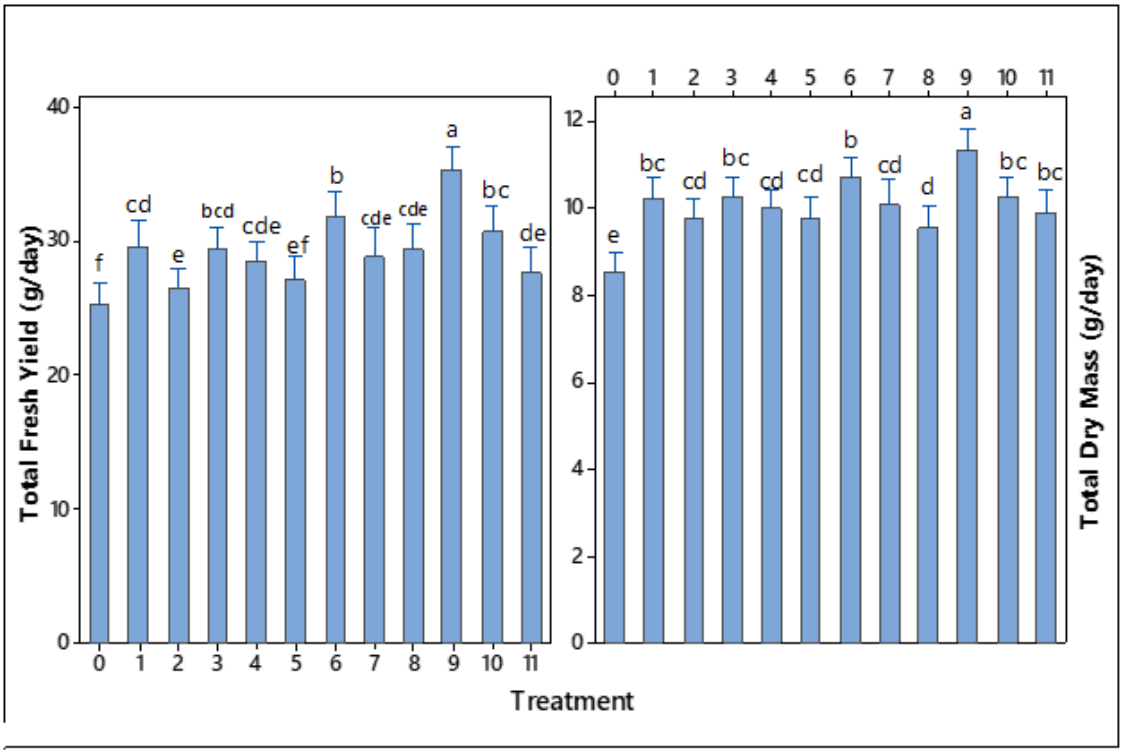

Figure 15: Effects of substrates on Total Fresh yield and total dry mass of mushroom grown in Kumba.

Bars represent means ± SE. Means separated through GLM ANOVA with Tukey HSD test at α = 0.05. Bars sharing a letter for each response variable are not significantly different. Total Fresh Yield and Total Dry Yield all decreased over time (Figure 16). The total fresh yield was highest at Week 3 (37.36 ± 0.37 g) and lowest at Week 9 (17.37 ± 0.33 g). The total dry yield was also highest on Week 3 (12.35 ± 0.09 g) and lowest on Week 9 (6.88 ± 0.09 g).

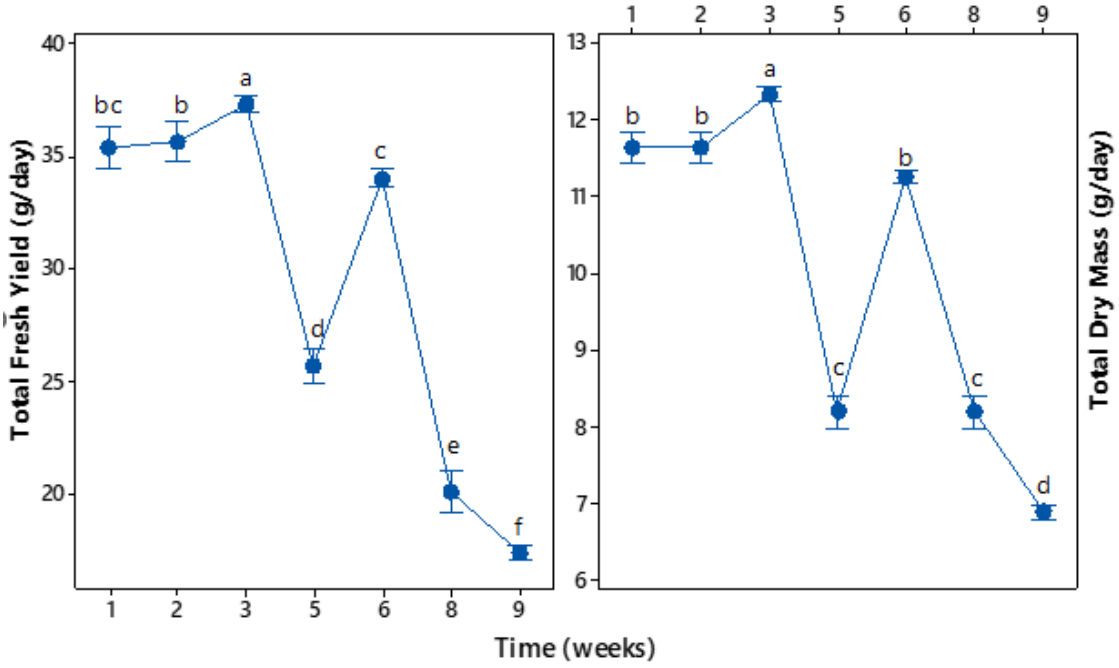

Figure 16: Changes in Total Fresh yield and total dry mass of mushroom grown in Kumba over time.

Values represent means ± SE. Means separated through GLM ANOVA with Tukey HSD test at α = 0.05. Means sharing a letter for each response variable are not significantly different.

DISCUSSION

Mushrooms are becoming a significant component of our diets globally, for their medicinal properties, a source of income, a method of environmental conservation and high nutritional value. The choice of the substrate in mushroom production is of importance since it has a significant influence on the productivity of oyster mushrooms for better growth, development, infestation and yield. At the end of experiment, the following findings were gotten:

Analysis of Variance results on growth parameters show that there is a significant effect of substrate on all yield parameters measured. The result indicates that T9(10g corn husk + 6g NPK) had the highest diameter of fruiting body(9.32cm), the highest average number of fruiting bodies (34.67), highest diameter of pileus (6.54cm), the highest average length of stalk (2.90cm), highest average width of stalk (2.60cm), highest total length of mushroom (6.98cm) meanwhile the lowest growth parameter was gotten at T0(corn husk) and the growth parameters all decreased over time. The possible reason for this result is because NPK contains essential Macro nutrients which is essential for mycelia and Hypha growth and development. Also, the reason for decreases in the growth parameters over time is due to the fact that NPK is made readily available and deplete over time, as opposed to the organic fertilizer which takes time to demineralised. This finding is in accordance with the work of Pathan *et al*. (2009) who reported that NKP was the best in relation to growth characters. There was a similar trend with the work of Sarker*et al*. (2011) who reported that the diameter pileus was highest in NPK (2:1:1). while fruiting bodies were lowest in mushroom grown with corn husk. This was similar to the findings of Mondal et al. (2010) reported that the stipe length, pileus diameter and total yield variation of different substrates might be due to low lignolytic and cellulonitic activity of the substrates.

From the analysis of variance result collected it is evident that different substrates have a significant effect on incidence of three major diseases of mushroom. From the resulted obtained the highest number of mushrooms affected with Brown Blotch (1.38) was recorded on Treatment T10 while the least was recorded on T1 lowest (0.38).This could be attributed to the fact that T10 substrate absorbed more humidity in the cropping house. These are conditions that influence high bacterial disease incidence. This was in agreement with the finding of Jin *et al*. (2006) who cited that High humidity and improper hygienic conditions promote this bacteria disease.

The was a noticeable highest mean number of mushrooms affected with Dieback (1.42) at T3. And the least mean number of mushrooms affected with Dieback was recorded on Treatment T1 (0.46). The incidence of Dieback could properly be as a result of poor sanitation followed closely by mycelia rot this result was in conformity with the work of Aman *et al.* (2008) who had similar result where he stated that Die Back is the most common viral disease where mycelium does not permeate the casing layer or disappears after the normal spread.

From the result it was apparent that the highest mean number of mushrooms affected by Green Mould was recorded on Treatment T9 (1.63) while the least was recorded on Treatment T8 (0.33). This could probably be because of the presence of Red Pepper Mite which is a vector of the fugus *Trichoderma spp.* This is in concordance with the finding of Fletcher *et al*. (2006) who cited that One of the most serious production problems that affects mushroom cultivation is that caused by competitor and pathogenic green moulds (*Trichoderma species*). Which cause the most serious oyster mushroom yield and quality losses.

Analysis of Variance results on yield parameters show that there is a significant effect of substrate on all yield parameters measured. From the result T9 had the highest fresh mass (35.42g/day) and the highest Total Fresh Yield (11.3g/day) as compared to To(control). The yield parameter all decreased over time. This outcome could be as a result of the fact the corn husk +NPK is rich in lignin, cellulose hemicellulose and NPK which is necessary for growth and development hence better yield. This is similar to the findings of Chowdhury et al. (1998) examined the effects of adding different supplements to substrates for growing oyster mushrooms (*Pleurotussajor-caju)* and found adding 5% supplements gave the highest yield of oyster mushroom. This is agreement with the findings of Upadhyay *et al*. (2002), who cited that the nitrogen content of mycelium ranges between 3 to 6%. Cereal straw used for cultivation of oyster mushroom is a poor source of nitrogen (0.5 to 0.8%) and at the time of fructification when most of the nitrogen is utilized for mycelial growth, the depleted nitrogen in the substate becomes inadequate and limits mushroom yield. This is in agreement with the work of Kabir et al. (2022), who said that Phosphate is an essential macronutrient for fungal proliferation as well as a key mediator of antagonistic, beneficial and pathogenic interaction between fungi and other organism. Phosphate sensing is important for responses to stress and regulation of cell-surface changes with an impact on fungal pathogenesis, host immune response and disease outcomes.

CONCLUSION

The study was conducted to check the efficacy of different substrates on the growth, infestation and yield on oyster mushroom. It can be concluded that 10gcorn husk+6g NPK (substrate) supported the growth, infestation and yield of the *Pleurotusostreatus*, thus 10gcorn husk+6g NPK would be recommended as the most suitable substrate for the cultivation of *Pleurotusostreatus* because it practical and economically feasible due to the availability throughout the year at little or no cost in large quantities.

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