International Journal of Advanced Research and Review

www.ijarr.in

INFLUENCE OF VERMICOMPOST ON THE PARAMETERS OF PRODUCTION OF EDIBLE MUSHROOMS: CASE OF *PLEUROTUS OSTREATUS* (KUMMER, 1871)

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ABSTRACT

One of the major problems to the promotion of mushroom culture is the weak productivity of the substrata. The present work, had for objective to formulate a substratum susceptible to increase the profitability of culture of *Pleurotusostreatus*, to identify the best composition of the organic substrata to use in vermicomposting for an improvement of the production of *Pleurotusostreatus*. Two substrata have been formulated. The substrata have been divided in 3 shares each and submitted to 3 treatments of (15 ± 3, 30 ± 3 and 45 ± 3) days by vermicomposting in the goal to determine the best level of mineralization for mushroom culture. These treatments are compared to the control substratum constituted of sawdust of wood (94 %), rice bran (5 %), $CaCO_3$ (1 %) composting during 45 ± 3 days. The comparative survey of the biologic and economic outputs of the substrata showed that the vermicomposts got better results in relation to the control substratum. It is some in the same way for the results of the biologic efficiency as well as the middle number of runts.

Keywords: Vermicomposting, *Eudriluseugeniae, Pleurotusostreatus*, Mushroom

INTRODUCTION

Oyster mushrooms are saprophytic mushrooms cultivated worldwide, particularly in Asia and Europe (Boulmerka, 2017). They are the third commercially produced mushrooms in the world (Boulmerka, 2017). Their taste and high nutritional value ensure their great popularity with consumers. In addition, adapted to a wide variety of climates and capable of growing on various substrates, their cultivation is relatively easy and is practiced on all continents (Lin, 2006). Indeed, according to their enzymatic complexes which allow the decomposition of lignocellulosic complexes, oyster mushrooms are able to develop on all kinds of decomposing organic waste (Velăzquez-Cedeño et al. 2002). Their production therefore adapts to a global waste management problem. This makes it the only common process that combines the production of protein-rich food with the reduction of environmental pollution (Beetz and Kustudia, 2004).

Although it is quite recent in Côte d'Ivoire, there is a lot of interest in mushroom growing. Particularly in the midst of women's groups like that of (FESAAP) (Women in Solidarity for Action and Self-promotion) in Dabou, who have made it an income-generating activity.

However, the profitability of this activity remains one of the major problems in promoting it. The amounts of additives used in conventional composting increase the cost of production. While these substrates are often faced with a quality problem linked to a low availability of minerals which does not allow optimal production of mushrooms.

Indeed, fungi are heterotrophic and fairly sensitive organisms. Thus, the quality of the growing medium considerably affects their growth and yield parameters (Curvetto et al. 2002). Because the growth of the mycelium only depends on the climatic conditions in the substrate (Boulmerka, 2017). The choice of a good substrate and additives is therefore a major advantage in the cultivation of edible mushrooms (Bram and Janna, 2007). Because determining the optimal dose of additives compared to one or more supplements is one of the major problems that makes this culture difficult (Boulmerka, 2017). This is why it is necessary to conduct research on the growing substrates of mushrooms to improve productivity by biological methods such as vermicomposting. Vermicomposting is a process of bio-oxidation and stabilization of organic matter thanks to the combined action of microorganisms and earthworms (Saint-Pierre et al. 1999). The action of earthworms in this process is both physical (fragmentation and aeration) and biochemical (mineralization, humification) and gives a substrate rich in available minerals with a good granular structure (Dominguez et al. 2004).

The aim of this work is to set up inexpensive productive mushroom growing substrates through vermicomposting. More specifically, it involved:
- Formulate a substrate likely to increase the profitability of the myciculture of *Pleurotusostreatus.*
- Identify the best composition of organic substrates to use in vermicomposting for an improvement in the production of *Pleurotusostreatus*.

MATERIALS AND METHODS

This study was conducted in Côte d'Ivoire in the city of Dabou (West Africa). The fungus strain that was the subject of this study is *Pleurotusostreatus* obtained from the NGO (FESAAP) which imports it from Ghana. This strain was used for its adaptation to climatic conditions and its high productivity. The earthworm of the species *Eudriluseugeniae* has been used for the production of vermicompost. This species has a great capacity to mineralize organic matter and make the pH of breeding environments neutral (Saint-Pierre et al. 1999).

Vermicomposting

For the production of vermicompost, 2 substrates have been formulated. These substrates consisted of sawdust, peanut shells, rice bran, cow dung. These substrates were precomposted for 20 days, then subjected to the vermicomposting process through 3 treatments of (15; 30; 45 ± 3 days). In each formulation, 20 g of earthworms were seeded per kilogram of substrate (Boughaba, 2012), i.e. 200 g of worms in each 10 kg treatment. Vermicomposting takes place in 6 compartments measuring 1m x 1m.
As for the control, it was obtained with the conventional formula of the substrates used in myciculture (Oei, 2005).

Preparation of logs

Determination of pH and its adjustment

The pH was measured using a Mettler-Toledo MP 225 type pH meter. It was determined according to the international standard ISO 10390 (1994). The method consisted in preparing a suspension of vermicompost in 5 times its volume of water. Then it is stirred for 5 minutes

and left to stand for at least 2 hours and at most 24 hours. According to Oei (2005), for optimal growth of oyster mushrooms, the pH of the control must be adjusted with calcium carbonate (CaCO3) to 0.25% of the dry weight of the compost in addition to the 2% provided before composting. The following formula has been established to determine the amount of $CaCO_3$ required to adjust the pH of each substrate.

$$\mathrm{CaCO3} = \frac{\mathrm{pHa} * 0{,}25}{\mathrm{pHaT}} * 100$$

$CaCO_3$: Calcium carbonate level to bring.
pHa :Adjustment pH (difference between the measured pH and the optimal pH)

pHaT:Control adjustment pH (difference between the pHthe measured control and the optimal pH)
0.25:$CaCO_3$ level to bring to the witness

Bagging of substrates and sterilization of logs

Bagging consisted of putting the substrates in heat-resistant sachets up to 0.4 Kg / sachet called "logs", ie 4 Kg per treatment after adjustment of the pH (Table 1). Each log was closed with a cotton plug with a collar which conditions the opening. Sterilization consisted of exposing the logs on wooden benches to boiling water vapor in closed metal drums for 8 hours at 70 ° C.

Table 1:Formula for preparing substrates for larding

Substrates	Formulations Treatments	MO (Kg)	H_2o (liter)	$CaCO_3$ (%)
Control	Te	4	1,5	0,25
S1	T_1	4	1,5	0,39
	T_2	4	1,5	0,28
	T_3	4	1,5	0,271
S2	T_1	4	1,5	0,40
	T_2	4	1,5	0,285
	T_3	4	1,5	0,275

S1= substrates1 ; S2= substrate 2

Larding and incubation of logs

The larding or sowing of the logs was carried out at the end of sterilization under aseptic conditions. It consisted in bringing to each log the equivalent of 3% of its mass in seedling blank, or approximately 12 g in the present experiment. The logs were stored in the seeding room sterilized with bleach and hermetically sealed. The cooling of the logs was done in 24 hours. The blank was introduced by opening the collar and then closed with the same sterile cotton stopper.

The incubation lasted 45 days in the dark. The contaminated logs were systematically removed from the room during daily checks to avoid contamination. Incubation was maintained until the logs were completely invaded by the mycelium and the first mushrooms appeared.

Cultivation of carpophores and harvest

The colonized logs were opened and moved to the fruiting room with a daily temperature between 23 and 28 ° C and disinfected with bleach. For this, the floor of the room was daily watered. Direct sunlight has been avoided while allowing good air circulation. The walls of the room were fitted with louvers and ventilation space. The roof was made of "papo" woven raffia leaves. The fruiting of the mushrooms in the substrates was followed until the harvest which lasted 30 days. The carpophores were picked just after opening their hat corresponding to their maximum growth level.

Determination of biological parameters of earthworms

Earthworm mass

The mass of earthworms was determined by the following formula:

$$\mathbf{G = fm - im}$$

Survival rate of earthworms

Survival is the percentage of earthworms that survived for the duration of the experiment. It was determined by relating the final abundance of adult worms to the number of worms introduced in the different substrates.

$$\textbf{Survival}\ (\%) = \frac{\textbf{final abundance}}{\textbf{initial abundance}} * \mathbf{100}$$

Earthworms birth rate

The birth rate represents the average number of juveniles per adult. It was determined by the following formula:

$$\boldsymbol{Birthrate}(\%) = \frac{\boldsymbol{numberofjuveniles}}{\boldsymbol{Numberofadults}} * \mathbf{100}$$

Morphometric parameters of fruiting bodies

The morphometric parameters such as the average diameter of the caps, the average height of the stipes and the average height of the fruiting bodies were measured using a tape measure.

Biological yield

The biological yield in g / log, is the fruiting biomass harvested by log. This biomass includes mycelial strains, runts, which are fungi whose growth has been aborted either by lack of nutrients or because of bad climatic conditions and well-developed fruiting bodies. It was determined by weighing with the electronic balance (Pathmashini et al. 2008).

$$\boldsymbol{Biological\ yield}(\boldsymbol{g/log}) = \frac{\boldsymbol{Fresh\ harvested\ biomass}}{\boldsymbol{number\ of\ logs}}$$

Economic performance

The economic performance (EP) expressed in FCFA / log is the selling price of the fresh biomass of the marketable part of the fruiting bodies of a log. For the determination of this yield, the fruiting bodies were weighed after separation of the mycelial strain and the runts with the electronic balance. This biomass was multiplied by the field price per gram of fruiting bodies (Pathmashini et al., 2008).

$$EP(FCFA/bûche) = \frac{Biomass\ of\ fruiting\ bodies * 25}{Number\ of\ logs}$$

Abundance of fruiting bodies

The average number of fruiting bodies and runts per log was determined by counting.

Biological efficacy of treatments

Biological efficiency represents the conversion rate of a substrate into a fresh mushroom. It was calculated by relating the biological yield to the dry mass of the substrate before larding (Pathmashini et al. 2008).

$$Biological\ efficacy\ (\%) = \frac{Biological\ yield}{Dry\ mass\ of\ substrate\ before\ plating} * 100$$

Productive efficacy of treatments

The productive efficiency is the mushroom biomass produced per gram of colonized substrate of mycelium. It is the fruiting capacity of a colonized substrate. It was calculated by relating the biological yield to the average mass of the colonized logs (Peng et al. 2000).

$$\textbf{Productive efficacy}\ (\%) = \frac{\textbf{Biological yield}}{Dry\ mass\ of\ the\ colonized\ substrate} * 100$$

Statistical analyzes

The software R 3.5.1 was used for the statistical analyzes. The Mann Whitney statistical test was used to compare the means of the biological and morphometric parameters measured on the fungi as well as those of earthworms.

RESULTS AND DISCUSSION

RESULTS

pH of substrates

The pH of the substrates ranges from 5.54 for the 15-day treatments to 6.2 for the 30-day treatments. The 45-day treatments had the best pH, which reached 6.75 (Table 2). By comparing the treatments of the same duration two by two using the Mann Whitney statistical test, this one showed that there was no significant difference ($p > 0.05$). The two-by-two comparison of treatments of different durations whatever the substrate, showed a significant difference between the variations in pH ($p \leq 0.05$).

Table 2:$CaCO_3$ level brought to adjust the pH of the substrates

parameters / treatments		pH of substrate	Rate of $CaCO_3$ (%)
control		6.98 ± 0.13 [c]	0.25 [c]
Substrate 1	T_1	5.7 ± 0.04 [a]	0.64 [a]
	T_2	6.25 ± 0.18 [b]	0.45 [b]
	T_3	6.75 ± 0.12 [c]	0.27 [c]
Substrate 2	T_1	5.54 ± 0.05 [a]	0.70 [a]
	T_2	6.2 ± 0.05 [b]	0.46 [b]
	T_3	6.74 ± 0.49 [c]	0.27 [c]

Results assigned identical letters indicate non-significant difference ($p > 0.05$)
Results with different letters indicate a significant difference ($p \leq 0.05$)

Adjustment of pH by adding calcium carbonate ($CaCO_3$)

The control substrate received 1.25% of its dry mass to adjust the pH. The levels of $CaCO_3$ supplied gradually decreased with the durations of the treatments, going from 0.7% for the 15-day treatments of the dry mass of the substrate to 0.27% for the 45-day treatments (Table 3). By comparing treatments of the same duration two by two using the Mann Whitney statistical test, this one showed that there was no significant difference ($p > 0.05$). The two-by-two comparison of treatments of different durations whatever the substrate, showed a significant difference between the $CaCO_3$ levels ($p \leq 0.05$).

Survival of worms in different substrates

Earthworm survival was determined at the end of each treatment and stabilized between 100% and 99.80% (Table 3). Mann Whitney's statistical test showed that there was no significant difference between survival in the different treatments ($p > 0.05$).

Natality of worms in different substrates

The birth rate increased very significantly with the duration of treatment. This increase was expressed by a birth rate of 31% for the 15-day treatments, whereas it reached 157.63% for the 30-day treatments and went up to 188.06% for the 45-day treatments (Table 3). By comparing survivals in treatments of the same duration two by two using the Mann Whitney statistical test, this one showed that there was no significant difference ($p > 0.05$). The two-by-two comparison of treatments of different durations whatever the substrate, showed very significant differences ($p \leq 0.05$).

Variation in mass of worms in different substrates

Mass gain increased significantly from treatment to treatment in all substrates. With 28 ± 4% of the initial mass after 15 days, the mass gain reached 212 ± 6% (Table 3). The two-by-two comparison of mass gains in treatments of the same duration using the Mann Whitney statistical test, which showed that there was no significant difference ($p > 0.05$). The two-by-two comparison of treatments of different durations showed very significant differences ($p \leq 0.05$).

Table 3: Biological parameters of earthworms in the differents treatments

Parameters / Treatment		Survival of earthworms (%)	Natality of earthworms	Mass gain of earthworms (%)
Substrate 1	T_1	99.80 [a]	38.24 [a]	28 ± 4 [a]
	T_2	99.85 [a]	165.22 [b]	179 ± 9 [b]
	T_3	100 [a]	188.06 [c]	212 ± 6 [c]
Substrate 2	T_1	100 [a]	31.82 [a]	15 ± 8 [a]
	T_2	99.89 [a]	157.63 [b]	173 ± 6 [b]
	T_3	100 [a]	178.97 [c]	207 ± 7 [c]

Results assigned identical letters indicate insignificant difference (p> 0.05)
Results with different letters indicate a significant difference (p ≤ 0.05)

Colonization rate of logs

At the end of the incubation, the proportions of well colonized logs were evaluated (Table 4) and are as follows: S1T1 = 90%, S2T1 = 80%, S1T2 = 80%, S2T2 = 100%, S1T3 = 60 %, S2T3 = 70%, Te = 70%. The colonization rates obtained showed that treatments 2 (T2) were better than the others, followed by treatments 1 (T1). Treatments 3 displayed a contamination rate identical to that of the control, ie 30% of the contaminated logs. Mann Whitney's statistical test showed that the colonization rate was not linked to the treatments.

Morphometric parameters of fruiting bodies

Comparisons between means using Mann Whitney's statistical test showed that neither the treatments nor the substrates significantly influenced the morphometric parameters measured on the mushrooms. However, the vermicomposting times showed a better development of the fruiting morphology. The development of the morphology improved with the duration of the treatments and was optimal in the T3 treatments (Table 5).

Table 4:Influence of treatments on the colonization of logs

ParametersTreatments		Colonisation rate (%)
control		70 [c]
Substrate 1	T_1	90 [d]
	T_2	80 [b]
	T_3	60 [e]
Substrate2	T_1	80 [b]
	T_2	100 [a]
	T_3	70 [c]

The identical letters carried by the values indicate a non-significant difference (p> 0.05). Values with different letters indicate a significant difference (p ≤ 0.05).

Table 5: Influence of treatments on morphometric parameters

Parameters / Treatments		Average hat diameter (cm)	Average stipe size (cm)	Average mushroom size (cm)
Control		5.18 ± 10 [a]	3.89 ± 1 [a]	7.24 ± 1.4 [a]
	T_1	5.79 ± 1.35 [a]	4.75 ± 1,7 [a]	7.5 ± 1.5 [a]
Substrate 1	T_2	6.36 ± 1.4 [a]	4.82 ± 1,7 [a]	7.77 ± 1.4 [a]
	T_3	6.41 ± 1.77 [a]	4.89 ± 2 [a]	7.82 ± 1.4 [a]
	T_1	5.78 ± 0.97 [a]	4.73 ± 1.3 [a]	7.66 ± 1.6 [a]
Substrate 2	T_2	6.21 ± 1.81 [a]	4.86 ± 1.2 [a]	7.8 ± 0.8 [a]
	T_3	6.48 ± 1.13 [a]	4.93 ± 1.1 [a]	7.96 ±1.15 [a]

Substrate 1(T1=S1T1, T2=S1T2, T3=S1T3);Substrate 2(T1=S2T1, T2=S2T2,S2T3)
The identical letters carried by the histograms indicate a non-significant difference (p> 0.05).

Biological parameters of fruiting bodies

The biological parameters measured (Table 6) on the fruiting bodies were the biological yield, the economic yield per treatment and the average number of stems per log for each treatment. The different treatments influenced the average abundance of fruiting bodies in the logs. It was better in the S2T2 substrate with 75.5 feet / log, against 37.2 feet / log in the S1T3 substrate which recorded the lowest abundances followed by the control substrate which recorded 40.29 feet / log (Table 6). However,The Mann Whitney statistical test indicated a non-significant difference between the abundances harvested($p > 0.05$). The variation in the biological yield of the substrates was influenced by the treatments. The yield was better in the S2T2 substrate with 261.6 ± 1.62 g / log, against 165.29 g / log in the control substrate which recorded the lowest economic yield followed by the S1T1 substrate which recorded 201.33 ± 1.78 g / log (Table 6). Comparisons of biological yield results between treatments indicated that there was no significant difference($p > 0.05$) according to the Mann Whitney statistical test. Mann Whitney's test indicated a significant difference ($p \leq 0.05$).

The economic yield of fruiting bodies was influenced by the different treatments. It was better in the S2T2 substrate which yielded 6,265 ± 40.25 FCFA / log, compared to 4,132.25 ± 37.75 FCFA / log in the control substrate which recorded the lowest economic return. The lowest yielding vermicompost was S1T1, which yielded 4566.75 ± 35 FCFA / log (Table 6).
The comparison of the results of the economic performance between treatments by the Mann Whitney statistical test indicated that there was no significant difference for ($p > 0.05$). Whereas for ($p \leq 0.05$), the Mann Whitney test indicated a significant difference.

Table 6: Influence of treatments on the biological parameters of fungi.

Parameters / Treatments		Average abundance by log	Biological yield (g / log)	Economic performance (FCFA / log)
Control		40.29 [d]	190.29 ± 1.7 [d]	4132.25 ± 37.75 [d]
Substrate 1	T_1	43.33[a]	201.33 ± 1.78 [a]	4566.75 ± 39[e]
	T_2	59.71 [b]	218.87 ± 1.82 [b]	5165.75 ± 45 [a]
	T_3	37.2 [a]	225.29 ± 2.15 [b]	5232.25 ± 53,75 [a]
Substrate 2	T_1	51.25 [b]	212.37 ± 1.62 [a]	4825 ± 40.5 [b]
	T_2	75.5 [c]	261.6 ± 1.62 [c]	6265 ± 40.25 [c]
	T_3	47.29 [e]	211.43±1.41[a]	5453.5± 35 [a]

Substrate 1(T1=S1T1, T2=S1T2, T3=S1T3);Substrate 2(T1=S2T1, T2=S2T2,S2T3)
Identical letters indicate an insignificant difference (p> 0.05). The values affected by different letters indicate according to the Mann Whitney test, a significant difference (p ≤ 0.05).

Biological and productive efficiency of the different treatments.
The biological efficiency was influenced by the treatments with a better result in the S2T2 substrate which gave 65.4%, against 47.58% in the control substrate. The control substrate recorded the lowest biological efficiency followed by the substrate S1T1 which recorded 50.33%.

The comparison of the results of the biological efficacy of the treatments (Table 7) are all significantly different from each other according to the Mann Whitney test. ($p \leq 0.05$).

The productive efficiency was influenced by the treatments with a better result in the S2T2 substrate which gave 72.46%, against 52.71% in the control substrate. The control substrate recorded the lowest productive efficiency followed by the substrate S1T1 which recorded 55.46% (Table 7). The comparison of the results of the productive efficacy of the treatments are all significantly different from each other according to the Mann Whitney test($p \leq 0.05$).

Table 7: Influence of treatments on biological and productive efficiencies

Parameters / Treatments		Biologicalefficacy (%)	Productive efficiency (%)
Control		47,58 [a]	52,71 [a]
Substrate 1	T_1	50,33 [d]	55,46 [d]
	T_2	61,19 [b]	67,61 [b]
	T_3	64,46 [e]	70,64 [e]
Substrate 2	T_1	53,09 [f]	57,55 [f]
	T_2	65,4 [c]	72,46 [c]
	T_3	57 [g]	62,81 [g]

Substrate 1(T1=S1T1, T2=S1T2, T3=S1T3) ;Substrate 2(T1=S2T1, T2=S2T2, S2T3)

Identical letters indicate an insignificant difference (P> 0.05). The values affected by different letters indicate according to the Mann Whitney test, a significant difference (P ≤ 0.05).

DISCUSSION

The results of the survival and birth rate of earthworms showed that the different substrates and the conditions maintained in these substrates were favorable for the growth of earthworms. Because the rate of multiplication of worms depends on the quality of the substrates, the humidity of the environment and the temperature (Hardouin, 2001). The weight gain resultscould confirm the good quality of the different substrates. Indeed, for a cultivation period of around one month, the biomass exceeds 2.5 times that sown. These results corroborate those of Rouschop (1984), who stipulate that the biomass of *Eudriluseugeniae* doubles in one month under the optimal conditions of a vermicomposting system.

The results showed that vermicompost had an effect on the pH. The variations in pH during the treatments indicated that they increased and would tend towards neutrality. This behavior of pH during vermicomposting would be a confirmation of the work of Tomlin (1981). In fact, because of its neutrophilic nature, the activity of the *Eudriluseugeniae* worm in a medium would cause a variation in pH until reaching neutrality (Tomlin, 1981). The level of ($CaCO_3$) supplied to the various substrates has dropped considerably in vermicomposts. Indeed, the contribution of ($CaCO_3$) was aimed at adjusting the pH of the substrates to an optimal value for the development of the mycelium. This pH being close to neutral, vermicompost recognized for its neutral pH (Hardouin, 2001) would naturally be little dependent on the contribution of $CaCO_3$.

The high contamination rate of the logs from treatments 3 which lasted 45 ± 3 days could be due to an overdose of nutrients. Because the rate of mineralization of the material increases with the duration of the vermicomposting which is accompanied by an enrichment in minerals. This hypothesis corroborates the results of (Boulmerka, 2017) which stipulate that the overdose in nutrient promotes infections of the logs.

The morphometric parameters measured (the size of the stipes, the diameter of the caps, the height of the fruiting bodies) as presented have shown a better growth of the fruiting bodies in the vermicomposts. There were no significant differences between the morphometric parameters of the different treatments according to the Mann Whitney test. However, an observation in the details showed a better development of the morphology of the fruiting bodies in the vermicomposts. In addition, the 45-day treatments were favorable for the development of the fruiting morphology. The measured morphometric parameters showed that the substrates would be of better quality and would have allowed good development of the fungi. Indeed, these measurements are included in the intervals measured on the morphology of *Pleurotusostreatus.* According to Mostak et al., (2013), the diameter of *Pleurotusostreatus* hats is between (3.5 cm and 7 cm), while the size of the stipes is between (4.5 cm and 8 cm). As for the size, it would be between (5.5 cm and 9 cm). The biological parameters showed that the vermicomposts would be of better qualities compared to the control substrate. After a comparative study of biological parameters, it turns out that vermicomposts could improve the productivity of mushrooms. Indeed, with the results of the colonization rate, the S2T2 substrate presented a better biological and economic yield. The biological and productive efficacy of the substrates has shown that despite high contamination rates, the substrates of treatments 3 (T3), once colonized, were very productive. This result could reinforce the hypothesis that this contamination is linked to the overdose phenomenon. Indeed, as much the excessive intake of minerals can cause an overdose, as much, this intake

increases the productivity of the substrate by optimizing the development of the mycelium (Quieroz et al., 2004).The number of runts per log showed that the vermicomposts produced better promote the development of the morphology ofthe fungi compared to the control substrate. This result not onlyconfirms the hypothesis of better availability of nutrients in vermicomposts, but also justifies the biological and productive efficacy of vermicomposts. Because the more a substrate is poor in nutrients, the less it would promote good fruiting development (Quieroz et al., 2004).

CONCLUSION

At the end of this work we note that the use of the additive for pH adjustment had been reduced. The biological and economic yields per log were significantly better in the vermicomposts than in the control substrate. It was the same for biological and productive efficacies of vermicomposts. Finally, the determination of the average number of runts showed a clear drop in the later in vermicomposts. The results obtained in this study have shown that vermicompost can used instead of conventional substrates. Better still, these results showed that they could be recommended at the expense of these substrates. These results remain to be confirmed by new studies. However, they have shown that improving productivity as well as reducing theamount of chemical additives in mushroom growing is possible through the action of earthworms on the substrates.

ACKNOWLEDGMENTS

At the end of this work, we thank the NGO FESAAP of Dabou for their collaboration in the implemention of this study.

CONFLICT OF INTEREST: NO ONE

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