INNSPUB

International Journal of Agronomy and Agricultural Research (IJAAR)
ISSN: 2223-7054 (Print) 2225-3610 (Online)
http://www.innspub.net
Vol. 7, No. 6, p. 42-46, 2015

RESEARCH PAPER OPEN ACCESS

Valorization of agro-alimentary waste for a production of maggots like source of proteins in the animal feeds

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Article published on December 20, 2015

Key words: Production, Density, Mixture, Maggot, Productivity.

Abstract

An experimentation of production of maggots starting from agro-alimentary waste was led to the research station on the diversification of the pisciculture of the University of Abomey-Calavi (Benin). Seven substrates were used for the production: dejections of pigs (P), chicken viscera (V), and soybean oil cake (T) and their respective mixture dejections of pigs-chicken viscera (PV), dejections of pigs-soybean oil cake (PT), chicken viscera-soybean oil cake (VT) and chicken viscera-soybean oil cake-dejections of pigs (VTP). At the end of the experiment, the best productivities of maggots of 8.89 g.100g $^{-1}$ and 7.20 g.100g $^{-1}$ are respectively obtained with substrates VT and VTP. Low productivities of 2.62 and 3.20 g.100g $^{-1}$ being obtained respectively with the dejections of pigs and the chicken viscera. It comes out from this study that the mixture of the soybean oil cake to the chicken viscera seems the best substrate having had a significant attractive effect on the flies and thus of productivity of maggots.

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Introduction

Today, food safety passes by the development of the aquiculture (FAO, 2012). The aquaculture is confronted with the problem of the high cost of food available (Omoruwou and Edema, 2011; Zhou *et al.*, 2010). The food is a factor determining in the production cost in aquaculture (Aniebo *et al.,* 2009). Its high cost is due to the fish meal, principal ingredient, rich in proteins in particular in essential amino acids (Médale *et al.*, 2013). However the use of the fish meal is justified by its good content of nutritive elements in comparison with the other sources of proteins.

But its high cost especially constitutes a brake for the development of the aquaculture in West Africa. With this intention, several studies were undertaken to identify alternative sources with the fish meal like cottonseed and soybean meals (Imorou Toko *et al.*, 2008); plants (Médale *et al.*, 2013); earthworms (Sogbesan *et al.*, 2007). The larvae of flies (maggots) seem one of the alternative sources (Sheppard, 2002; Teguia *et al.*, 2002) with the fish meal, because of their strong nutritive content (Ogundji *et al.*, 2006 ; Odesanya *et al.*, 2011) and their wealth of essential amino acids (Adesina, 2012). Moreover, their very short cycle of production (Ekoue and Hadzi, 2000; Bouafou, 2011) fact of them a potential substituent with the fish meal because of their easy production. The present study aims at determining the substrate leading to a better productivity of the maggots starting from agro alimentary waste for their efficient valorization in aquaculture.

Material and methods

The test of production of the maggots took place at the research station on the diversification of the Pisciculture of the University of Abomey-Calavi in February 2015 during five (5) days.

Seven (07) substrates were used for the production of the maggots like: the dejections of pigs resulting from the pigsties installed on the station, chickens viscera resulting from the markets of chicken demolition, the soybean oil cake resulting from the food transformation of the soya and asset on the local market and of the mixtures of these substrates (Table 1).

A quantity of 3 kg each substrate and their mixture is used in triplicate for the production of maggots. Each substrate type, tested in triplicate, is put in containers out of plastics in the shape of watch glass and deposited at the shade under trees at the shelter of the solar rays and rain.

The morning of the first day, each container is filled with 3 kg of substrate (weighed with a spring balance) and is left with the free air then sprinkled slightly water each evening until the harvest of the maggots. Harvest begins 3rd at the 5th day after neither the beginning of the experiment without renewal nor contribution of substrate. It is done each day by reversing the substrate on a sieve with the lower part of which there is a basin to collect the maggots.

The temperature and the relative humidity of the air were measured every day with a thermo-hygrometer of mark Extech, model MO210.The counting of the maggots was carried out according to the method of Ekoue and Hadzi (2000). The weighing of the maggots is made using a range 1000g and balance of precision 0.01g.

Calculations

$$\text{Average weight by maggot (g)} = \frac{\text{Total quantity of maggots (g)}}{\text{Total number of maggots}}$$

$$\text{Density of production (g.100g}^{-1}\text{ of substrate)} = \frac{\text{Total quantity of maggots (g)}}{\text{Total quantity of substrate (g)}} \times 100$$

Density of production (g.100g^{-1} of substrate) data were statistically analyzed by one-way analysis of variance (ANOVA), using LSD Fisher test for pair comparison of means among treatment ($P \leq 0.05$ level of significance). All statistical analyses were carried out using the STAVIEWS (version 5.01).

Results and discussion

The values of temperature 28.7 ± 0.3 °C recorded

during the experimentation show that they are in conformity with the requirements of development of the larvae of fly for a maximum production (Bouafou, 2011). To develop, the maggots need high water content. The humidity relative recorded during the experimentation is of 94 ± 2 %, which is close to the 97% necessary for the development of the larvae (Nzamujo, 1999).

Table 1. Nature and composition of the substrates.

Substrate	Quantity (Kg)
Dejections of pigs (P)	3
Chicken viscera (V)	3
Soybean oil cake (T)	3
Dejections of pigs + Chicken viscera (PV)	1.5 + 1.5
Dejections of pigs + Soybean oil cake (PT)	1.5 + 1.5
Chicken viscera + Soybean oil cake (VT)	1.5 + 1.5
Chicken viscera + Soybean oil cake + Dejections of pigs (VTP)	1 + 1 + 1

The productivities of maggots obtained on the level of the whole of the various substrates (Table 2) are definitely better compared to those obtained by Ekoue and Hadzi (2000) which used the contents of the rumen of cow and Bouafou (2007) which have a mixture of peelings and pieces believed of yam, raw peelings of bananas wall and fresh fish and raw meat scrap of rat for the production of maggots. Work of Teguia *et al.* (2002) on the production of maggots containing the dung of cow and the chicken droppings respective outputs of 0.017g and 0.23g for 100g of substrate gave. These results are definitely lower than those obtained in the whole of the substrates used during this experiment. It arises that the production obtained depends not only on the temperature, the relative humidity, and the season of production (Bouafou, 2011) but also on the technique of production.

Table 2. Productivity of the maggots starting from the various substrates.

Substrates	Total productivity		Sample		Density of production
	Quantity (g)	Total numbers of maggots	Numbers	Average weight by maggot (g)	(g.100g^{-1} of substrate)
P	236.6	7890	1000	0.03	2.62^{a}
V	288.1	5762	1000	0.05	3.20^{a}
T	376	12534	1000	0.03	4.18^{ab}
PV	497.4	12435	1000	0.04	5.52^{b}
PT	528.2	17606	1000	0.03	5.87^{b}
VT	800	20025	1000	0.04	8.89^{cd}
VTP	648	16200	1000	0.04	7.20^{d}

The values of the same column having the same letter are not significantly different (p>0.05).

The best productivities 7.20 g.100g^{-1} and 8.89 g.100g^{-1} (Table 2) are obtained respectively with substrates VTP and VT. These productivities are justified by the abundance of eggs laid by the flies on their surface. Also the odor released by the fermentation of the soybean oil cake mixed with the chicken viscera it had a significant gravitational effect on the flies. Indeed, a mixture of waste of animal origin and vegetable a significant attractive potential on the flies from their color, their texture and of the odors which it releases (Keiding, 1986; Bouafou, 2011). The development of the maggots depends on the availability in the substrates of the matters nitrogenized and phosphorated necessary for the decomposition

(Hardouin *et al.*, 2000). Spiller (1963) affirms that the proteins in particular the amino acids support the formation of eggs of the female but not greases. High protein rates and their profiles in especially essential amino acids in the soybean oil cake (Imorou Toko *et al.*, 2008) and chickens viscera (Hèdji *et al.*, 2014) can explain the strong productivity obtained with substrate VT.

Nevertheless the soybean oil cake T of vegetable origin compared has a relatively interesting productivity to the weak results obtained by Bouafou (2011) with the vegetable substrates, in particular the dry semolina of manihot, the peelings and believed pieces of yam which not only are not rich in proteins, but, have little attraction for the flies. These results are justified by the nature of the substrate used but also by the technique of production unfavorable to the deposit of the flies. This work corroborates those carried out by Ekoue and Hadzi (2000) and Nzamujo (1999) which affirm that the productivity of the maggots is influenced by the type of substrate. The maggots degrade much more the substrates rich in organic matter that it is of origin animal or vegetable (Hardouin *et al.*, 2000).

According to Odesanya *et al.* (2011), the maggots contain rough protein 48% in particular lysin 5.03%; methionine 2.58%; 31.76% of lipids rough and approximately 3755 $Kcal.kg^{-1}$ of energy. The maggots have a high food value with a very short cycle of production (Nzamujo, 1999; Ekoue and Hadzi, 2000; Bouafou, 2011), which makes them a very interesting ingredient in the animal feeds.

The maggots thus constitute a preferential source of proteins of the animals. Its cycle and its production cost by the decomposition of agro-alimentary waste make them of him an ingredient able to entirely replace the fish meal ?

Conclusion

The mixture of the soybean oil cake and the chicken viscera constitutes the best substrate with a density of production of 8.89 $g.100g^{-1}$ of substrate. Agro-alimentary waste can thus be developed by the production of maggots which constitute a source of proteins of lower cost, easy to produce and able to substitute the fish meal in the animal feeds. Its duration of very short production and its high food value deserve that one is interested in it but the method of harvest must be improved for a production on a large scale.

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