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YIELD AND CHEMICAL COMPOSITION OF CHLORELLA SPECIES CULTIVATED IN PIG, POULTRY AND COW DUNGS IN SOUTHERN NIGERIA

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ABSTRACT

A study was conducted to examine the yield and chemical composition of chlorella species, a single cell protein (SCP), cultivated on poultry, pig and cow dungs in southern Nigeria. The experiments were carried out using the completely randomized design in plastic bowls instead of ponds usually used for the culture. The cultures were enhanced by inoculating them with *Actinomycetes* bacterium which helps to break down the nutrients available in the organic materials for the chlorella species utilization. The yields of the chlorella from the poultry, pig, cow dungs and the control were 131.26, 128.42, 119.55 and 32.65, respectively, in 4 days harvesting interval. The crude protein values of 39.77% for poultry, 35.3% for pig, 35.3% for cow were not significant different values also range between 5.4 to 7.30% for ether extract while crude fibre varies between 4.64 to 5.47%. The ash contents were generally high in all cultures and there was no significantly difference (P>0.05) except the culture with pig dung having ash content of 10.90%. The nitrogen free extract content was significantly different (P<0.05) with the highest value obtained from poultry culture at 39.77%. The results have shown that chlorella species cultured in poultry droppings yielded the highest crude protein of 39.77%. For the cultivation of chlorella species, poultry dung is therefore recommended. Chlorella species is a suitable alternative source of protein in animal feeds.

Key-words: Chlorella species, animal dungs, Actinomycetes
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INTRODUCTION

Shortage of food and feed reserved in developing countries today has led to exploitation of alternative feed resources, since conventional sources of protein cannot meet the demand for animals and human consumptions (Becker, 1986). Therefore, the cultivation of chlorella species a single cell protein (SCP) from waste could be a welcome development to overcome the dwindling food and feed stuffs (Davis *et al.,* 1995). During the last two decades the utilization of chlorella species and other forms of microorganisms as a source of SCP has gained increasing popularity (Eddy, 1996). Cultivation conditions of algae (Chlorella species) are different from those required by most other microorganisms. The production depends on four major factors; nutrition, light, temperature and pH Chlorella is a photosynthelic microorganism which utilizes solar energy, high ambient temperature and organic waste materials as their major source of nutrient (Hill, 1978). This makes the cultivation of chlorella cheap, therefore its use as feed supplement for animals will reduce cost of production, since the major expenses in animal production is feeds (Yakoub *et al.*, 1992). Under favourable conditions, chlorella multiply at an incredible rate (Phang, 1990). Chlorella is very resistant to changes in environmental conditions as well as against attacks by other microorganisms. Because of these properties, they are distributed almost all over the areas of the world whose conditions are such as to permit growth of green plants (Khatun and Kamal, 1993). It constitutes 95% of the algae population. However, cost of separating chlorella biomass during harvesting from the culture medium under large-scale production is a major limiting factor.

Most of the chlorella species cultured in ponds with waste materials such as poultry, piggery and cow dung cannot themselves utilize complex organic constituents without the help of the common *Actinomycetes* species. This bacterium helps to break down the organic matters into simple substances that can be readily used by the chlorella (Calvert *et al.*, 1971).
Among the different unconventional feed sources, chlorella appears to have the highest potentials as an alternative to fish mean with content of up to 51% crude protein, 14-22% lipid, 12-17% carbohydrate and 5-10% minerals (Phang, 1997). Various analysis of the chlorella constituents have been carried out and the findings have been on the positive values (Aaronson *et al.*, 1980). Lipophilic pigments such as chlorophyll and caroteniod constitute up to 5% of the chlorella biomass, which is similar to that found in higher plants (Becker, 1984). The light conversion efficiency of chlorella is between 6-8% (Phang, 1992), which showed that the large scale production of chlorella is dependent on sunlight as a primary source of energy. Chlorella can grow in a wide range of temperature from 5 to 42^0C (Khafun *et al.*, 1994) and its growth is inhibited at pH 11 and the optimum pH for growth is between 6.8 to 7.0.

The study aimed at the yield and chemical composition of chlorella species cultured in poultry, piggery and cow dungs in southern Nigeria. This single cell protein (SCP) could be used as a suitable alternative source of protein in animal feeds.

MATERIALS AND METHODS

Eight plastic bowls of (1 x 0. 52 x 1.82m) were filled with ordinary clean water respectively. Two of the bowls were used as control without dung and *Actinomycetes*. All the bowls were raised 2ft from the ground with blocks to avoid water splash during heavy rains. Two (2)kg each of cured poultry, pig and cow dungs were added and thoroughly stirred to dissolve the particles. The pH of the culture medium were taken after the addition and stirring of the dung.

Samples of humus soil suspected to contain *Actinomycetes* species bacterium were collected from

i. Rubber Research Institute of Nigeria Plantation, Iyanomor,
ii. Ogba Zoo forest, Benin City.

The soil samples were cultured to isolate and identify *Actinomycetes* bacterium usually harboured in soils of this nature (decaying organic matter) (Brady and Weil, 1999). Isolation and identification of *Actinomycetes* was conducted according to the method of Medha et al. (1998) and Cheesbrough, (2000).

10 grammes of *Chlorella* species collected from the University of Benin, Department of Fisheries was used to inoculate each bowl containing the dung medium and the control without dung.

The average temperature of each bowl was 37^0C before the treatment. On day 2, 6ml of isolated and identified *Actinomycetes* species suspension was inoculated into each bowl containing culture of chlorella species except the control and the average temperature was again taken and also the pH. The bowls were agitated regularly to facilitate floating of the chlorella to the surface of the bowl and also permit rapid multiplication.

RESULTS

The temperature at harvesting was 37^0C and the pH of each culture media was 6.46 from pig, 5.94 for poultry, 5.66 for cattle and 7.42 for the control.

DISCUSSION

Since the major expenses in animal production is on feeds, there is need to look for alternative high quality protein supplement to replace soybean meal or other conventional protein sources. Studies on the use of algal meals in the diet showed that chlorella species is one of the vegetable protein sources that can replace fish meal (Becker, 1986). Chlorella does not only provide nutrient to animals but their carotenoids are also excellent sources of pigmentation for egg yolk (Chamorro, 1980) Lipstein and Hurwitz, 1980, stated that the incorporation of chlorella into poultry diets offer the most promising prospect for commercial utilization in animal feeding trials at a ration levels of 5 to 10% as partial replacement of conventional protein. For pig ration, Hintz et al. (1966), Hintz and Heitman (1967) substituted soybean meal and cotton seed meal at different concentrations (2.5, 5 and 10%) and no major differences were observed in the feed conversion efficiency. The addition of chlorella species did not impair feed conversion efficiency, therefore it could be used as sole protein source in pigs ration (Berker, 1986).

In feeding trial, Ganowski et al. (1975) reported that ruminants can utilize fresh untreated chlorella. These authors stated further that it was observed in a feeding trial when one litre of concentrated chlorella ($12x10^8$ to $3x10^8$ cells/ml) was fed to calves daily for three weeks and this increased the digestibility process in the intestine.

Goluke and Oswald (1965) stated that the major factors affecting good yield of chlorella species are temperature, sunlight and pH. Oswald (1980) stated further that in the tropics there often occurs cloud cover in the sky which alternates available sunlight while temperature remains high. However, tropical areas without frequent cloud cover could have very high productivity. Hence the most ideal locations could be where there is good temperature and semi-tropical deserts where cloud cover is minimal and nights are generally cooler than days. The ideal sight for cultivation of chlorella species should have average temperature (20-30^0C) relative humidity of below 50 to 60% most of the year (Khatum *et al.*, 1994). The yield gotten from the various bowls have an average of 131.26, 128.14, 119.55 and 32.65g for poultry, pig, cow

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and control showed respectively that good nutrient is needed for high yield of chlorella.

The surface area used for this experiment was too narrow, hence the poor harvest.
The chemical composition level of the algae depends on the medium of culture as well as the cultivation measures (Phang, 1990). The chemical composition obtained from this study ranged from 32 to 39.91% protein, 5.50 to 7.30% fats, 4.64 to 5.91% fibre, 9.09 to 10.90% ash and NFE 37.08 to 47.04%. However, Phang (1990) got a higher protein content of 51-58% in his report. He used a bioreactor in which the system was highly automated.

Our study was carried out in an open environment and the chlorella used for this study was collected for fish pond. Phang (1990) stated that it is very difficult to find a pure culture of chlorella even in its natural habitat. There were significant differences among the treatments A,B,C,D used in this study. However, Khatun et al. (1994) used different organic nutrients in culture of chlorella and the chemical composition had different levels of protein. Braddy (1999) analysed different organic nutrient sources and found that poultry dung had the highest proportion of NPK (4.42:2.1:2.6) and the least was from pig.

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Table 1: Yield of chlorella spp, Mean comparison and Standard Deviation (SD)

Treatment	Yield	Mean	SD
Poultry	131.26	126.22	2.044[a]
Pig	128.42		
130.20	1.6578[a]		
Cattle	119.56		

Values with same superscripts (a) were not significantly different (P.>0.05) while the one

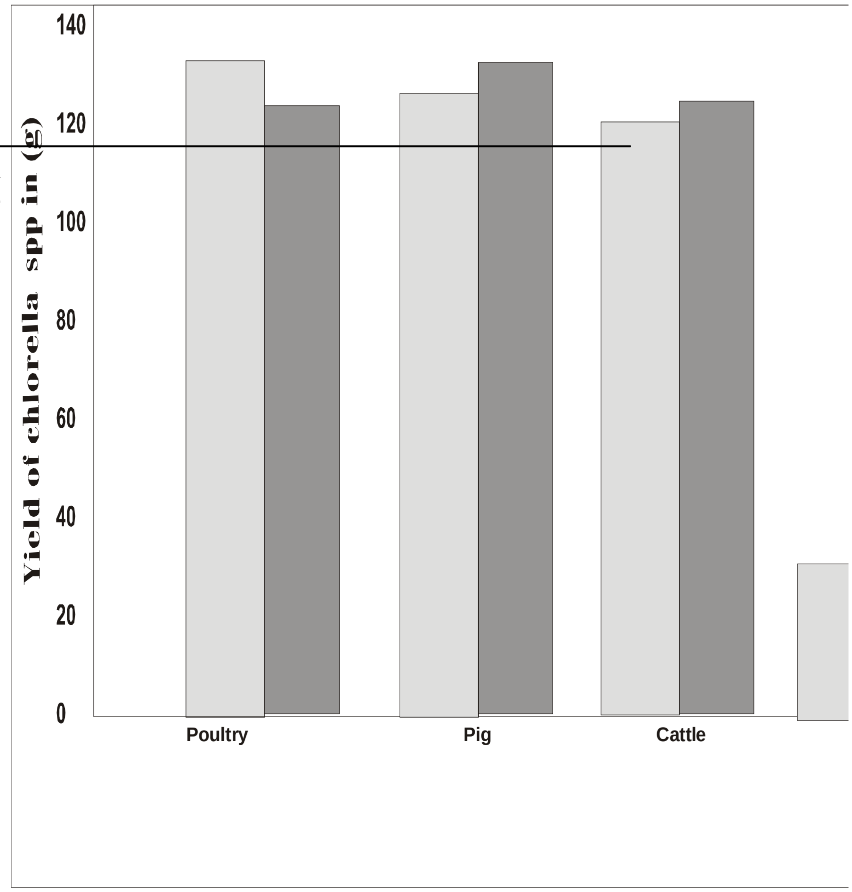

Fig. 1: Bar chart showing the yield of Chlorella spp. cultivated in poultry, pig and cattle dung

Table 2: Proximate chemical composition of chlorella species (g)

Treatment	Crude	Ether	Crude	Ash	NFE
A_1	35.20	6.20	5.19	10.04	43.37
A_2	35.40	7.28	5.68	9.09	42.55
B_1	32.55	5.43	5.39	9.84	46.79
B_2	32.52	5.50	5.10	9.84	4.704
C_1	34.35	5.70	5.17	10.90	43.88
C_2	34.32	5.85	4.64	10.89	44.30
D_1	39.62	5.68	5.28	9.72	39.70
D_2	39.91	7.30	5.97	9.74	37.08

A: Chlorella cultured in cow dung
B: Control
C: Chlorella cultured in pig dung
D: Chlorella cultured in poultry dung

Table 3: Mean separation of the proximate composition of chlorella species

Components	A	B	C	D
Crude protein	35.30^{a}	32.54^{b}	34.34^{c}	39.77
Ether extract	6.74^{a}	5.47^{a}	5.78^{a}	6.49^{a}
Fibre	5.44^{a}	5.25^{a}	4.91^{a}	5.63^{a}
Ash	9.57^{b}	9.84^{b}	10.90^{a}	9.73^{b}
NFE	42.96^{b}	46.92^{a}	44.09^{b}	38.39^{a}

abcd: Means on the same row having different letters are significantly different (P<0.05). A.B,C,D are experimental units.

Summary of the proximate chemical composition gotten during the analysis of the harvested chlorella species showed 32.52 to 39.91% crude protein, 5.43 to 7.3% ether extract, 4.64 to 5.49% crude fibre, 9.09 to 10.96% ash and 35.08% to 47.04% nitrogen free extract (NFE)