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Effects of Method of Killing on Decomposition of Pig (*Sus scrofa* L.) Carrions in Benin, Nigeria

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ABSTRACT: The decomposition of 48 pig (*Sus scrofa* L.) carrions (mean weight = 22.30 ± 1.20 Kg) was monitored in the wet season (June – October) and dry season (November - March) from June 2006 to March 2008 in Benin City. The pigs had been killed by slaughtering, oxygen-deprivation or poisoning with aluminum phosphide (Phostoxin®) or monocrotophos (Monocrown®). The stages and duration of decomposition of the carrions as well as mass maggot production and density were recorded. In both seasons, decomposition progressed through four distinct stages, namely, fresh, bloated, wet and dry decay but duration of decomposition was shorter in the dry than in the wet season. Decomposition duration varied with method of killing, being in the range of 32 - 41 days for slaughtered, 32 - 41 days for oxygen-deprived, 49 - 53 days for aluminum phosphide- poisoned, and 64 -75 days for monocrotophos-poisoned pigs. Over the active decomposition period, monocrotophos-poisoned pigs produced no maggot mass; maggot densities (cumulative number/carrion) in slaughtered- and oxygen-deprived pigs were statistically comparable but each differed significantly from the values for poisoned pigs. Irrespective of the method of killing the pig and the season, the species of dipteran flies involved in decomposition were similar. It was concluded that method of killing exerted influence on rate of carrion decomposition through effect on mass maggot production and density as well as the elevated carrion temperature that resulted.

Keywords: Pig carrions; Maggot, Decomposition rate; Killing method.

INTRODUCTION

The environment of man is predominantly dominated by arthropods and therefore interaction with them is inevitable. Insects contribute very immensely to continuity of life as they pollinate plants, serve as food resource to other animals including man, give products (silk, honey, beeswax, etc) of economic value to man, recycle nutrients from dead plants and animals, and studies with them advance knowledge in science inclusive of forensic science (Aggarwal, 2005; Schowalter, 2011). In forensic science, the commonly used criminology investigation tools include ballistics, firearm examination, bite marks, gunpowder residue chemistry, blood splatter analysis etc.; the insects associated with death scenes were largely ignored (Catts and Haskell, 1990). Increasingly, studies on insect infestation, developmental biology, and pattern of succession on corpses assist in homicide investigation through determination of post-mortem interval.

Carrions support a great assemblage of insects in a characteristic pattern of succession. Different researchers in carrion ecology have used different types of animals to study the decay process and insect succession. Pigs are one of the most commonly used animals in this kind of research (Gill, 2005). They are readily

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available and selection for size uniformity is easy, they are monogastric, and have skin similar to the human's, thus making them a reliable model for human decomposition studies (Anderson, 1996; Gill, 2005). Other animals including rabbits, cats, dogs, mice, birds, turtle, and elephants have been used (Abell *et al.*, 1992; Coe, 1978; Denno and Cothran, 1976; Payne, 1965). Gill (2005) emphasized that the rate of decomposition for different animals can be affected by accessibility to insects, body hair, feathers, skin type, and body size. He added that except at the Anthropology Research facility in Tennessee, it is both uncommon and uncustomary to use human cadavers for carrion decomposition and arthropod succession research. Anderson (1996), Lord and Rodriguez (1989), among others, have studied colonization of carrions by insects with a view to determining the cause and time of death, as well as documenting and adducing reasons for observed pattern of decomposition. Carrions' studied were either those under criminal investigation or simulated laboratory models. Generally, there is a dearth of information on effect of mode of death on insect colonization and succession pattern. In this study, the effects of method of killing pigs on carrion decomposition was investigated.

MATERIALS AND METHODS

The study site was the Demonstration Farm of Benson Idahosa University, Ugbor Village, Benin City, Edo State, Nigeria. The area (Latitude 06°17'01.6"N and Longitude 005°36'10.6"E) lies within the rainforest vegetation belt of Nigeria and is characterized by two distinct wet and dry seasons.

Forty-eight pigs (mean weight = 22.30±1.20 Kg) purchased from a piggery farm in Ekae Village, Sapele Road, Benin City, were killed by slaughtering; strangulation (oxygen deprivation); poisoning with Alluminum phosphide (Phostoxin®) admixed with feed in the ratio of 1:5; poisoning with monocrotophos (Monocrown®) intravenously at 5ml/pig. For each method, three pigs were used in both the wet season (June - October) and dry season (November - March) of the years 2006 to 2008. The dead pigs were transported in labelled heavy-duty bags to the study site and arranged in completely randomized design.

The carrions were observed daily to document stages and duration of decomposition. During the active decomposition stage, the daily temperatures of the exposed maggot masses on different aspects (cut region, mouth, stomach, anus) of the carrion were taken by inserting a digital thermometer into the maggot mass in June (wet season) and November (dry season) and the average temperature for each season computed. Sampling for insects was carried out between 1400 and 1600 hours in the wet season and between 1300 and 1500 hours during the dry season.

A 15cm diameter sweep net was used to collect adult flies and the collection preserved in 70% alcohol for identification. In the period of mass maggot production, a 5ml plastic spoon was used to take samples three times a day over a 4-day period; the maggots were counted and the mean number computed. Thereafter, one-half of the larvae were killed in hot water and preserved in 70% alcohol while the other half was reared to adult stage on pig liver in plastic cages, containing decomposed grass/soil mixture, at 28±2°C and 70% relative humidity in the Biological Sciences Laboratory.

The mean numbers of larvae collected from the different carrions were subjected to one-way analysis of variance and significantly different means were separated using New Duncan's Multiple Range Test at α=0.05.

RESULTS AND DISCUSSION

Varied numbers (3-6) and stages (fresh, bloated, wet-decay, dry-decay, active-decay, advanced-decay, remains) of carrion decomposition have been reported (Benecke, 2001; Early and Goff, 1986; Lord and Burger, 1984; Parikh, 1999; Payne, 1965; Pillay, 2004; Tantawi *et al.*, 1996; Vij, 2001). In this study, four successive but distinct stages were observed, namely: fresh, bloated, wet decay and dry decay in agreement with Reed (1958), Rodriguez and Bass (1983), and Tantawi *et al.*, (1996). Duration in each stage varied, being 1- 4 days in the fresh stage, 3-6 days in the bloated, 9-28 days in the wet

decay and 19-35 days in the dry decay stage (Figs. 1 and 2).

Maggot densities in slaughtered- and oxygen-deprived carrions were statistically comparable but each differed significantly ($P<0.05$) from values for the poisoned carrions. In contrast, monocrotophos poisoning created unfavourable environment as there was no mass maggot production. Toxicant seepage into carrion fluid and consequent deterrence of oviposition and suppression of larval development precluded maggot aggregation. The latter effect was profound on the blow fly species, *Lucilia sericata* Meigen and *Chrysomya rufifacies* (Macquart) as their eggs hatched on monocrotophos-poisoned carrions but the larvae died before reaching the voracious feeding stage. Oviposition deterrence and suppression of larval development, due to presence of toxicant in carrion fluid, also explained the slower decomposition rate on aluminum phosphide-poisoned carrion compared with carrions of slaughtered and oxygen-deprived pigs. Flies reared from maggots collected from the carrions belonged to six species in four families (Table 2).

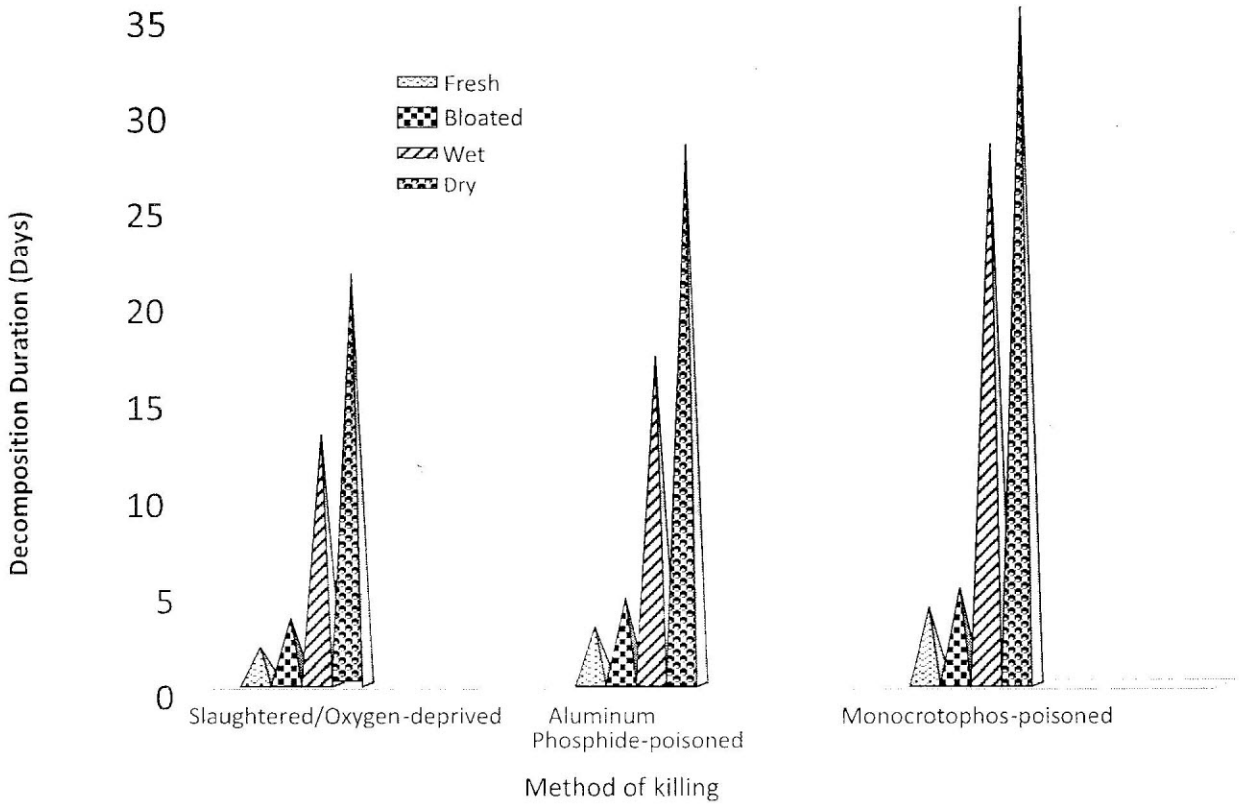

Figure 1: **Duration of decomposition during the wet season for carcasses of pigs killed by four different methods**

Table 1: **Maggot mass production and density in carrion of pigs killed using four different methods**

Method of killing	Maggots density (Mean Cumulative No./Carrion)
Slaughtered	75.50 ± 16.07^{a}
Oxygen-deprived	71.94 ± 14.39^{a}
Aluminum phosphide-poisoned	48.68 ± 15.23^{b}
Monocrotophos-poisoned	0.00 ± 0.00^{c}

Each value is the mean of four replicates. Means followed by the same letter are not significantly different ($P > 0.05$) from each other, using New Duncan Multiple Range Test.

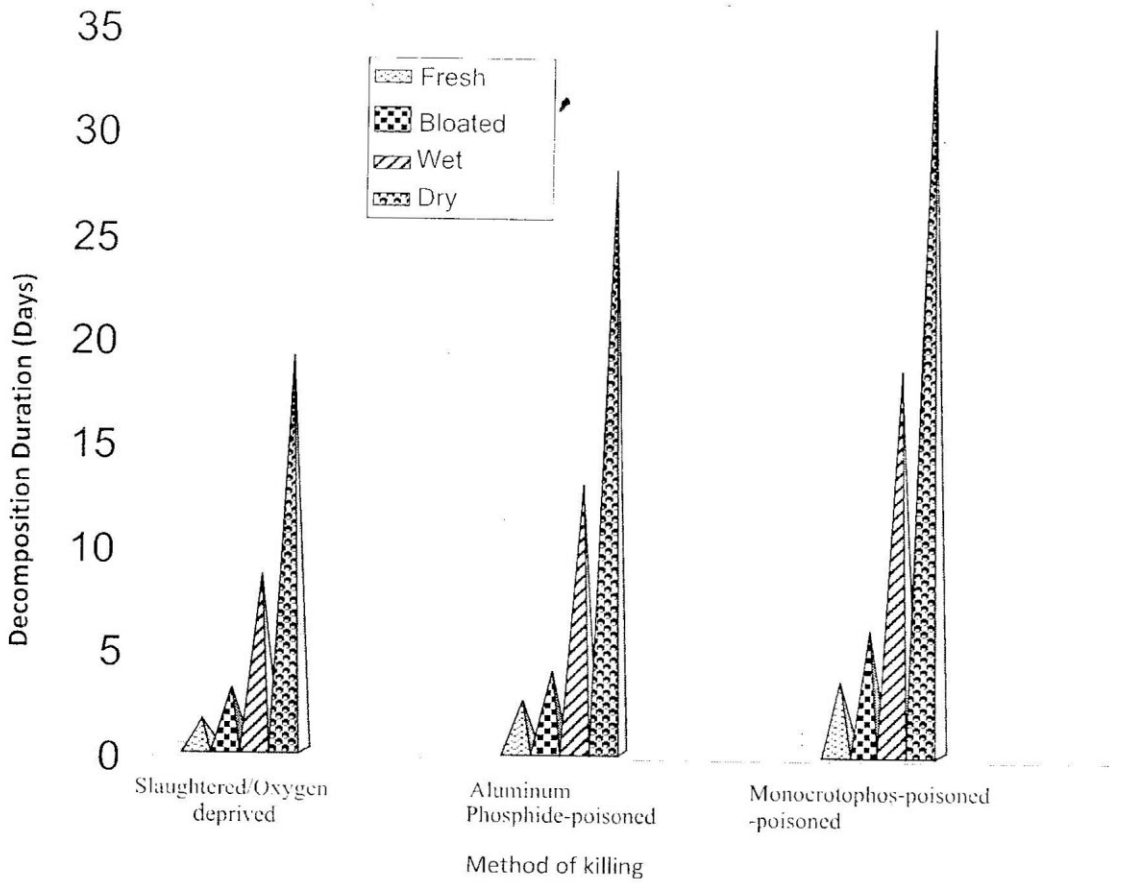

Figure 2: **Duration of decomposition during the dry season for carcasses of pigs killed by four different methods**

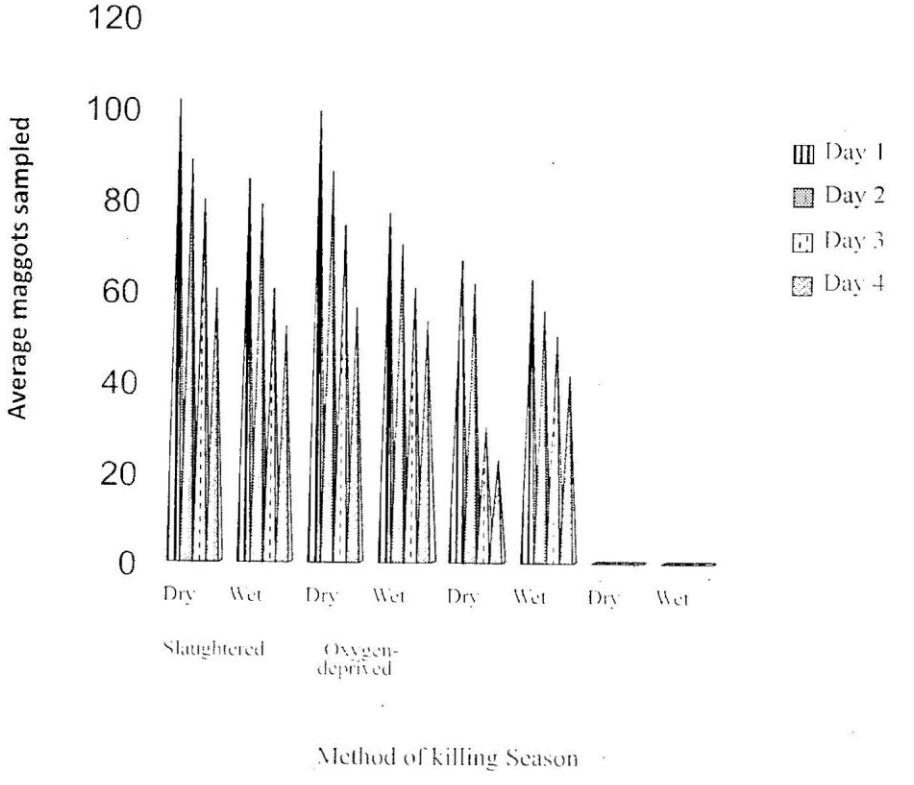

Figure 3: **Average maggots sampled during the investigating periods of 2006/2007 and 2007/2008**

Table 2: **Dipterans reared from maggots collected in carrion of pigs killed using four different methods**

Family	Species
Calliphoridae	*Lucilia sericata* Meigen
Calliphoridae	*Chrysomya rufifacies* (Macquart)
Muscidae	*Musca domestica* L.
Muscidae	*Ophyra aenescens* (Weidemann)
Stratiomyidae	*Hermetia illucens* (L.)
Sarcophagidae	*Sarcophaga carnaria* (L.)

Decomposition of monocrotophos-poisoned carrion took 22 - 30 days longer in the wet season (with a mean temperature of 27.2°C and a range of 23.0 - 31.3°C in June) and 15 - 32 days longer in the dry season (with a mean temperature of 36.1°C, and a range of 34.3 – 37.1°C in November) compared with duration of decomposition of carrions killed by other methods. For aluminum phosphide-poisoned carrion, duration was 8 days longer in the wet season and 17 days longer in the dry season compared with the duration in each of slaughtered and oxygen-deprived carrions. Besides the effect of maggot mass production and density, inhibition of microbial activity especially at the bloated stage cannot be ruled out. Variations in temperature and relative humidity between and within seasons influenced speed of decomposition. Table 3 shows the mean temperature of selected maggot masses in the wet and dry seasons and the length of time taken for the different carrions to decompose beyond the active larval stage. Decomposition was 6-8 times faster in carrion of pigs killed by slaughtering compared with carrions of pigs poisoned with monocrotophos. Higher temperatures and lower relative humidity during the dry season probably increased insect activity and stimulated faster rate of development. Despite lower temperature and higher relative humidity in the wet season, magnitude of difference in rates of decomposition was not very large. This is due to increase in carrion temperature arising from aggregation and feeding of the second and early third instar larvae. Maggot mass temperature was 0.8°C to 11.3°C above ambient wet season mean of 28.2°C, and just 1.8°C to 6.9°C above ambient dry season mean of 34.1°C, thus signifying greater elevation at lower ambient temperature than at higher ambient temperature.

Previous reports on the above-ambient maggot mass temperature include those by Gill (2005), Payne (1965), and Turner and Howard (1992). The results from this study have reaffirmed that ambient weather conditions, most notably temperature, are important determinants of rate of carrion decomposition. Also, the overriding effect of maggot mass temperature has been highlighted.

Table 3: **Maggot mass temperature at selected sites on carrion in relation to rate of decomposition in the wet and dry seasons of 2006-2008**

Method of killing	Dry season Mean maggot mass temperature (°C) at indicated region of carrion					Wet season Mean maggot mass temperature (°C) at indicated region of carrion				
	Stomach	Mouth	Anus	Neck	Duration of active decomposition (Days)	Stomach	Mouth	Anus	Neck	Duration of active decomposition (Days)
Slaughtered	41.0	36.8	37.7	41.0	3 - 5	29.0	37.1	38.0	39.5	4 - 6
Oxygen-deprived	36.1	35.9	36.2	-	4 - 6	38.1	38.1	36.2	-	5 - 7
Aluminum phosphide-poisoned	39.0	39.5		-	4 - 6	35.0	36.1	37.1	-	5 - 7
Monocrotophos-poisoned	-	-	-	-	25 - 30	-	-	-	-	25 - 35

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