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Estimating the Effect of Stabbing and Evisceration on Decomposition Timeline

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ABSTRACT

This study aimed to evaluate the decomposition rate in pig models that were either stabbed or eviscerated. Six pigs were divided into two groups (A and B), each consisting of three pigs. After euthanizing the animals via stunning, pigs in group A were subjected to repeated stab wounds in the trunk and lower abdomen, while those in group B were eviscerated by creating semi-lunar incisions to fully expose the abdominal organs. The decomposition process was monitored over

15 days, observing signs such as swelling, color change, and tissue liquefaction. The results showed that stabbing accelerates the decomposition process by providing additional points of entry for bacteria and insects, leading to a more rapid advancement through the bloat and active decay phases. Evisceration accelerates the decay process by directly exposing internal organs to the environment, leading to rapid colonization by microorganisms and tissue destruction. The rate of decomposition in eviscerated carrions was significantly greater than in stabbed pigs, indicating the direct involvement of organ exposure. Both stabbing and evisceration play a crucial role in influencing the rate of decomposition. These findings enhance the precision and accuracy of postmortem interval estimates in forensic cases that involve severe trauma, thereby aiding investigators in reconstructing the circumstances surrounding the death.

Keywords*:* stabbing, evisceration, decomposition, postmortem interval, forensic

INTRODUCTION

Decomposition is a natural process that occurs in all organisms after death. The early signs of this deterioration process will generally commence at the cellular level and are driven by the autolytic actions of endogenous microbes [1]. This initial phase of decomposition will usher in advanced stages with visible changes that taphonomies rely on to determine the post-mortem interval (PMI). The gradual process of human body decomposition from soft tissue level to skeletonization is a complex process that involves chemical, molecular, histological, and gross changes. The changes that occur within this period that are referred to as the postmortem interval [2, 3].

Post-mortem interval (PMI) estimates can help police and forensic experts narrow down the probable time of death or possible identity of a body, include or exclude suspects, and/or establish the order of death for inheritance purposes, especially when two or more potential beneficiaries die at the same time [4]. When multiple potential beneficiaries pass away at the same time, PMI estimates can help forensic experts determine which suspects to include in the investigation or rule out. They can also be used to determine the order of death for inheritance purposes [4.] A schedule for computing the post-mortem interval is provided by decomposition scores, which measure the body's degree of decomposition, in combination with accumulated degree days (ADD) [4, 5.]

These post-mortem changes depend on a diverse range of factors, such as the ambient temperature, seasonality, and geographical location in which the body is found [6.] Other factors might include the fat content of the body, sepsis/injuries, intoxication, the presence of clothes/insulation over the body, mode of death and a host of other factors [7; 8, 9.] Understanding how these various factors alter the decomposition process is vital for the accurate estimation of the PMI in forensic cases [10].

In the past few years, there has been a growing interest in studying how taphonomy processes occur in Nigeria, with the bulk of this research carried out in the Department of Anatomy Forensic Anthropology Research Facility (DAFARF) located in Okuku, a town in Southern Nigeria.

A recent study conducted by Obun *et al.*, [10] in DAFARF explored the decomposition rate between hanged and surface carrions, with their findings showing that surface pigs decomposed faster than pigs hung on tree branches. They attributed their findings to insects that were more attracted to the surface carrions than the hung carrions due to the gravitational alignment of the hung carrions that prevented the build-up of maggot masses that usually accelerated the decomposition process. Other related studies by Onyejike *et al.*, [2] and Nandi *et al.*, [11] carried out in DAFARF explored the impact of how different depositional environments and climatic factors like temperature, wind speed, precipitation and relative humidity influenced the decomposition of surface carrions. They concluded that depositional environment played a huge role in carcass decay while post-mortem interval estimates can be estimated by developing predictive formulas that can be derived from Total Body Scoring (TBS) scales and Accumulated Degree Days (ADD).

Forensic anthropologists infer that estimating PMI is very negligible owing to the above-mentioned factors, and they recommend that carrying out more comparative studies involving different scenarios will make data available for reference purposes and also make PMI predictions a lot more accurate [12]. Therefore, to underscore the factors that affect post mortem interval, this study sought to investigate the rate of decomposition and predict the postmortem interval between stabbed and eviscerated porcine models in a typical Nigeria weather using domestic pigs (*Sus scrofa*) as there is no "one size fits all" decomposition model data.

MATERIALS AND METHODS

Study area

The study was conducted at the Department of Anatomy Forensic Anthropology Research Facility (DAFARF), University of Cross River State (UNICROSS), located in Okuku, Yala Local Government area of Cross River State. Yala is located at 6° 35′ 35″ N 8° 38′ 01″ E, with a total area of 1,739 km² and a population of 210,843 at the 2006 census. The vegetation is a Guinea forest Savannah which comprises grasslands, shrubs, and low hanging tress [13].

Experimental protocol

Ethical approval was obtained from the Faculty of Basic Medical Sciences, Research and Ethics Committee (FBMSREC), University of Cross River State, Okuku Campus, Nigeria. The ethical approval certification numberis FBMS/REC/2021/284.

The study utilized six pigs (*Sus scrofa domesticus*) to simulate the decomposition process. The use of pigs as human surrogates in taphonomic research has been well established by previous studies [6; 14; 15].

The six experimental pigs had a mean weight of 26 kg. They were purchased from a piggery at Okuku market, Ogoja, Cross River State, Nigeria.

All pigs were certified healthy by a veterinary doctor. The pigs were transported to DAFARF and separated into two groups; A and B. Pigs in group A were stabbed multiple times around the trunk while the pigs in group B were eviscerated with all entrails partially removed and the trunk left open. All experimental pigs were placed inside steel cages that allowed access to insects but prevented large vertebral scavengers.

Results

Weather data

The daily maximum and minimum temperatures recorded throughout the study period were presented to show how climatic variables also influence carrion decomposition. The onsite temperature readings were compared with those obtained from the closest weather station located in Calabar to ensure that our onsite readings did not significantly differ from theirs. The temperature data are presented in Fig. 1.

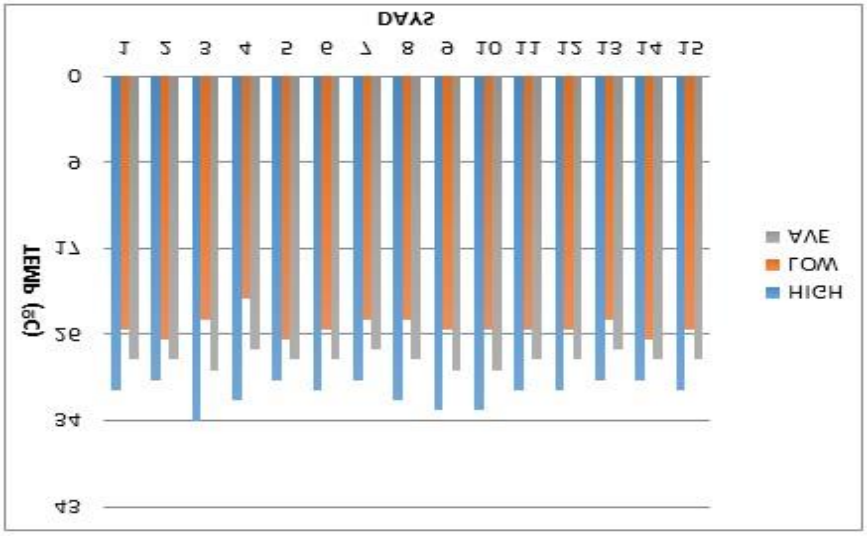

Figure 1: Atmospheric Maximum, Minimum & Average temperatures (Celsius) gotten from temperature data Logger on Site.

Decomposition timeline for stabbed pigs

The following figures are pictorial representations of observations made within the 15-day study period for the stabbed and eviscerated pigs. The weather conditions on the day of placement were hot and dry with an average ambient temperature of 30 °C. The first day of deposition is normally characterized by the visitation of resident insects with very minimal changes occurring. The key milestones that were observed within this period included the beginning and end of rigor and the onset of lividity.

By the second day of the observations, the stabbed carrion had become noticeably discolored, with bloating of the skin on the head, limbs, and some parts of the trunk. There was also expulsion of decomposition fluid from the mouth. It was also discovered that due to the open wound in the stabbed area, flies laid eggs, which would later develop into maggots. Lividity had begun on Day 1 and was clearly visible, with a mild odour associated with this stage (Fig. 2A). The active stages of decay began between the third and sixth days, with decomposition characterized by an increase in maggot activity as the maggots spread to all other regions of the body, particularly the stabbed area and open orifices where the body came into contact with the ground (Fig. 1B). The odor from the carcass became pungent. The maggots grew larger as they fed. The hair and skin on the dorsal aspect of the trunk began to peel and slough off from the carrion, as shown in Fig 3B

On Days 7-10, the stabbed carrion had gotten to the advanced stage of decomposition, as evidenced by the dismemberment of bones in the thoracic region (rib cage), head, and limbs, as well as the exposure of lower limb bones held together by loose ligaments. Putrefaction has developed to the point where there is little fluid around the carcass. Later, bone dryness was noted around the skull and vertebral column (Fig. 2C). From Day 11 to Day 14, there were no maggot activity, no odor, and no flies. On Day 15, there was notable skeletonization, as evidenced by dried carcass, and the soft tissues were starting to mummify (Fig. 2D).

Figure 2: Various stages of decomposition on the stabbed carrion (A- Bloat stage; B- Active decay; C- Advanced decay; D- Skeletonization stage)

Decomposition timeline for Eviscerated pigs

The eviscerated pigs on placement immediately attracted a lot of insects due to the large surface area around the trunk where insects could easily gain access to abdominal viscera. The eviscerated carrions did not undergo the sequential decomposition stages as witnessed with the stabbed carcasses. The fluid already dripping from the open cuts was a fertile ground for insects to lay their eggs which immediately signaled the rapid liquefaction of the carrions (Fig. 3A).

By the third and fourth day, maggot masses could be seen aggregating in the hollow trunk, eye sockets, nose, and mouth leading to the purging fluid from these orifices. The skin around the limbs and ventral trunk could be seen sloughing off with adipocere formation observed on the dependent side of the face. The pungent smell associated with this decomposition stage was the catalyst that attracted more insects like blow flies and beetles to the carcass (Fig. 3B)

From the fifth day to the final day of observations, differential decomposition progressed steadily in all body segments with the limbs showing the most significant levels of deterioration. The skin around the trunk gradually started to mummify as the maggot masses dwindled, with most soft tissues now completely degraded. At about the tenth day, scavengers gained access to one of the eviscerated carcasses by digging beneath the cages resulting in the disarticulation of the hind limbs that were dragged about eighteen meters away from the cage. At the end of observations on the fifteenth day, bone fragments like the mandibles and some teeth fell off from the rest of the skull while some vertebral bones around the ventral trunk could also be seen scattered few meters from the rest of the carcass (Fig. 3D).

Figure 3 : decomposition process for the eviscerated carrion from fresh to skeletonization stage (A, B, C & D)

Observations for carrions décomposition

The study was carried out for 15 days, in the Department of Anatomy Forensic Anthropology Research Facility (DAFARF) in Okuku campus. Both sets of carrions were randomly observed three times daily (morning, afternoon, and evening) for the first seven days, and twice daily for the remaining eight days. Observations lasted for fifteen days and included assessments for visible post-mortem changes, insect activity, and temperature readings. The observations of visible postmortem changes in both pigs were recorded for three regions: head and neck, torso, and limbs which made up the total body score (TBS). Additionally, temperature data derived was used to calculate the accumulated degree day (ADD) which comprises the daily cumulative temperature averages over the entire study duration.

DISCUSSION

This study was conducted to illustrate the decomposition patterns of punctured and disemboweled carcasses. The analysis found that the pigs that were stabbed did not undergo the typical five stages of decomposition, as documented by Megyesi *et al.* [16] and revised by Comstock *et al.* [17]. The five stages of decomposition (fresh, bloating, early decomposition, advanced decomposition, and skeletonization) were similar to those outlined by Nandi *et al.*, [11].

During the investigation, it was found that the eviscerated pig deteriorated at a faster rate than the stabbed pig. This might be attributed to the dissection of the abdomen, which provided a larger surface area and access to the viscera for insects to work upon compared to the stabbed pig. These results align with the findings of Almulhim and Menezes [18], who observed a notable influence on the occurrence of mortality and the rate at which decomposition takes place. Previous research has established that insects and temperature are the primary factors influencing the decomposition process. These studies have also indicated that the rate of decomposition is directly correlated with the level of accessibility of a body to insects. This study aligns with previous research that has shown the importance of insect succession in influencing the rate of decomposition [10, 19].

The process of decomposition in the stabbed carrions exhibited the onset of autolysis and putrefaction symptoms soon after placement. The carrion was invaded by exogenous germs at the sites where the knife punctured it. The relevance of this observation in the field of forensics is that, in most cases, when a body is found, it can be confidently asserted that decomposition will typically begin near the point of entry or where trauma may have happened, as indicated by blood splatter and the relative ease of accessing internal tissues. The presence of blood splatter and the ease of accessing interior structures are contributing variables. The highest level of maggot activity was detected in the thorax and belly region, where the majority of the many stabs took place. These findings contradict Smith's findings, which suggested that stabbings have no major impact on the decomposition timeframe [20]. Furthermore, Cross and Simmons [21] argued that the impact of a gunshot wound on the rate of decomposition and the duration required for a person to become skeletonized should not be considered important. However, this study's findings align completely with those of Onyejike *et al.* [2], who found that penetrative trauma had a substantial impact on accelerating the rate of carrion decomposition.

The process of skeletonization in the stabbed pig was initially observed to commence in the head and neck region, followed by progression to the upper limb, and ultimately extending to the lower leg. This sequential pattern persisted until the final day of observations. Obun *et al.* [22] examined the sequential process of skeletonization for surface depositions in a study conducted in the same area. It was discovered that the process of skeletonization initially took place in the cranial region. The upper extremities usually underwent skeletonization before the lower extremities, and the feet were the final body part to lose their structural integrity. The results were consistent with a previous study that had been undertaken. Due to sun exposure, it was observed that a portion of the skin would undergo mummification instead of skeletonization.

The study of the disemboweled pigs was abruptly terminated on the sixth day due to a scavenger assault. This could have significant forensic utility, particularly for cadavers found in dense vegetation and other remote locations. This factor should be carefully considered, especially for research efforts that aim to measure the extent of decomposition. The results of this study were consistent with several previously published investigations [23-25]. Scavenging animals possess the capacity to extract soft tissue and disassemble and disperse residues, resulting in a breakdown process that happens at a faster rate than initially expected. In their respective studies, Séguin *et al.* [26] and Spies [7] observed comparable patterns and documented a scavenger assault that resulted in the destruction of the torso and the partial removal of both the upper and lower limbs. This hindered the ability to see the various stages of decomposition and prevented precise estimations of postmortem interval.

Conclusion

The data acquired from this work enhances our understanding of assessing the impact of stabbing and evisceration on the timeline of decomposition, particularly its forensic significance.

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