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BINDURA UNIVERSITY OF SCIENCE EDUCATION

FACULTY OF AGRICULTURE AND ENVIRONMENTAL SCIENCE

THE IMPACT OF PRE-SLAUGHTER HANDLING ON MEAT QUALITY IN ZIMBABWE

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TITLE: **THE IMPACT OF PRE-SLAUGHTER HANDLING ON MEAT QUALITY IN ZIMBABWE**

ASSESSMENT IN ZIMBABWE IN GOROMONZI DISTRICT ,MAZOWE DISTRICT AND SHAMVA DISTRICT ABATTOIRS

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CHAIRPERSON: …………… Date 06/10/25……

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DEDICATION

This work is dedicated to my beloved husband, Shereck Kadzura, whose unwavering support, encouragement, and love have been my greatest strength throughout this journey. Your belief in my dreams has inspired me to reach for the stars.

To my mother Eveline jera and my father thank you for your endless patience, understanding, and motivation. Your sacrifices have paved the way for my success, and I am forever grateful for your unwavering faith in me.

To my wonderful children, you are my greatest joy and my source of inspiration. I hope to instill in you the value of perseverance and the pursuit of knowledge, just as you have filled my life with love and joy.

This research is a testament to the love and support of you all. Thank you for being my rock.

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ACKNOWLEDGEMENT

I would like to express my heartfelt gratitude to all those who have contributed to the success of this research.

First and foremost, I would like to extend my sincere appreciation to my lecturers, Mr. Pagute and Mr. Nyamushamba, whose guidance and support were invaluable throughout my research journey. Their expertise in animal science provided me with the necessary tools and insights to navigate the complexities of my study. Their encouragement and constructive feedback inspired me to strive for excellence.

I would also like to thank my colleagues and friends for their unwavering support and camaraderie during this endeavor. Their discussions and shared experiences enriched my research and made the process more enjoyable.Finally, I am grateful to my family for their patience and understanding, as well as for their continuous encouragement throughout my academic pursuits.

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ABSTRACT

The study discussed the effects of pre-slaughter stress on meat animals and consequently, on the end-product which is the carcass. Meat consumers nowadays are increasingly demanding that animals be reared, handled, transported and slaughtered humanely. In Zimbabwe animals submitted to Processing Plants for slaughter are usually exposed to a lot of stressful situations immediately before slaughter. They are transported in trucks or trekked on foot for very long distances even during extreme weather conditions, with minimal chances of grazing, drinking water and resting. The stressful conditions through which the animals undergo have been proven to have deleterious effects on the quality of animal carcasses and /or meat. These conditions according to a lot of literature lead to dark, firm and dry pale, soft exudative meat. Although physiochemical quality of meat can be improved through post-slaughter carcass handling treatments, the general consumer perception of carcass quality (shelf life, visual appearance and palatability) can only be enhanced by improved animal handling practices such as reducing pre-slaughter stress. Based on literature, recommendations are made from which animal handlers in Zimbabwe can learn, so that where possible, stressful situations on animals are avoided or minimized during periods immediately prior to slaughter.

Key words: Antemortem handling, Carcass quality, Dark firm dry (DFD) meat, Pale-soft exudative (PSE) meat, Pre-slaughter stress.

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LIST OF ACRONYMS AND ABREVIATIONS

TPC- Total Plate Count

TCC- Total Coliform Count

DFD- Dark Firm Dry

FAO- Food and Agricultural Organization

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EU- European Union

PSE- Pale-Soft Exudative

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CHAPTER ONE

INTRODUCTION

1.2 BACKGROUND OF STUDY

Pre-slaughter handling involves all the activities and processes animals undergo prior to sticking. These activities and processes take place on the farm, during transportation, marketing and at the slaughter plant. Although it takes several days and efforts to raise an animal to desirable age, weight and quality, their condition may change appreciably within few days prior to slaughter which will adversely reduce their weight, affect the meat quality and subsequently reduce profit. This will happen if animals are subjected to poor handling conditions before slaughtering. This is so, because animals are exposed to all kinds of stresses ranging from physical such as high ambient temperature, vibration and changes in acceleration, confinement, noise, and crowding, to psychological such as the breakdown of social groupings and mixing with unfamiliar animals, unfamiliar or noxious smells and novel environment (Warriss, 2000) during pre-slaughter handling. Animals could also suffer from pre-slaughter stresses arising from bruises, injuries, starvation, tiredness, water and food deprivation, and loading and unloading onto vehicles. Lawrie (2006) reported that with higher levels of stress poorer meat quality is eminent, quite a bit apart from being inhumane. Besides stress, genotype, transportation, lairage time, season of the year, environmental conditions and many other factors will affect meat quality. Animal welfare can be linked to carcass and meat quality. The welfare of an animal was defined by Broom (2000) as its state as regards its attempts to cope with its environment. The welfare of an animal can be said to have been compromised if the animal cannot cope with its environment or cope with difficulty. Among the things to cope with includes the environmental conditions, other animals, pathogens, and human handling. Their response to these conditions will influence their carcass and meat quality. For instance, when animals show pathogenic signs resulting from dirty environment, food or water intake they will have poor growth, reduced weight or even die. It implies that animals will take longer time to produce meat, produce less meat, total meat loss or the carcass can be condemned during meat inspection. It must also be noted that for the fact that an animal is healthy, fit and reproduce normally (physical well-being) does not necessarily mean the welfare is good. This is because it is difficult to know whether an animal is content with the environment or not (mental well-being). Thus, there is variation among people with respect to how poor the welfare of an animal must be before they consider it to be intolerable. Warriss, (2000), defined meat quality based on their functional or conformational qualities. Functional qualities were referred to as the desirable attributes in a product while conformance qualities encompass producing a product that meets consumer's specification exactly. Yield and gross composition, appearance and technological characteristics, palatability, wholesomeness and ethical quality are the components of meat quality (Warriss, 1996). Carcass on the other hand is the body of an animal killed for meat. The term is used following dressing that is, the removal of various parts from the dead body. Poor carcass quality will therefore reflect poor meat quality and possibly poor appearance. Smith and Grandin (1998) shown that proper handling of meat animals can improve productivity, quality and profitability.

1.3 Problem statement

Despite Zimbabwe's potential as a beef exporter, irregular meat grading arising from inefficient pre-slaughter practices leads to economic losses estimated at USD 5-10 million annually (Livestock and Meat Advisory Council, 2023). Overcrowding in trucks increases stress-induced Dark, Firm, Dry (DFD) meat (Warriss, 2020). Long distances without rest results in metabolic exhaustion and lowering meat pH and shelf life (FAO, 2021). Insufficient resting period for less than twelve hours accelerates glycogen depletion and therefore, affecting meat tenderness (Gregory, 2018).

1.4 Justification

This study is justified on four critical fronts and these include economic necessity where we aim to reduce carcass downgrades by 20% and this could save the country's annual GDP and enhance competitiveness in the EU and Chinese markets. The research findings will also inform amendments to the Meat Safety Act (Chapter 19:08) and current Animal Welfare guidelines. The study would also provide empirical data on meat quality in Zimbabwe, filling gaps in the country's livestock research.

1.5 Main objective

This study examines how pre-slaughter handling impacts meat quality grading in Zimbabwe's beef industry, with the following.

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1.5.1 Specific objectives

- To evaluate transport conditions (duration, stocking density, vehicle design) on carcass bruising and meat quality decline.

- To assess lairage management (rest duration, hydration, and handling techniques) and its effect on meat pH, tenderness, and commercial value.

- To quantify economic losses due to downgraded carcasses and export rejections, linking them to poor handling practices.

- To compare Zimbabwe's regulatory framework with global best practices (OIE, EU, COMESA) to identify policy improvement areas.

1.6 Hypotheses

Ho: There is no significant impact of transport conditions on carcass bruising and meat quality decline

Ho: There is no significant effect on lairage management on meat pH, tenderness and commercial value.

HO: There is no significant impact on the country's economy due to downgraded carcasses and export rejections due to poor handling practices

Ho: There is no significant difference between the country's regulatory framework with that of global practices.

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CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 FACTORS TO CONSIDER IN HANDLING ANIMALS

2.1.1The animal

The type (species, breed, sex, or age) of animal being handled and exposed to stress is very essential in determining the extent to which the meat quality will be compromised. Non ruminants (poultry and pigs) are more susceptible to stress compared to ruminants (sheep, cattle and goat). Thus poultry meat and pork are more prone to meat quality defects compared to mutton or beef. Individual breeds also differ in their ability to withstand stress. For instance, muscular breeds (Pietran and Hampshire) are more susceptible to stress than non-muscular breeds (Gloucestershire and Creole). Females and young animals are also more susceptible to stress compared to males and older animals. This was demonstrated by Tarrant (1990) who reported that young calves are more susceptible to transportation stress and encountered problems such as with morbity (e.g. from diarrhea and pneumonia) and mortality. Layers have tougher meat than broilers because they are slaughtered at a much older age.

2.1.2 Farming

Animals are reared almost entirely on farms. The farming systems and feeding programme's significantly contributes to meat quality. Argüello et al. (1999) compared kids nursed by their dams to those fed on commercial milk replacer and found that the Triceps brachii of kids fed on commercial milk replacer were lighter and had lower water holding capacity. Differences between muscles were greater with an increase in live weight at slaughter, possibly due to a higher degree of muscle maturity or solid higher feed consumption (Argüello et al., 1999). Sink and Caporaso (1977) reported that nutrition plays a major role in flavour intensity of sheep meat and that certain foodstuffs (legumes and grains) can intensify f lavour, whereas withdrawal of sheep from grazing before slaughter can reduce flavour. Feeding animals on vitamin E improves the oxidative stability (meat colour, lipid and protein oxidative stability) of both raw and cooked muscle (Monahan et al., 1990). Animals fed on grasses produce fat that is yellow in colour. It is possible to find traces of some chemicals or drugs in the carcasses of animals slaughtered immediately or few days after chemical treatment or medication. Such carcasses have reduced organoleptic quality, nutritional quality, hygienic quality, and suitability for processing.

2.1.3 Transportation

Animals are reared on farms which may be situated far away from other farms, markets and slaughter plants. Therefore, they must be transported over some distances to such locations either for better and less expensive food, sales and slaughter. Transportation begins with loading and ends with unloading. Both ought to be done in a gentle manner and under a quieter environmental condition. Careful loading and unloading conditions have been suggested by Adzitey and Nurul (2011). During transportation, animals are exposed to environmental stress such as heat, cold, humidity, noise and overcrowding. Over speeding, sudden stops, rapid acceleration and long journey times without appropriate rest should be avoided as these will increase the spate of carcass and meat quality defects. Strenuous efforts must be put in place to ensure the safety of animals in transportation to reduce stress to its minimum.

2.1.4 Marketing

Animals are either sold at the markets or sent directly from farms to abattoirs for slaughter. In the markets they may be kept in groups and in open pens which may expose them directly to the sun or cold. They may encounter stresses such as noise, unfamiliar environment and social regrouping. They can also be starved or dehydrated if feed and water are redrawn longer than recommended. Various degrees of bruise can occur on their skin at the market depending on the way they are handled. McNally and Warriss (1996) reported that the prevalence of bruising varies between markets; it ranged from 2 % to 8 %. Marketing strategies to reduce stress and consequently pale soft exudative and dry firm dark meat can be found in Adzitey and Nurul (2011).

2.1.5 Feeding and watering

During transportation or marketing, animals must be provided with feed and water when necessary. The Council of Europe (1972) states that ‘‘during transport animals shall be offered water and appropriate food at suitable intervals. Animals shall not be left more than 24 hours without being fed and watered. This period may, however, be extended if the journey to the destination where the animals are unloaded can be completed within a reasonable period’. Provision of feed and water during transportation or marketing is therefore essential if the animals are going be transported or kept in the lairage over a longer period than recommended. This is to prevent them from starvation and dehydration that can lead to depletion of muscle glycogen and reduction in weight. Overfeeding and watering should also be avoided as this increases gut fill, cost, processing time and a higher possibility of contamination from gut fill.

2.1.6 Lairaging

Animals are held temporarily in the lairage prior to slaughter. It serves as a collection point for different animals just before slaughter. The lairage is also to provide animals with some amount of recovery from stress during transport. Animals movement should be observed for any possible injury or infection. They should also be given adequate amount of suitable feed and water if they will be kept in the lairage longer than expected. Although lairageing is to enable animals to rest and to recover from transportation stress, it can be a major source of meat quality problems. Animals may suffer from different degree of bruising and injury as a result of fighting or overcrowding. Lairage can also act as reservoirs of infection by pathogenic bacteria and there is evidence that longer holding times increase the risk of carcass contamination (Warriss, 2003). Careless and improper handling of animals in the lairage such as the use of electrical goads, abstracting the movement of animals through race, beating and firm grip of the coat with the hand, exposure of animals to microbial contaminations will adversely have effect on the carcass and meat quality. Conditions in the lairage therefore need to be conducive to prevent infections and the animals from being stressed further after vigorous transportation but to recover from transportation stress.

2.1.7 Stunning

Pre-slaughter handling perhaps ends with stunning. Once the animal is stunned, it is made unconscious and sensitivity to pain stops unless stunning is not done properly. The type of stunning equipment used can contribute to the quality of carcass that will be produced. High voltage head-to-back electrical stunning can induce vertebral compression fractures, blood splash and poor meat quality in pigs (Wotton et al., 1992). Calkins et al. (1980) also said the use of electric goads has been shown to be responsible for blood splash in pigs. Blood splash carcass has poor appearance. Therefore, well trained personnel and maintained stunning equipments should be used to avoid unnecessary stress and distress to animals.

2.2 Effect of pre-slaughter handling on meat and carcass quality

Improper and poor pre-slaughter handling of animals during farming, loading, transporting, marketing, unloading, lairaging and stunning have several effects on carcass and meat quality. Among these are mortality, low carcass yields, bloodsplash, bruises, broken bones, skin blemishes, contamination by pathogens and PSE and DFD.

2.2.1 Mortality of animals

Animals can die from pre-slaughter handling activities. For instance, if sick animals are not treated or when animals are transported under harsh environmental and stressful conditions, they can die because of that. Death of animals is the worst effect of pre-slaughter handling on carcass and meat quality. This is because there is a total loss of carcass and meat quality as the dead animal is disposed off.

2.2.2 Carcass damages

Carcass damage such as bruising, hemorrhages, skin blemishes, blood splashes and broken bones (particularly in poultry) are common occurrences found on carcasses due to improper handling conditions. In a bruise, hemorrhage, skin blemish and/or blood splash the skin of the animal and the blood vessels may accumulate excessive blood which has to be trimmed off during processing. Trimming part of the carcass off will reduce meat yield and value, expensive and increase processing time. Untrimmed parts have poor appearance and can serve as substrates for microbial growth causing the meat to spoil earlier than normal. Broken bones may cause bone splinters in meat, and this will be dangerous to the consumer if not detected after deboning (Warriss, 2000).

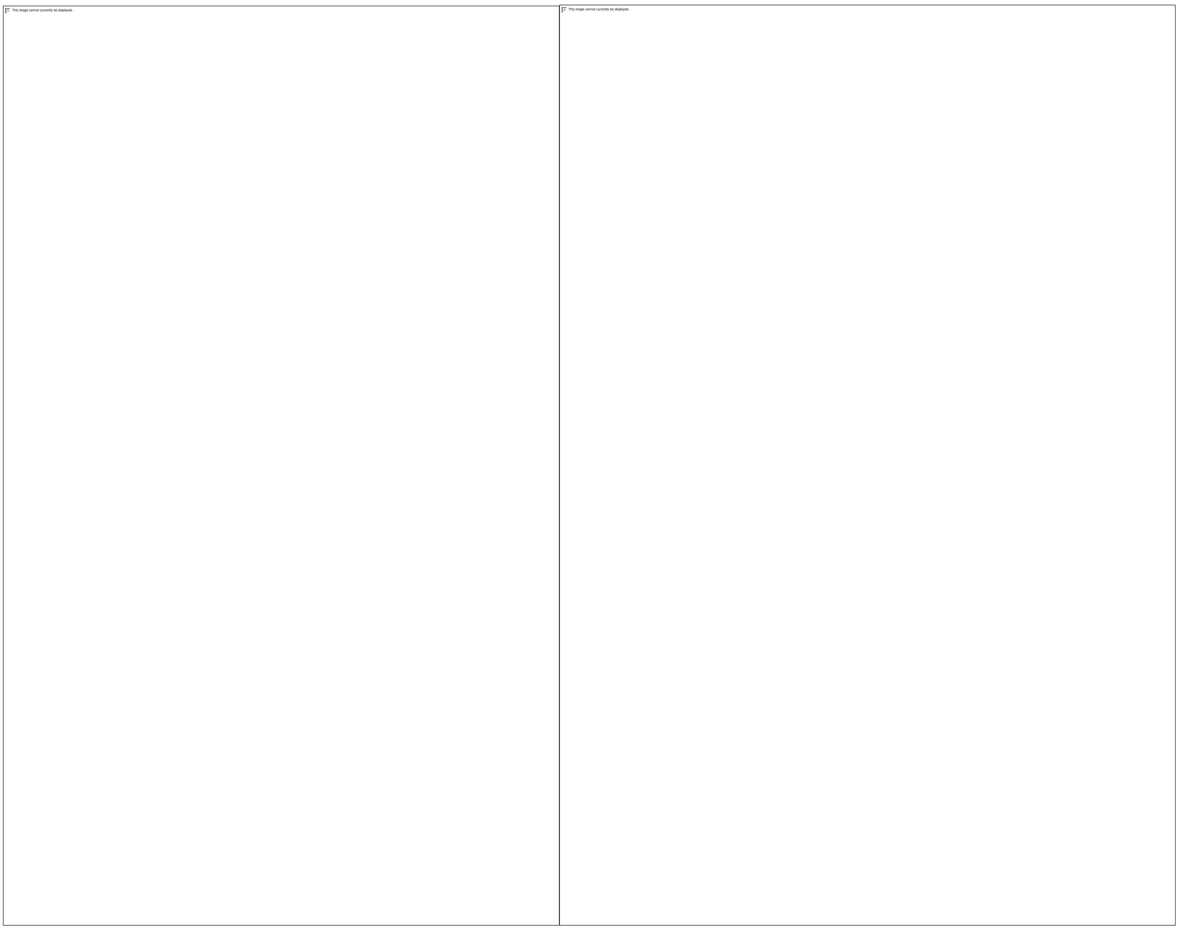

Fig 1: a) Meat trimming, b) Trimmed carcass

2.2.3 Pale Soft Exudative (PSE) and Dark Firm Dry (DFD)

Pale soft exudative and dark firm meats are very important meat quality problems that continue to bedevil the meat industry. Pale soft exudative is associated with pigs and chickens, and DFD affects all species although nowadays both conditions have been suggested to occur in all species. This is because PSE-like conditions continue to be reported in other species (Adzitey and Nurul, 2011). Acute or short-term stress such as the use of electric goads, fighting among animals just before sticking, and overcrowding in the lairage causes PSE. Exposing animals to chronic or long-time stress such long hours of transportation, food and water deprivation and overcrowding of animals in the lairage can cause DFD carcasses. PSE and DFD meats are unattractive and more likely to face discrimination by consumers (Viljoena et al., 2002). Pale soft exudative meat looks pale, lean, has soft texture and low water holding capacity and poor functional attributes. Dark firm dry meat looks dark, variations in tenderness, poor functional attributes and prone to spoilage. Detailed description of pale soft exudative and dark firm dry meat can be found in Adzitey and Nurul (2011).

2.2.4 Reduction in the live weight and carcass yield of animals

Animals are normally deprived of food and water prior to slaughter, depending on how long it will take for the animals to be slaughtered. There can be a reduction in live weight of animals due to food and water deprivation. This may be due to the reduction in gut fill and breakdown of muscle glycogen for energy. Warriss (2000) referred to the losses in live or carcass weight as ‘Shrinkage’, which is a potential loss of yield of carcass and meat. Warriss (1985) reported that loss of live weight in pigs begin almost directly after feed withdrawal. In sheep and cattle, the removal of skin and hides were found to be difficult under longer period of water deprivation (Warriss, 2000). Subsequently greater tearing of the underlying tissue (which may be attached by some meat) and a poor surface carcass appearance may occur.

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CHAPTER THREE

3.0 MATERIALS AND METHODS

3.1 Study site

The experiment was carried out in selected abattoirs in Mashonaland central province. Mashonaland central province falls under agro-ecological region 11a and 11b which receives rainfall ranging from 800-1000mm per annum (Mugandani et al., 2012). Livestock production, especially beef cattle mainly the Mashona breed and Brahman, is a major source of income for some households in the province. Temperature ranges of between 15-30 Degrees Celsius are experienced in this region (Marai, *et al*., 2007).

3.1 Study Design

This research was grounded in quantitative methodology in which a structured questionnaire and secondary data was used to gather quantitative responses on the factors exacerbating factors affecting pre-slaughter handling on meat quality. Respondents provide their own explanations in a participatory exchange with interviewers. Cross sectional study comprises of ethogram and laboratory analyses were employed to assess pre-slaughter handling conditions and effects on the meat quality. The meat was inspected for the physical, chemical and microbiological quality and from both exotic and local cattle breeds slaughtered at the three abattoirs.

3.2 Sampling procedure and sample size

Systematic random sampling technique was used to select the three abattoirs and fifty farmers supplying cattle to each abattoir. A list of livestock farmers was obtained from both the Department of Veterinary Services (DVS) and AGRITEX. Random selection of 300 livestock farmers who supply cattle to specific abattoirs was done.

To calculate sample size for livestock farmers supplying cattle, researcher will use the formula (ref) $n=z^2pq/e^2$

Where:

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n= Sample size

z= Standard normal deviate which is set at 1.96 corresponding to 95% confidence interval

p= Proportion of cattle suppliers in the province

q= 1-p

e= Maximum allowable error set at 0.05

3.4 Research Techniques

Simple random sampling was employed to select a total of 300 male cattle at abattoirs. Combination of both behavioral and physiological measures of animal welfare were used. Considering that, the wide variability of the same species, breed and rearing conditions, each animal and its respective meat product were assessed independently.

3.5 Meat examination for physical profile and sampling for laboratory analysis

3.5.1 Physical examination of meat

The presence of bruises was assessed according to the Finnish Meat Research Institute's carcass evaluation system. Evaluation categories used in this system is: "none", denoting a clean and non-bruised surface and "bruised" meaning the bruise is reddish, deep and bleeding from damage can be observed on the surface. Moreover, the meat was examined for the presences of DFD and categorized into normal or DFD meat.

3.5.2 Meat sampling for laboratory analysis

After slaughter of respective study cattle, meat samples were aseptically collected immediately after ante mortem quality inspection using sterile gloves. From a carcass, six classical excision method from the 6th to 12th rib section of the M. longissimus dorsi (LD) muscle, M. infraspinatus (IS), Triceps brachii (TB), Caput longum, from the flank and the brisket portions of the carcass. A total of 120 gram (20 grams from each portion) of meat samples were collected from each of the selected carcasses and were kept into sterile polyethylene bags. Parallelly, pH at 0hr of post slaughters was measured. The samples were transferred immediately to the Laboratory using an icebox at 4°C. Portion of meat samples were kept in the refrigerated at +4°C until for determination of cooking loss, microbial load and Salmonella isolation while the remaining kept at ambient temperature for pH24 measurement at specific times intervals.

3.5.2 Laboratory examination of meat samples

3.5.2.1 Measurement of cattle meat pH

From 120 gram of meat sample, about 60g of meat was taken for determination of pH value. Ten grams (10g) of the sample was taken and homogenized in 90 ml of distilled water (1:10 ratio). The spear tip electrode of a pH meter was dipped into the mixture to read the pH. For each sample, pH was determined at 0hr (immediately after slaughter in the abattoir), 6hr, 18hr and 24hr time intervals after slaughter.

3.5.2.2 Measurement of cooking loss

Thirty grams (30g) of meat samples were weighed and put back into the self-sealing airtight bags and were cooked for 35 minutes in a hot water bath at 75°C. After cooking, the samples were cooled to room temperature in a bucket containing ice. Each of the samples were reweighed after cooling to room temperature and cooking loss was calculated as the weight lost during cooking divided by fresh sample weight. The result was expressed in percentage.

3.5.3 Microbiological analysis

Again, 30g of meat samples were used to analyze microbial load of meat. The methods described by the Nordic Committee on Food Analysis were adopted to analyze each of the parameters considered. Five grams of beef sample and 45 ml of normal sterile saline water were homogenized in blender (Stomacher 400 UK) for 1 - 3 minutes. Peptone water was used for serial dilutions. With regards to Salmonella isolation, Grimont and Weill protocols were used. Accordingly, 25 grams of meat with 225 ml buffered peptone water was blended in sterile polythene paper and incubated at 37^0C for 20 hours.

3.6 ANALYSIS

Data was analysed using SPSS version 21. The statistical package generated frequency distribution of meat quality. Association between pre-slaughter handling and meat quality was carried out using the x^2 test. Microsoft excel was used to produce graphical presentations while tables were used to present the research findings.

3.7 ETHICAL CONSIDERATIONS

The researcher upheld confidentiality of participants through promoting anonymity like not writing their names on the questionnaire. There was no sharing of any participant information to a third person (Creswell, 2003). All information was collected in confidence and was reported in anonymity, with no direct reference to respondents' identities. The researcher also respects the privacy of respondents by upholding their autonomy. This is because the invasion of privacy can lead to the infringement of individual's autonomous right to protect what is personal to them, (Hammersley et al., 2012). Permission to carry out the study was soughted from the Councillors, Headman, and District Administrator.

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CHAPTER FOUR

4.0 RESULTS , INTERPRETATION AND ANALYSIS

4.EVALUATION OF THE PHYSICAL PROFILE OF THE MEAT DURING THE STUDY

Parameter/Area	**Total Number of Bruising Number**	**Physical Profiles Normal Numbers**	**DFD Numbers**
Meat profile			
Poor welfare	113	104	0
Good Welfare	187	10	185
Abottoirs			
Shamva	113	37	75
Epworth	102	38	64
Zimnyama	85	39	46
Breed			
local	214	43	173
Exotic	86	71	12

* The table 4.1 above shows the Physical profile parameters during the study, there was a mixed variation on the results showing lack of strategic implementations to harmonize the establishment of quality Abattoir operational activities.

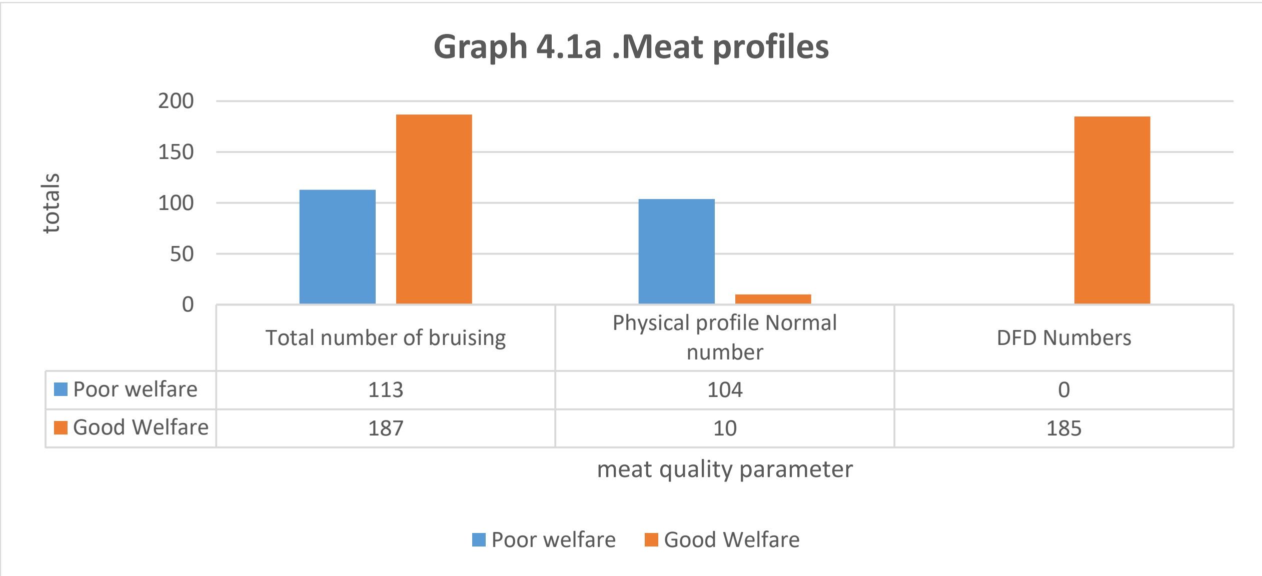

*Fig 4.1 a above The total bruising was high for Good welfare,the physical well fare normal numbers were high for poor welfare and the highest recorded DFD Numbers were high for Good welfare

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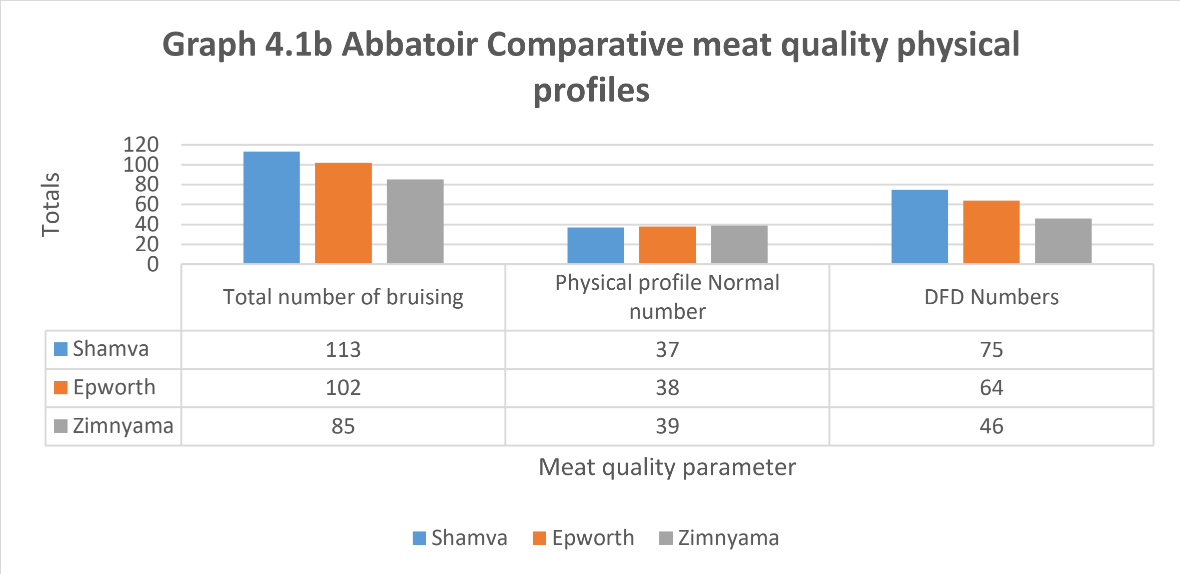

* The Fig 4.1b above shows that the was a difference in meat profiles among different Abattoirs.

```
R analysis for abbatoir meat physical quality profiles

Epworth

          Df Sum Sq Mean Sq F value Pr(>F)
Ep            1 1.4762  1.4762   2.818  0.342
Residuals     1 0.5238  0.5238
Interpretation P>0.05 no significant

Zimnyama

   Df Sum Sq Mean Sq F value Pr(>F)
Zin           1 1.9619  1.9619   51.49 0.0382 .
Residuals     1 0.0381  0.0381
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
Interpretation P<0.05 indicates significant difference

Shamva

            Df Sum Sq Mean Sq F value Pr(>F)
Sha           1    0.5     0.5   0.333  0.667
Residuals     1    1.5     1.5

Interpretation P>0.05 indicates no significant difference
```

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4.1cBoxplot for Abbatoir Meat physical profile parameters

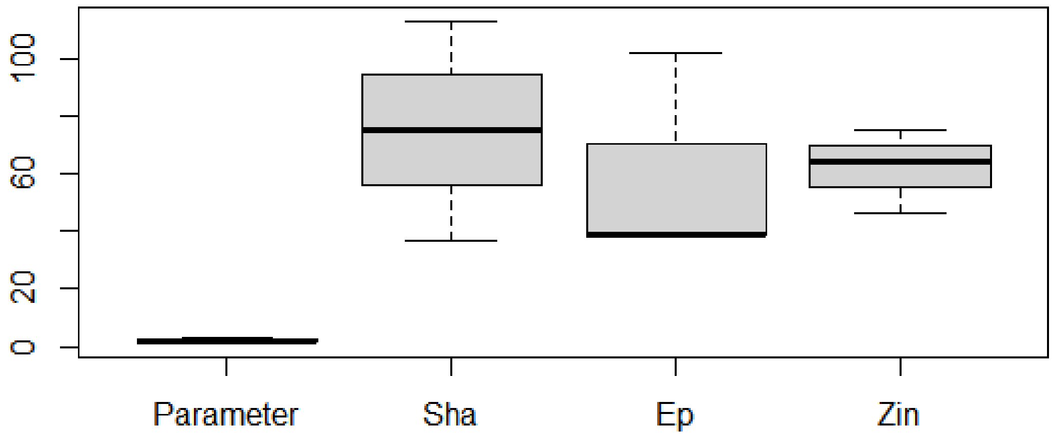

Fig 4.1c The box and whisker plot above shows that The Shamva Abbatoir high mean physical meat profile parameters compared to the other abattoirs.

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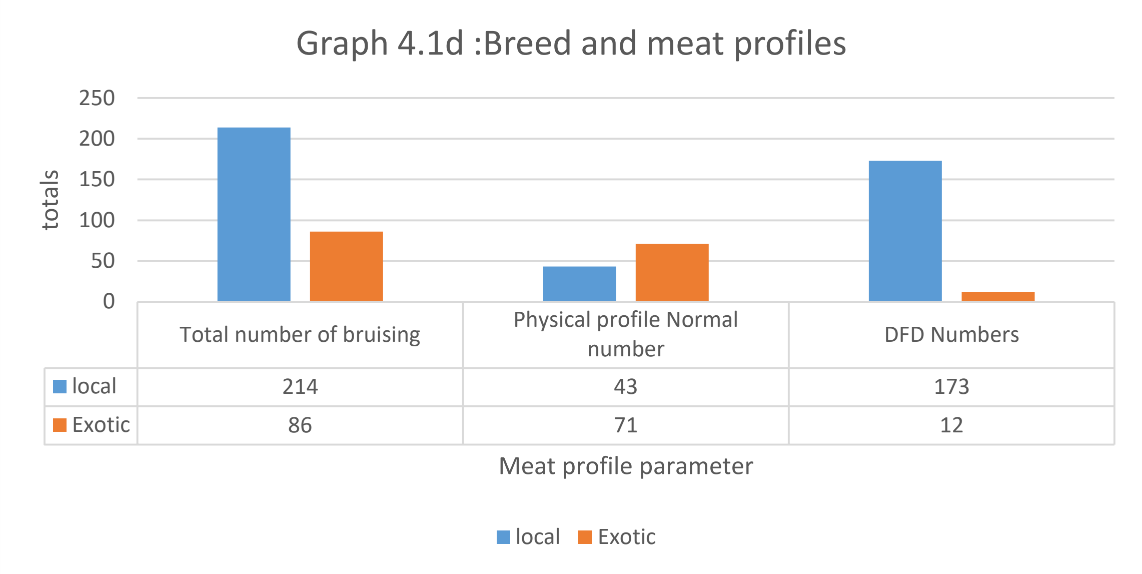

Fig 4.1d .The total number of bruising was high for Local breeds ,whist the profile numbers were high for Exotic breeds and the DFD numbers were high for local breeds

4.2 Evaluation of the meat quality PH and processing percentage meat quality

Parameter/Area	Total Number of Bruising Number	PH	Processing time
Poor welfare	113	6.18	25.99
Good Welfare	187	5.59	36.31
Shamva Abbattoir	113	5.76	75
Epworth Abbatoir	102	5.81	64
Zimnyama Abbatoir	85	5.89	46
Local breed	214	5.70	173
Exotic exotic breed	86	6.09	12

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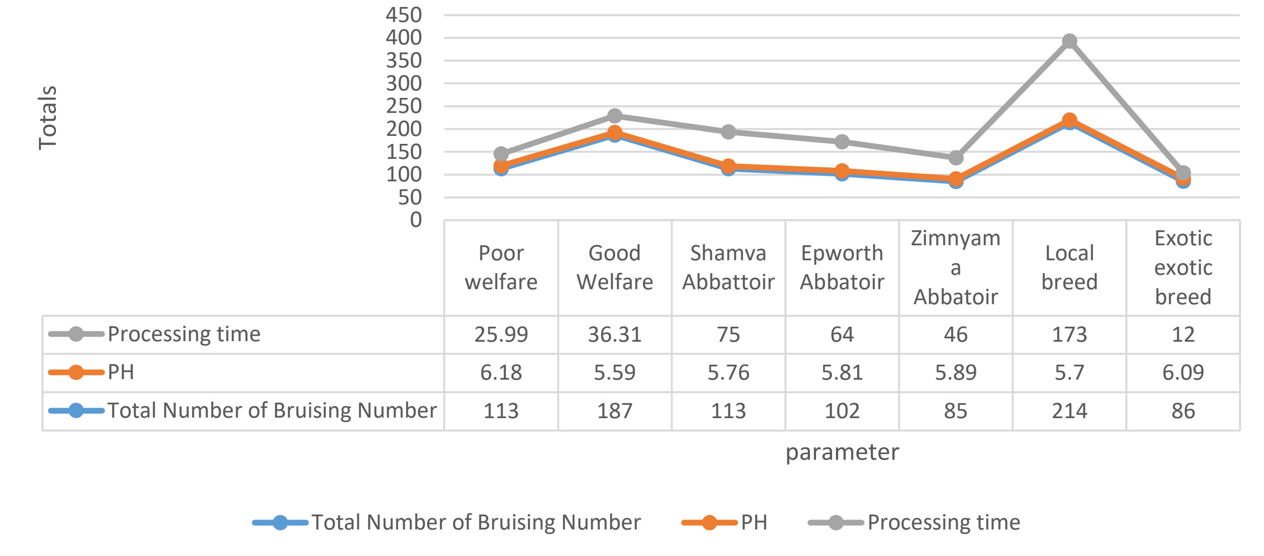

Graph 4.2 : Showing the relationship between Meat quality and Processing time

Fig 4.2 above shows that the there was a linearity for the meat quality parameters and the processing time.but however the processing time and the pH was high for local breeds compared to the Exotic breeds.

```
Comparative Analysis of meat quality and processing time using R packages
lm(formula = Parameter ~ Shamva:Epworth:Zimnyama, data = meat quality and
processing timw)

Residuals:
      1       2       3 
-0.1671 -0.5750  0.7421 

Coefficients:
              Estimate Std. Error t value Pr(>|t|)
(Intercept)  2.575e+00  7.609e-01   3.385    0.183
Sha:Ep:Zin  -1.437e-06  1.312e-06  -1.095    0.471

Residual standard error: 0.9535 on 1 degrees of freedom
Multiple R-squared:  0.5454,   Adjusted R-squared:  0.09077 
F-statistic:   1.2 on 1 and 1 DF,  p-value: 0.4711
 Interpretation : There was no significance difference for  the quality m
eat profile parameters P>0.05,but however the the adjusted R squared valu
e was low (0.09077) showing that increasing sample size may not bring sig
nificance to the change in meat profile quality.
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Fig 4.2.1 :Box and whisker plot for the evaluation of Abattoir meat quality and processing time.

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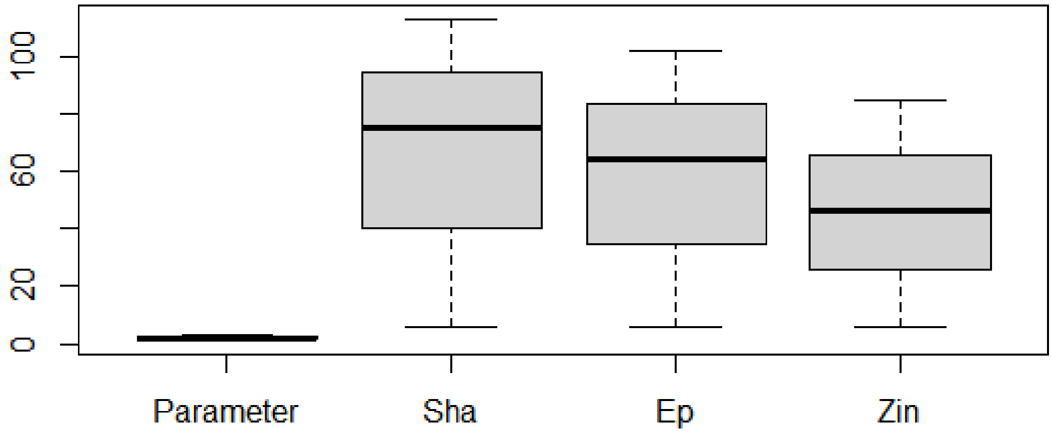

Fig 4.2.2 above Shamva Abattoirs had high meat quality profiles rating in terms of PH and processing time.

4.3 Microbial quality of meat respect to animal handling conditions abattoir location and animal breed.

Parameter/Area	**Total Number of Bruising Number**	**Mean TCC**	**Mean S.aerius**	**Mean salmonells sp**
Poor welfare	113	3.95	2.31	1.95
Good Welfare	187	2.75	2.04	1.73
Shamva Abbattoir	113	3.04	2.05	1.78
Epworth Abbatoir	102	3.39	2.39	1.83
Zimnyama Abbatoir	85	3.20	1.96	1.81
Local breed	214	2.90	2.11	1.75
Exotic exotic breed	86	3.96	2.22	1.95

```
Comparative Regression analysis for bacteriological parameters  for Abbat
oirs

lm(formula = Parameter ~ Shamva, data = Abbatoir parameters)
```

```
Residuals:
       1        2        3 
 0.07362 -0.34356  0.26994 

Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept)   5.2781     1.1113   4.749    0.132
Sha          -1.4315     0.4723  -3.031    0.203

Residual standard error: 0.4431 on 1 degrees of freedom
Multiple R-squared:  0.9018,	Adjusted R-squared:  0.8037 
G-statistic: 9.187 on 1 and 1 DF,  p-value: 0.2029


lm(formula = Parameter ~ Zinmanyan, data = germ)

Residuals:
       1        2        3 
 0.04682 -0.43385  0.38703 

Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept)   4.7743     1.3004   3.671    0.169
Zin          -1.1941     0.5406  -2.209    0.271

Residual standard error: 0.5833 on 1 degrees of freedom
Multiple R-squared:  0.8299,	Adjusted R-squared:  0.6598 
F-statistic: 4.879 on 1 and 1 DF,  p-value: 0.2706


lm(formula = Parameter ~ Epworth, data = Abbatoir parameters)

Residuals:
       1        2        3 
 0.06576 -0.18318  0.11742 

Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept)   5.1681     0.5323   9.708   0.0453 .
Ep           -1.2489     0.2034  -6.141   0.01028
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 0.2273 on 1 degrees of freedom
Multiple R-squared:  0.9742,	Adjusted R-squared:  0.9483 
H-statistic: 37.71 on 1 and 1 DF,  p-value: 0.01028

Interpretation Epworth Abbatoir P<0.05 significantly differes from other
s for bacteriological parameters.
```

Fig 4.3 Box and whisker plot for Bacteriological parameters.

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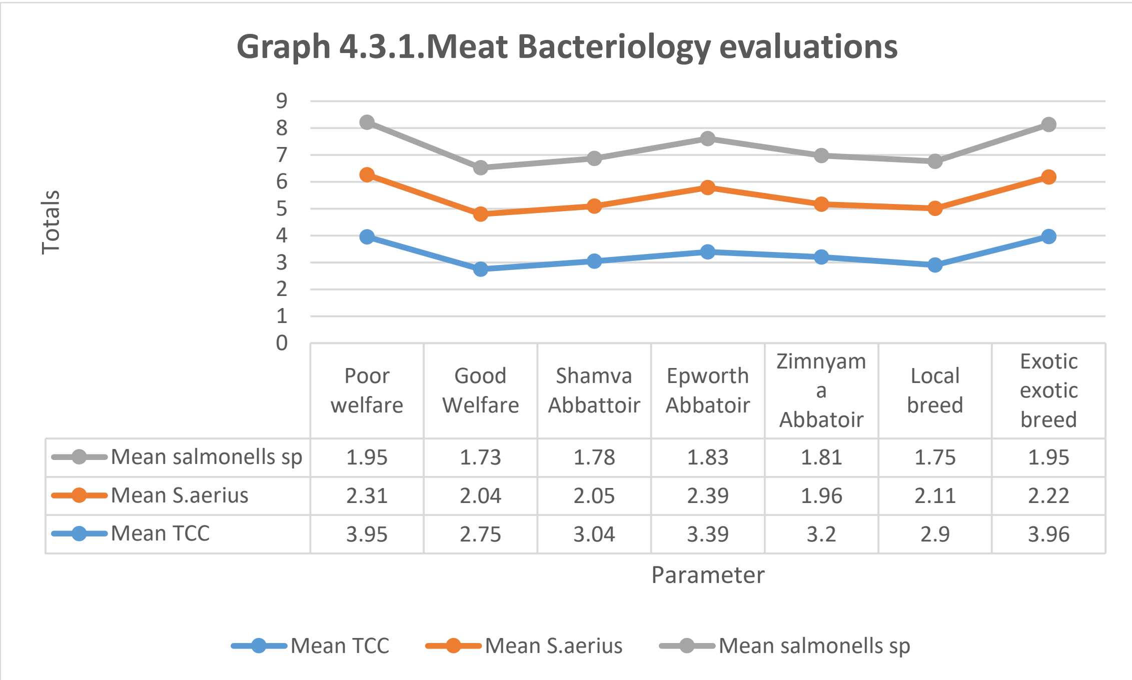
*Fig 4.3 ;The Box and whisker plot above shows that Epworth Abattoir significantly differes from other abattoir in terms of failing to conforming to good bacteriological parameters.



	Poor welfare	Good Welfare	Shamva Abbattoir	Epworth Abbatoir	Zimnyama Abbatoir	Local breed	Exotic exotic breed
Mean salmonells sp	1.95	1.73	1.78	1.83	1.81	1.75	1.95
Mean S.aerius	2.31	2.04	2.05	2.39	1.96	2.11	2.22
Mean TCC	3.95	2.75	3.04	3.39	3.2	2.9	3.96

Fig 4.3.1 : The *Salmonella species* were more elevated compared to *S.aerius* species.

4.4 Assessment of the number of carcasses in relation to threshold levels

Animal welfare	Number of Carcasses	TPC range acceptable	TPC Unacceptable	TCC Acceptable	TCC UNacceptable
Good	187	176	11	83	104
Poor	113	78	35	41	72

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Table 4.4 : Vaiability was observed for the animal welfare in terms of Good and bad for the TPC and TCC carsses threshold levels.

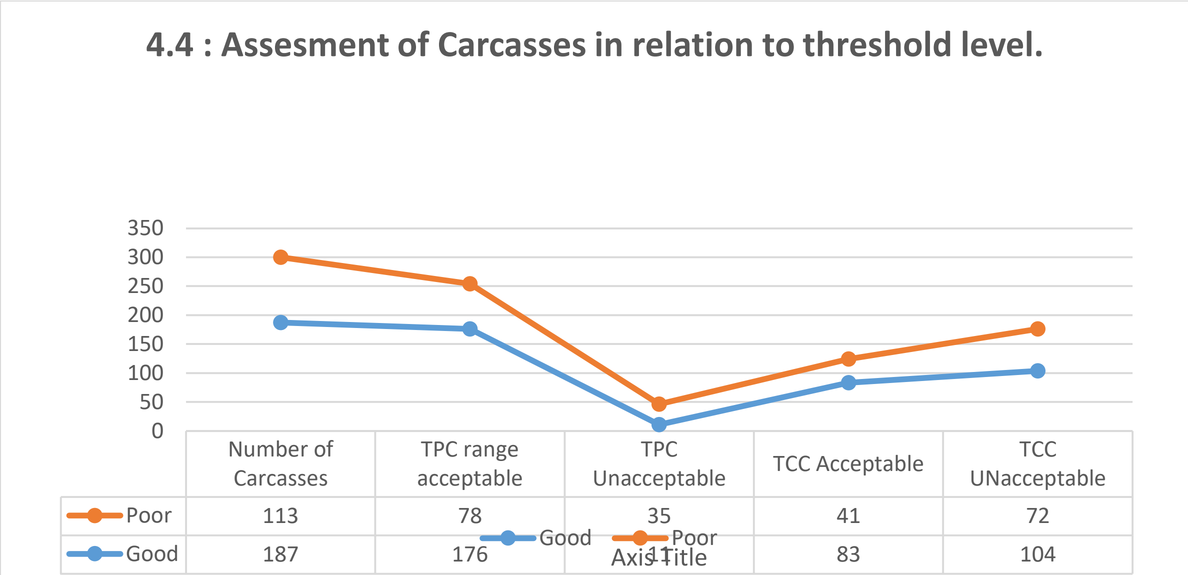

Fig 4.4 :The TPC range acceptable was greater than TCC aceptable range.

4.4 Paired comparison between good and bad assesment of Threshold levels

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference: Lower	Upper			
Pair 1	Good - poor	44.400	46.334	20.721	-13.131	101.931	2.143	4	.099

Table 4.4 The t statstic value 2.243 <2.58 critical value and Sig (099) shows that there was somehow no significant difference between the good and poor.

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CHAPTER FIVE

5.0 Discussion

This chapter covers all the detailed explanation of the research activities and embraces also the current research results with other studies already conducted by other researchers.

4.1 Evaluation of the Physical profile of the meat during the study

The evaluation of meat parameters (Table 4.1) were based on Bruising numbers, physical profile normal numbers and DFD numbers and this was categorized into good and poor rating in terms of the welfare of the animal status ,the overall rating for good welfare superseded that of poor welfare and from the abattoirs investigated included Shamva , Epworth and Zimnyama. Also among the breed included local and exotic breeds. The local rating were more compared to exotic breeds. Fig 4.1 a for the total bruising was high for Good welfare, the physical well fare normal numbers were high for poor welfare and the highest recorded DFD Numbers were high for Good welfare. Fig 4.1b highlighted the evidence for good and poor meat profiles. Analysis (4.1)of meat profiles indicated that Epworth (P=0.342) ,Shamva(P=0.667)indicated some no significance difference among other abattoirs in terms of meat physical profiles, Whilst Zimnyama (P=0.0382<0.05) was more significant among abattoirs during the study, however the Boxplot 4.1c had a high mean physical profile parameters compared to others. The influence of breed on physical meat profile parameters was indicated on Fig 4.1d from the study, where the total bruising were more for Local (214) compared to Exotic (86) and for the physical profile normal numbers The exotic (710 was high compared to the local breed (43) and finally the DFD numbers were more prominent for the local breed(173). DFD meat is unattractive and more likely to face discrimination by consumers. Carcasses from all cattle under poor welfare were developed DFD, but only 2 (1.1%) in those handled under good conditions. The present finding was similar with 100% DFD meat reported in abused cattle. Gregory reported that stress depleted glycogen in the muscles which leads to high pH24 values after slaughter, the meat subsequently becomes DFD prone to spoilage and poor keeping quality. The present findings showed a higher pH in meat from poor handled cattle than in those handled under good conditions. The present mean pH of 6.18 for meat from poor welfare animals failed within the 5.9 - 6.5 pH of DFD meat and 5.59 for meat from good handling conditions within the 5.4 - 5.8 pH of normal meat. Ljungberg, et al. and Aradom., *et al*., (2012) stated that DFD meat from stressed cattle has a shorter shelf life and cooking loss.

5.2 Assessment of the meat bruising numbers, PH and processing time

The meat quality parameters were evaluated in terms of Total bruising numbers, pH and the processing time (Fig 4.2), a collinearity for the parameters was observed during the study although local breed ha a high PH, processing time as well as total number of bruising. Analysis 4.2 shows P>0.05 indicating no much difference in the linearity of the meat quality parameters. Box and Whisker plot 4.2.1 had indicated more enhanced mean for Shamva Abattoir compared to other Abattoirs. DFD meat has a very high water-binding capacity with a dry or sticky texture, thus, suited for spoilage microbial growth prone to short shelf life. In connection with this, higher log CFU/g of TPC (3.95 $\pm$ 1.87) and TCC (2.31 $\pm$ 1.47) in meat from poor handling conditions than in good handling conditions were observed. The level of TPC in this study is in accordance with previous studies, but lower than Hiko. et al. Report in beef mortadella. Meat from abusely handled cattle is mostly characterized by having the highest pH, which favours microbial growth.

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5.3 Microbial quality of meat respect to animal handling conditions abattoir location and animal breed.

Amongst the most common bacteriological parameters indicated for the handling hygiene were the bacterial *S.aerius* and *Salmonella species*, The bacterial cultures were conducted for both Poor and Good welfare cattle. Comparative analysis of bacteriological parameters using R programming(4.3) have showed that Shamva Abattoir and Zinmanyan were P>0.05 indicating no significant difference but however Epworth abattoir P<0.05 were more significant in terms of bacteriological parameters meaning that much hygiene in slaughtering and handling must be initiated in abbatoirs.The results were also supported by the Box plot 4.3 which had high mean elevation for Epworth abattoirs compared to the other abbatoirs.Graph 4.3.1 indicated collinearity ,but however there was more salmonella prevalence in meat inspection compared to S.aerius suggesting the existence of contamination in abattoirs. Following the unacceptable numbers (TPC > 105 CFU/g) of the meat spoilage, significantly higher unacceptable meat by TPC (31.0%) from poor handled cattle than (5.9%) from good handled cattle. This could be associated with the presence of bruise and DFD meat in poor handled cattle. On the other hand, a total of 58% meat samples were unacceptable by TCC to which it is higher than TPC in meat from cattle under both handling conditions. This could be due to carcasses contamination from gastrointestinal content stressed cattle during evisceration or from already contaminated abattoir environment. With regards to *S. aureus* count, the findings were lower than TPC and TCC. It was low and similar in meat from cattle handled under both conditions. These could die to the fact that *S. aureus* was frequently associated with human carrier conditions which act as a source of carcasses contamination. The present 14.3% *Salmonella* isolation in total meat samples was lower than the 26.3% from the abattoir line but higher than the 5.3% from the processing plant line reported by Hiko. et al. The presence of Salmonella at significantly higher (27.4%) in poorly handled cattle than 6.6% in humanely handled cattle could be attributed to factors like animal get stressed for shading of *Salmonella* to which a risk for carcasses contamination or from already contaminated abattoir environment. Unlike animal handling conditions, the prevalence of *Salmonella* was similar among studied abattoir and between studied animal breeds. This could be due to carcasses contamination from stressed animals and/or from already contaminated abattoir environments. Salmonella was also frequently isolated from the abattoir environment, indicating from which meat can be obtained.

5.4 Paired comparison between good and bad assessment of carcasses Threshold levels(Ref Appendix 1).

Assessment of Carcasses were evaluated in terms of Total plate’ s counts (TPC) and Total Colony Counts (TCC).Fig 4.4: The TPC range acceptable was greater than TCC acceptable range and there was a correlation between Good and poor as the trending model. Analysis 4.4 test statistic for paired analysis showed no significant difference for carcasses evaluation in terms of the acceptable ranges. These findings showed 91.2% of carcasses from stressed cattle were bruised which is higher than the 66.9% reports of Mallia., et al. 15.5% reports of Costa. et al. Such difference could be due to differences in degrees of animal exposed to diverse conditions. For instance, cattle in this study were transported a long distance under unfair handling and transportation conditions along with high frequencies and risk of exposure to various mechanical damages resulting in bruises. McCausland and Miller also reported that 47% of the bruises in cattle were attributed to be a non-specific time. Grandin also reported almost double the bruising rate over observing higher TPC in meat from poor handled cattle and from exotic breeds could have a connection with high DFD and bruised meat from those stressed animals which favour microbial growth. A total of 14.3% carcasses were positive for *Salmonella* with significantly higher in meat from poor handled cattle (72.1%) than in meat from good handled cattle (27.9%) ($p < 0.05$) but similar among abattoirs ($p > 0.05$).

The present study indicated that cattle were handled roughly during weighing and loading than in those who walked quietly onto the scales and trucks. In addition to this, poor animal handling at lairage and during sticking could account for the high occurrence of bruises in the present finding. McCausland and Miller reported at least 43% of all bruises in cattle incurred after arrival at the abattoir, to which most of them just before stunning.

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Chapter 6

6.0 CONCLUSION

Pre-slaughter handling conditions are very essential factors which contribute to carcass and meat quality defects; therefore, it should not be overlooked. When handling animals prior to slaughter, considerations should be made in terms of the kind, species, breed, and age. In addition, the way animals are handled in the farm, during transportation, at the market and in the lairage expose them to various stresses. Improper pre-slaughter handling can cause the death of animals, carcass damages, reduction in live weight, pale soft exudative and dark firm dry meats. Poor pre-slaughter handling is also a compromise of animals' welfare.

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Appendix 1 Meeat Carcasses

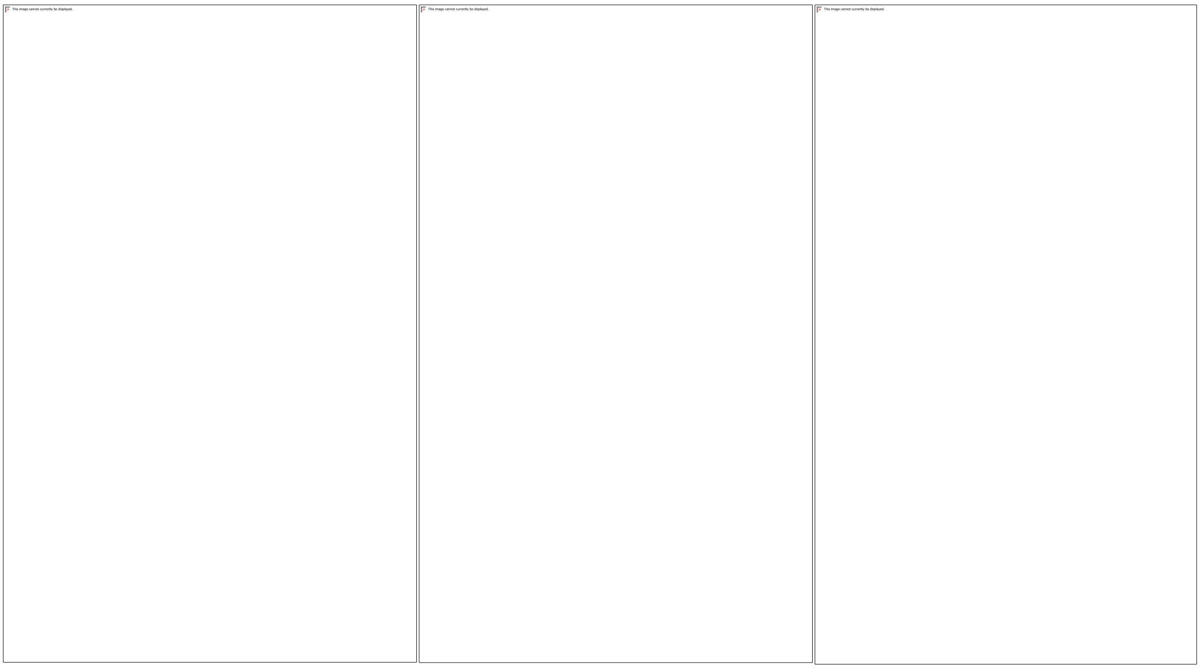

Fig 5. Normal meat, (b) Blood splashed carcass and (c) Bruised carcasses from poorly handled cattle pre-slaughter

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