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Research Article

Effects of Slaughter Weights on Meat Yield and Chevon Characteristics of West African Dwarf Goat (bucks)

Ayanniyi, N.N.[1], Olusola, O. O.[2], Kenneth-Obosi, O.[4], Adeyemi, S. A.[3], Umar A.[1], Eze, J. N.[1] and Orimogunje, A. D.[1]

[1]Research Outreach Programme, National Cereals Research Institute, Badeggi, Nigeria
[2]Meat science Laboratory, University of Ibadan, Ibadan, Nigeria
[3]Department of Animal Science, Faculty of Agriculture, University of Ibadan, Ibadan, Nigeria
[4]National Horticultural Research Institute, Ibadan, Nigeria
Corresponding e-mail: newrain36@yahoo.com

Abstract

The study was conducted at the Ruminants section of the Teaching and Research Farm of the University of Ibadan, Ibadan to evaluate the effects of slaughtering weights on the meat yield and other chevon characteristics of West African Dwarf bucks (WAD). Fifteen WAD bucks were fed similar diets before sacrificing nine at three pre-determined weights of 15, 20 and 25kg to evaluate relative percentage proportions of Eviscerated Weight-EW, Hot Carcass Weight-HCW, Dressing percentage-DP, Rib Eye Area-REA, Meat to Bone Ratio-MBR and Total Fat Deposit-TFD in a Completely Randomised Design (CRD). Also evaluated were the physicochemical characteristics of each of the carcasses relative to the pre-determined weights. The results showed that the EW ranged from 62.0% in 15kg-bucks to 71.8% in 25kg-bucks, while HCW ranged from 52.1% in 15kg-bucks to 55.3% in 25kg-bucks. The 25kg-bucks had the highest TFD of 4.7±0.3% compared with 3.1±0.1% and 4.4±0.4% in 15 and 20kg-bucks, respectively. Bucks with higher weights elicited more REA as compared with those with lower weights. However, there was an inverse relationship between ether extract and the crude protein as the weights of the bucks increased. The DP was not significantly different among the treatments. In conclusion, the higher weights observed in the bucks were not necessarily in terms of meat value but only in terms of fat. This goes to show that when an animal has reached its full maturity, it doesn't add more meat but rather it accumulates fat.

Keywords: *West African dwarf buck, Dressing percentage, Pre-determined weight, Chevon*

Introduction

There are over 300 known breeds of goats with some already extinct while a substantial number are endangered (Idahor, 2013). However, more than 250 breeds still exist today with their locations varying from the Sahel, dry and humid agro-climatic regions of the world (FAO, 2008). The world goats' population in the year 2000 was found to be around 715 million of which more than 60 % were predominantly in Asian and developing sub-Sahara nations including Nigeria (Anderson, 2005; Scherf, 2000). Over the years, however, there has been a tremendous increase in the goat population (FAO, 2001) probably due to their wide adaptability and tolerance to varying climatic regions. In Nigeria for example, from the intense dry region of Sahel to the extremely humid region in the South, goats thrive well even under free range or poor management system (Adu *et al.*, 1996; Tennin and Okubanjo, 1999). Goat domestication thereby becomes a poor man's investment. Goats' preference may not be only because of their wide range of adaptability and survivability to different climatic regions of

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the world, but essentially because they are very easy to manage with minimal inputs. Goat is generally classified into four main types; dairy, meat, fibre and feral goats. Dairy goats are typified by Saane and Nubian, Boer (Spanish) and West African dwarf goats are meat producing while Angora and Cashmere are examples of fibre goats (FAO, 2000). On the other hand, feral goats are characteristically wild with the likelihood of traits similar to fibre goats. Based on purposeful marketing especially for meat, goat is sub-divided into Capretto; which is obtained from milk fed. They are essentially meat from the suckling kids which produce carcass weight of less than 12 kg Dhanda *et al*. (2003). The meat is relatively pink in colour. The other one, Chevon is an older goat weighing between 15-25 kg. The preferences for goat production vary from country to country, region to region and more importantly on an ethnic basis. For instance in Nigeria, a goat is accepted as part of the bride price during a marriage ceremony. In Zimbabwe, goats are used as collateral; goats are accepted as school fees instead of cash in some schools. In some parts of the Asian continent and other developing worlds, goats are given to vulnerable individuals especially older women as means of poverty eradication and empowerment Dhanda *et al*. (2003). It is on records that more than 900,000 goats were distributed by World Bank in conjunction with the Federal Ministry of Agriculture and Rural Development to some groups of vulnerable women in the displaced people of Adamawa, Borno and Yobe States (Punch Newspaper, 3rd of July, 2017). In marketing goat meat, however, consideration is usually given to capretto with its relative pink colour (Naude and Hofmeyr, 1981) and not necessarily from matured goats, considering some underlying factors of breed, sex, body conformity and also the final body weight. The carcass yield is an important parameter in estimating the economic worth of goats relative to live weights and the production cost (Casey *et al*., 2003). Similarly, the carcass and the non-carcass components of small ruminants are significantly also correlated to the weight of animals (Akinleye, 2015) and could also be a measure of economics. An increase in the weight of animals following maturity does not translate into muscle build-up but rather an accumulation of fats. Therefore this study seeks to investigate the carcass yield of goats (bucks) at predetermined weights to evaluate the point of highest muscle build-up for the production of healthy lean meat (chevon) for consumer safety.

Materials and Methods

Location of the experiment

The study was carried out at the Sheep and Goat Unit of the Teaching and Research Farm, University of Ibadan, Ibadan Southwest Nigeria located on Latitudes 7' 26^{0}N and 3' 54^{0}E and is characterized by a humid climate, especially during the summer.

Animal management

Fifteen WAD bucks with an average weight of 8-9kg were purchased from Odo-Ori Market, Iwo in Iwo Local Government Area of Osun State. The animals were quarantined and stabilized for three weeks before they were intensively fed and managed to attain the target weights in a completely randomized design. The bucks were ear tagged and managed in separately equipped pens with watering and feeding assets throughout the feeding period. They were dewormed using 300 mg albendazole bolus and acarimic spray for internal and external parasites respectively. They were also vaccinated against viral diseases during the periods of the first 7 days of acclimatization and adapted for 21 days. This was followed by an intensive feeding experiment.

Feeds and feeding

Bucks were fed intensively with 40 to 60 % of hay and concentrate, respectively at 5 % of their body weight consisting of similar diets for all bucks. The animals were given access to salt-lick with fresh clean and cool water on a free choice basis. They were fed concentrate twice daily between 7.00-7.30 am and 3.00 -3.30 pm with roughages served in between the concentrate feeding precisely 12-1 pm each day. Partially dry Guinea grass, *Panicum maximum* and groundnut husk were the basal diets; the formulation for the feeds is shown in Table 2.

Slaughtering procedure

At the end of the feeding when the animals have satisfied the predetermined weights of 15, 20 and 25kg, three bucks from each group were sacrificed. They were slaughtered according to the animal welfare rules in an Hallal method; being humane during the process by severing the carotid arteries, jugular veins, trachea, and oesophagus at the base of the neck with a sharp knife.

The animals were slaughtered -Nine bucks, having reached the pre-determined weights were slaughtered after a sixteen-hour fasting period in the slaughterhouse of the Department. Thereafter, the head was removed at the atlanto-occipital joint while the hind and forelimbs were removed at the tarsal and carpal joints respectively. The remaining carcasses were then skinned and the slaughtering parameters were evaluated.

Dressing percentage

The Dressing percentage was obtained arithmetically following the procedures of (Aduku and Olukosi, 2000).

$$\text{Dressing percentage (\%)} = \frac{\text{Hot carcass weight} \ \ \text{x } 100}{\text{Fasted live weight}}$$

Evisceration of carcasses

The carcasses were eviscerated for all the carcass and non-carcass components. They were collected, weighed and their values recorded. The head, skin, feet, lungs, trachea, gastro-intestinal tract GIT heart, spleen, pancreas, diaphragm, testicles and liver were also weighed and recorded. All other muscles identified included the Adductor, Pectoralis profundus, Triceps brachii, and Lactissimus dorsi. Others parts such as Longissimus dorsi, semi-tendinous semi-membranous and their bones separated and weighed. Meat scrapings that were recovered during dissection were added to the lean and weighed while that those could not be reasonably classified as pure lean meat was added to the fat. The bones were scrapped as much as possible to remove the tendon using dissecting set and razor. The abdominal fat, pectoral fat and pelvic fats were harvested, weighed and also recorded.

Internal temperature of intact carcasses

The loin muscle part was cut to a depth of 1-2 cm and a sensitive digital type of thermometer was inserted to obtain carcass temperature immediately after skinning. This was done at an interval of 30 minutes up to three hours post-slaughter following (Okubanjo and Tenni, 1997; Omojola and Adesehinwa, 2006) procedures.

Fabrication of carcasses

The various primal cuts from representative chevon from each -treatment were obtained from one-half carcasses with a meat saw. Percentage wholesale cuts of the hind leg, fore leg, rack/rib, brisket, neck, loin and flank were recorded using the procedures of Field *et al.* (1967).

Statistical analysis

The data of all the carcass and chevon quality parameters were subjected to analysis of variance using SAS (2002) package to separate the means.

Percentage yield of wholesale cut

The yield was measured as the percentage of different wholesale cuts to hot carcass weight x multiplied by 100. It was done as recommended by Awosanya and Okubanjo (1993) Thus:

Wholesale cut yield (%)

$$= \frac{\text{Weight of wholesale cut} \ \ \text{x } 100}{\text{Weight of hot carcasses}}$$

Rib-eye area

The determination of the meatiness of a carcass is measured by a simple method popularly known as Rib-eye Area measurement. This can be measured between the 12^{th} and the 13^{th} ribs towards the lion part. The method is called by plastic grid mechanism. The small cut steak is placed on tracing paper and a sheet of Matte fine acetate material which is later measured via graph paper. The acetate paper was placed on the graph paper and boxes were counted as one when filled or more than half part full the other less than half filled were ignored and regarded as nil. A typical representation is outlined in Figure 1.

Shear force value of meat

The shear force is measured by Warner-Bratzler technique involves the use of a known weight of meat sample of 10g wrapped in thermo-resistant polyethylene nylon and pre-heated in a pressure cooking pot for 20 minutes with a hot plate model to a temperature of 72^oC (NO ECP 202)

Malgorzata *et al.* (2005) and allowed to cool at room temperature of between 25-27^{o}C for 15 minutes. The sample meats were thereafter re-weighed, wrapped in polyethylene bags and chilled for 18 hours at 4^{o}C. They were subsequently subjected core of 1.25 cm diameter parallel to muscle fibre orientation with a device (Qiaofen and Da-Wen, 2005). These cores were shared at three different points with the aid of Warner-Bratzler V-notch blade shearing instrument and read on the scale on the instrument according to (Honikel, 1997) procedure.

***Water holding capacity of meat* (WHC)**

The capacity within which meat can retain moisture when external power is exerted on it is the Water Holding Capacity (WHC) of meat samples. To determine the amount of moisture meat could hold, a principle suggested by (Suzuki *et al*., 1991) was followed and it involves placing a known weight of 1-2 g of meat sample in between two 9-cm filter papers was pressed within a pair of plexi glass of 10.2 x 10.2 cm^2 at a 35.2 kg/cm^3 force for 60-90 seconds in the pressing device. The meat samples were later put to oven drying for 24 hours at a temperature of 105^{o}C. The principle is an indirect method wherein water released on the filter paper is measured and compared with the area meat samples occupy. It is mathematically represented as follows;

$$WHC = \frac{100 - (Aw - Am) \times 9.47}{Wm \times Mc} \times 100$$

Where: Am = Area of meat samples (cm^2)
Aw = Area of water released from meat samples (cm^2)
Wm = Weight of meat samples (g)
Mc = Moisture content of meat samples (%)
9.47 = Constant value (factor)

The cooking loss

The cooking loss measures the amount of moisture loss in a known weight of samples on cooking. To evaluate the loss, meat is weighed, wrapped in airtight and waterproof polythene nylon and subjected to cooking in a pre-heated pot at 75^{o}C for 60-65 minutes. The meat samples were allowed to cool at ambient temperature and thereafter reweighed.

Cooking loss % =

$$= \frac{\text{Initial weight of meat (W1)} - \text{Final weight of meat (W2)} \times 100}{\text{Initial weight of meat (W1)}}$$

Poximate composition

The muscle samples for the chemical composition were obtained from *Longissimus dorsi* (from the trunk), Semi membranous (pelvic limb) and Triceps brachii (pectoral limb) and were thawed overnight at 4^{o}C and separately minced in a machine and stored for the proximate composition determined using AOAC (2005) method. After 24 hours, each of the grounded samples was allowed to thaw and remixed with aliquots for the analysis. Following this, the polythene bags containing the samples were left to equilibrate to room temperature before they were opened. The samples were then analyzed for moisture, crude protein, ether extract and ash content

Chilling loss

The muscle samples were chilled at 20^{o}C for 24 hours immediately after cutting. The chilling loss was determined as the difference between the warm weight and the chilled weight.

Results and Discussion

The ability of most indigenous breeds of goats as opposed to exotic species rest on their quick and wide range of adaptability to different ecologies. These animals thrive in virtually most terrible environments which is hitherto not conducive for extensive management system not to talk of intensive system. Most of these adaptive features are traceable to their inherent traits embedded in their genetic capability.

Dressing percentage and slaughter parameters

The slaughter characteristics of the WAD bucks were presented in Table 3. The bled weight was found to increase with the slaughter weight. A similar trend was also observed for both eviscerated and hot carcass weights. All were found to be a result of their slaughter weights. However, there was no significant difference (P >0.05) in the DP across the three pre-determined weights (49.36 %), (49.87 %) and (48.76 %) at 15kg, 20kg and 25 kg respectively. There were proportional increases in the bled weight, empty body weight and hot carcass weight as a positive correlation with weights at slaughter. These findings were similar to reports from the previous studies conducted by (Nakev *et al*., 1982; Al Jaryan *et al*., 1985). These workers reported that carcass parameters varies proportionately with weight change. This simply implied that breed presents a greater effect on carcass parameters which could probably be a function of feeds and proportions of the gastrointestinal tract. Breed exerts a significant effect on dressing percentage even across the different slaughtered weights. Findings from the present study which were within the range of (38.00 % to 56.00 %) reported by several workers including Anjaneyulu *et al*. (2007) and Okubanjo and Tenni (1997) showed that to a greater extent breed influences the dressing percentage. However, some workers reported a significant influence on dressing percentage as precipitated by plane of nutrition and not breed alone. For instance, Kumar *et al.* (1991) in their experiment had underscored the role of intensive feeding on dressing percentage, carcass parameters and the meat quality of Gaddi goats at 14 - 16 months old which were within the range observed from the present study.

Fat deposits of WAD goat (bucks) at three pre-determined weights

Table 4 shows the fat deposit as affected by different slaughtered weights. There were significant differences between all the parameters evaluated from the abdominal fat, kidney fat, pelvic and pectoral fats to the intermuscular fats, all varied with the slaughter weight. Similar findings were reported by El Hag and El Shargi (1996), Akinleye (2015) and Dhanda *et al*. (2003) who worked on sheep and opined that the heavier the sheep, the higher the fat deposits. However, the average total fats of non-carcass fat components of 149.01g, 89g and 137g for Afar, Long ear Somali and Central Highland Ethiopian goats respectively reported by Ameha *et al*., (2007) were far above that obtained from the present study, they were however similar to the values of 4.17 and 2.44 for chevon and capretto respectively reported by Dhanda *et al*. (2003).

Proximate composition of chevon from WAD as affected by three slaughtered weights

The chemical composition shown in table 5 of chevon from WAD bucks was affected by slaughtered weight. There was no observable difference in moisture content of all the treatment groups. However significant differences occurred in CP (22.66, 21.16 and 20.67), ether extract (2.69, 2.79 and 2.88) and ash contents (2.58, 2.63 and 2.98) of the chevon of the WAD bucks slaughtered weights at 15, 20 and 25 kg respectively. This obvious relationship should be expected as the weights of the animals increased so also are the parts of the body. However as the weight of the bucks kept on increasing, the percentage CP and EE exhibited an inverse relationship as seen in table 5

Tissues distribution in WAD bucks slaughtered at three pre-determined weights

Shown in Table 6 is the percentage of lean meat, bone and fat of the WAD bucks. While the percentage of lean and fat have a positive correlation with weight increase, the percentage of bone has an inverse relationship. The percentage increase in lean meat results in a decrease in bone and was observed across the different weights evaluated (60.45 %) vs (35.08 %), (64.97 %) vs (27.84 %) and (67.78 %) vs (24.76 %) at 15 kg, 20 kg and 25 kg respectively. On the other hand, the ratio of lean meat to fat decreases as the weight of the buck increases. The result was in tune with that of Aduku and Olukosi (2000) that stated more fat deposits were reported in goats placed on a concentrate ration and that as the weight kept on increasing, so also were the fat.

Physical properties of chevon from the WAD bucks

The Physical parameters of chevon from WAD goats (bucks) were presented in Table 7. The Rib Eye Area (REA) varied significantly ($P<0.05$) as the weight at slaughter; (0.80 cm^2), (1.10 cm^2) and (1.35 cm^2) at 15, 20 and 25 kg respectively Findings from this work could be related to previous studies by Rao *et al*. (2009), Okubanjo and Tenni (1997), and Getahun (2001) that the higher the rib eye area value, the higher the meat obtainable from such carcass. The ability of chevon harvested from the different bucks to retain moisture when an external force is applied which is referred to as the Water holding capacity (WHC) differed significantly across the different slaughtered weights; (60.90 %), (64.42 %) and (69.72 %) at 15kg, 20kg and 25 kg respectively. On the other hand cooking losses reduced with buck weights following the sequence of (37.50 %), (34.80 %) and (29.87 %) table 7. The tenderness is considered critical in the quality attributes of meat because it is a force that elongates the interest of seldom buyers to consistent and repeated buyers. The shear forces of the chevon from bucks were found to increase from 4.29 to 5.32 and then to 6.02 at 15, 20 and 25 kg bucks, respectively. This finding was however lower than 7.82, 8.52 and 6.98 kg/cm^3 which was reported by Omojola (2008) for beef S*uya* prepared from a matured bull. However, in the work of Sen *et al*. (2004) on meat quality attributes of sheep and goats under semi-arid conditions, the values of 3.74 and 7.42 shear forces reported for sheep and goats respectively were similar to the findings from the present study but that of sheep was comparatively low (3.74). This could probably be because the experiment was restricted to stall feeding. Furthermore, the average shear forces of 4.6- 3.7 reported by Dhanda *et al*. (2003) were somewhat similar but lower than that obtained from this work.

Conclusion and Recommendations

The current study revealed that an increase in live or slaughter weights has a positive correlation with the overall carcass output. Slaughtering at heavier weight produced carcass with higher total fat deposit however, the DP remains similar at the different slaughter weights probably suggesting dressing percentage is a breed's inherent quality and not the short term management system**.**

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Table 1: Ingredient Composition of Concentrate Feed on % Dry Matter basis

Ingredients	Percentage (%) g /kg
Dusa*	30.38
Brewer's dried grain	29.38
Peeled cassava meal	5.69
Wheat offal	19.56
Palm Kernel Cake	10.00
Dicalcium phosphate	3.00
Salt	1.00
Premix mixture	1.00
Total	100:00
Calculated value	
Crude Protein	14.00
Crude Fibre	13.71
Ether Extract	5.30
Digestible Energy	2200

*By-product of local (gin factory) grain processing

Table 2: Chemical Composition of the Concentrate Feed and Hay

Components (g/100g)	Concentrate	Hay
Dry Matter	88.05	91.40
Crude Protein	11.95	9.15
Ether Extract	4.50	0.90
Crude fibre	11.75	18.65
Ash	4.80	4.00
Neutral Detergent fibre	53.50	68.70
Acid Detergent fibre	35.20	49.01
Acid Detergent Lignin	9.89	15.20
Hemicellulose	18.30	19.69
Cellulose	25.31	53.50
Nitrogen free extract	56.95	58.70
Digestible Energy (kcal/kgDM)	3410.30	3960.10

Table 3: Dressing percentage and slaughter parameters relative to live weight at pre-determined weights

	WAD BUCKS				
Parameters (%)	**15 kg**	**20 kg**	**25 kg**	**SEM**	**P-value**
Bled weight	87.20^{b}	88.00^{b}	92.00^{a}	0.175	0.0047
Weight of Empty body	62.00^{c}	65.21^{b}	71.80^{a}	0.170	0.0023
Hot carcass weight	52.10^{b}	52.50^{b}	55.32^{a}	0.330	0.0001
Cold carcass weight	49.98^{b}	49.99^{b}	54.02^{a}	0.960	0.0068
Dressing percentage	49.37	49.87	48.76	1.220	0.8435

^{a,b,c}: means with different superscripts in the same row differ significantly ($p<0.05$).

Table 4: Fat deposits of chevon from WAD goat (bucks) slaughtered at pre-determined weights

	WAD BUCKS				
Parameters (%)	**15 kg**	**20 kg**	**25 kg**	**SEM**	**P-value**
Abdominal fat	1.42^{b}	2.00^{a}	2.01^{a}	0.0125	0.0001
Kidney fat	0.08^{b}	0.10^{b}	0.14^{a}	0.0023	0.0003
Pelvic fat	0.13^{c}	0.17^{b}	0.24^{a}	0.0011	0.0001
Pectoral fat	0.12^{b}	0.14^{b}	0.22^{a}	0.1416	0.0002
Inter muscular	1.35^{c}	2.01^{b}	2.09^{a}	0.0125	0.0001
Total fat	3.10^{c}	4.42^{b}	4.70^{a}	0.0338	0.0001

^{a,b,c}: means with different superscripts within a row differ significantly ($p<0.05$).

Table 5: Chemical composition of chevon from WAD bucks slaughtered at three pre-determined weights

	WAD BUCKS				
Parameters (%)	**15 kg**	**20 kg**	**25 kg**	**SEM**	**P-value**
Moisture	69.18	69.79	69.34	0.7820	0.6071
Crude protein	22.57^{a}	21.16^{b}	20.67^{c}	0.3360	0.0192
Ether extract	2.69^{c}	2.79^{b}	2.88^{a}	0.0102	0.0001
Ash	2.58^{c}	2.63^{b}	2.98^{a}	0.0110	0.0020

^{a,b,c}: means with different superscripts in the same row differ significantly ($p<0.05$).

Table 6: Distribution of tissues in the carcass of WAD bucks sacrificed at three pre-determined weights

	WAD BUCKS				
Parameters (%)	**15 kg**	**20 kg**	**25 kg**	**SEM**	**P-value**
Lean	60.45^{c}	64.97^{b}	67.08^{a}	0.0441	0.0001
Bone	35.08^{a}	27.84^{b}	24.76^{c}	0.0349	0.0024
Fat	3.14^{c}	4.48^{b}	4.77^{a}	0.0237	0.0001
Lean: fat	19.21^{a}	14.50^{b}	14.00^{c}	0.0467	0.0031
Lean: bone	1.73^{c}	2.33^{b}	2.88^{a}	0.0338	0.0012
Loss	1.03	1.05	1.02	0.0441	0.7161

^{a,b,c}: Means within the same row with different superscripts differ significantly ($p<0.05$).

Table 7: Physical properties of chevon from WAD bucks

	WAD BUCKS				
Parameters (%)	**15 kg**	**20 kg**	**25 kg**	**SEM**	**P-value**
Rib eye area (cm^2)	0.80^{c}	1.10^{b}	1.35^{a}	0.0141	0.0001
Water holding capacity	60.90^{c}	64.32^{b}	69.72^{a}	0.0450	0.0001
Cooking loss	37.50^{a}	34.80^{b}	29.87^{c}	0.044	0.0001
Shear force (kg/cm^3)	4.29^{c}	5.32^{b}	6.02^{a}	0130	0.0031
pH-	6.09	6.11	6.08	0.0044	0.7161

^{a,b,c}: means with different superscripts in the same row differ significantly ($p<0.05$).

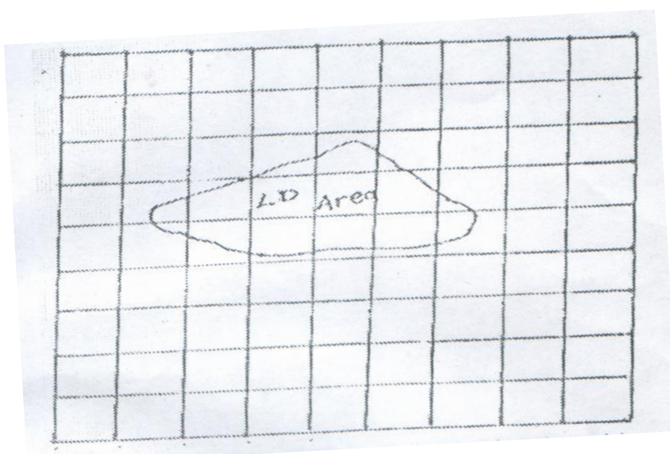

Figure1: Measurement of rib eye area using grid method [Source: Attah (1997)]