Study on phenotypic evaluation of exportable goat at Organic and Akseker abattoirs in Modjo town of central Ethiopia.

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research-note

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Abstract

Background: The Ethiopian livestock sector, which is mainly dominated by indigenous animal genetic resources, contributes significantly to the economy and food security of the country, providing livelihood for 37-87% of the country's population. Conducting phenotypic characterization is a prerequisite for sustainable utilization, conservation and improvement of a breed through designing appropriate sheep breeding programs.

Methods and materials: Phenotypic evaluations of indigenous goats were conducted in Organic and Akseker Export abattoirs of Modjo district of Eastern Shoa zone of central Ethiopia. A total of 200 goats from both export abattoirs were sampled randomly for phenotypic evaluations.

Result: Length, weight, height, and heart girth of the animal were measured for each goat exported to both abattoirs. The results show that significantly ($P<0.05$) presence of clear phenotypic variations between and within these indigenous goats exportable to Akseker export abattoirs (Table 2) whereas heart girth significantly ($P<0.05$) increased by 20.271(CM) the length, weight (KG) and height increases by (0.163 CM), (0.256 KG) and (0.479 CM) respectively. However, there is no evidence showing any association with sex, age, body condition, and age of animals. The examined phenotypic parameters of goats exported to organic export abattoirs were measured and but there is no-showed significant (P-value >0.05) association between and within heart girth, height, and body length of the goats except for the high level of significant variations ($P<0.05$) between hearth girth on body weights which says when heart girth increases by 7.26 (CM) centimeters, the body weight significantly with P value (0.001) increases by 1.92 (Kg) kilograms as also indicated in Table 3.

Conclusions: To sustainably utilize these goat populations the production constraints should be solved and selective community-based breeding strategies should be designed and implemented.Therefore this study was aimed at improving the community-based breeding strategies of indigenous goats and their phenotypic traits exported to export abattoirs for meat consumption.

1. Introduction

The Ethiopian livestock sector, which is mainly dominated by indigenous animal genetic resources, contributes significantly to the economy and food security of the country, providing livelihood for 37-87% of the country's population. The government is being utilized a considerable amount of resources to realize higher agricultural productivity and alter the state of agriculture in the country (1). Ethiopia has one of the largest livestock populations in Africa and the tenth in the world. The country had 59.5 million heads of cattle, 30.70 million heads of sheep, 30.20 million heads of goats, 56.53 million of poultry, and 1.21 million heads of a camel. Cattle in Ethiopia provide draught power, income for farming communities, and means of savings and investment (2). It is central to the Ethiopian economy contributing about 45% to the agricultural GDP, supporting the livelihoods of 70 % of the population, 18.7% to the national GDP, and 16–19% to the total foreign exchange earning of the country (3). Economic opportunities exist for

small ruminant producers to supply animals to both the export and domestic markets. The growing demands for meat products in the domestic, as well as international markets, also increase the importance of goats in the national economy of the country (4)

The day-to-day livelihood activity of smallholder farmers depends on the agricultural practices in almost all parts of Ethiopia. Ethiopia is endowed with huge livestock biodiversity adapted to varied agro-ecological conditions (3). Among the farm animal genetic resources, indigenous goats have unique adaptive mechanisms which enable them to fit in varied agro-ecologies and contribute to the livelihood of smallholder farmers through producing valuable milk and meat products. Within the agro ecology, there are also sub-agro ecologies that developed into niches as the home of specifically adapted ecotypes. (5) Described the domestic goat (*Capra Aegagrus*) as a subspecies of goat domesticated from the wild goat of southwest Asia and Eastern Europe. (5) described the origin and historical distribution of the highland indigenous goat population of Ethiopia that emphasized documentation of the goat breeds. The institute of biodiversity conservation (IBC) documented fifteen indigenous goat (15) breeds inhabited the lowland, midland, and highland agroecologies of Ethiopia (6). The total population of goats in Ethiopia is reported as 24.06 million of which 99.99% are indigenous goat breeds (7). There is also a high domestic demand for small ruminant meat, particularly during religious festivals. The country exported 12,000 tons of small ruminant meat in 2005/6. The proximity of Ethiopia to consumers in Middle Eastern countries and their taste preference for our indigenous animals are advantageous for the Ethiopian meat export market. However, the international meat market is becoming increasingly competitive and meat traders must adopt improved practices in the production, processing, and packaging of meat to maintain and grow market share (8). Strict quality control measures to meet specific export-market demands also need to be implemented. Hence, considerable training and extension will be essential in assisting various stakeholders to meet market requirements and maximize the foreign exchange generated from the growing meat industry (9).

Indigenous goat breeds/types are widely distributed and are found in all agroecologies of Ethiopia and it appears they have evolved through a process of natural selection (10) that favored adaptation and survival rather than production. A comprehensive phenotypic evaluation of Ethiopian goats was done by (FARM Africa 1996) classifying indigenous goats based on their geographic location and the ethnic communities who keep them (11). Based on the analysis of morphological data along with geographic distribution, fourteen distinct goat populations were identified across Ethiopia and Eritrea (12). These were categorized into four major families including the Nubian (Nubian, Barka), Rift valley (Worre, Afar, Abergele, Arsi-Bale, Woyto-Guji), Somali (Hararghe highland, short-eared Somali, long-eared Somali) and the small East African (central highland, western Highland, western lowland, Keffa) goat families (11) and (13).

Despite the large size of the country’s goat population, the productivity per unit of animal and the contribution of this sector to the national economy is relatively low. To ensure sustainable utilization of the indigenous goat, there should be a conservation strategy for the present and future use. Phenotypic evaluation is the first step in the identification of qualitative and quantitative traits of the indigenous goat

(14). Therefore the objectives of this study were to the phenotypic characterization of the goat population using linear body measurement (LBM) and physical body characteristics and to evaluate the effect of sex and age on body weight and LBM under extensive management conditions according to (15).

2. Materials And Methods

2.1 Study Areas

The study was conducted in Organic and Akseker export abattoirs of Modjo district of Oromia regional state of central Ethiopia. There are seven functional export abattoirs found in Ethiopia, and five of them are located in the cities of Debre Zeit and Modjo, Central Ethiopia. This investigative work has been done in two export abattoirs located at Modjo namely Organic and **Akseker** export abattoirs. Modjo is about 77 km southeast of Addis Ababa located at 8°35'N and 39° 10'Eatan altitude of 1777 masl. The average maximum and minimum temperatures are 28 and 18° C.

Modjo is Located in the Misraq Shewa Zone of the Oromia Region. Modjo Modern Export Abattoir Plc is one of the leading exporters of chilled sheep and goat meat from Ethiopia. The abattoir is strategically located town of Modjo, about 70 km southeast of Addis Ababa, which is supplied by the three major export livestock producing regions of Oromiya, Afar, and Somali (17).

2.2 Study Animals

The study animals were indigenous goats that come from different locations of the country such as the Borena breed namely Jenka, Guji, Bale, and Affar, Somali. Quantitative (body weight, height at withers, body length, heart girth, ear length, rump width, and sacral pelvic width) and qualitative traits (coat color and pattern, head profile, head shape, ear form, horn orientation, and hair type) were documented using a semi-structured questionnaire along with a visual appraisal of the appearance of the goat types and measurements following the descriptor lists of the Food and Agriculture Organization of the United Nations (FAO, 1986) (18). Besides, focus group discussions were held with livestock keepers and knowledgeable key informants for generating general information regarding the history of the various goat types, special distinguished features of the targeted goats, production systems, and knowledge on the husbandry practices, challenges, and opportunities of indigenous goats. As farmers did not have the birth record of their animals, the age of each sampled goat was estimated from dentition as suggested by (19).

2.3 Study Design

From each abattoir phenotypic evaluation with 100 individual goats respectively; Organic and Akseker export abattoirs in Modjo districts were sampled and the morphological measurements were collected from young male goats having three to four pairs of permanent incisors according to the methods

described by (20). The goat populations in the district are traditionally recognized by ethnic and/or geographic nomenclatures; they were sampled in areas where each genotype is predominantly found following the guidelines by (9);(6) and (21)

The questionnaire survey was conducted using oral interview approaches to collect the required data through an oral interview for the abattoirs workers by the language they communicate. In addition to this, the meat inspection daily, monthly, and annually reports documents that are available in the abattoir are collected and systematically arranged and analyzed in different forms (Asmamaw, 2018).

2.4 Parameters determined

Body parameters measured were body length (BL), Body heights (BH), Heart girth (HG), Body condition score (BCS), and Age was determined based on dentition and with live weights and they were subjectively accepted as very good and young aged animals between six months up to two years and all required data were recorded according to the methods described by (23).

The animals are properly conditioned at their holding ground. The company has been certified with ISO 22000: 2005 food safety systems. The production capacity of the company ranges up to 2500 sheep/goat per day. The company currently exports chilled meat to U.A.E. and Saudi Arabia (24).

2.5 Statistical analyses

2.5.1. Measuring of Phenotypic traits

The data collected from the quantitative and qualitative variables were analyzed with the General Linear Model (GLM) using R Statistical software of version 4.1. In addition, regression analyses in GLM were used to predict body weights of the studied goat populations from heart girth and body length measurement traits in terms of intercept, the regression coefficient, and the p-values. Significant value differences occurred among means that were used to separate them (23).

3. Results

3.1 Phenotypic Evaluation.

The phenotypic parameters used to evaluate the indigenous goat populations studied at both export abattoirs were respectively heart girth, body height, body length, and body weight as methods described by (21); (25) were presented in Tables 1, 2, and 3 and Figure 2 ,3 and 4; where sex, age and body conditions of the goats were found to be in the similar condition. It is important to know the different parts of the goat's body to understand the different linear measurements described in this present study as least square (Means ± SE). The relationship between the mean and standard deviation of phenotypic

traits of goats exportable to Akseker and Organic export abattoirs were explained in Table 1 using R statistical software. Determination of the accurate degree of correlation between dependent variables and heart girth of the goat was made by regressing the body weight on measurements of heart girth of the animals. The regression coefficients of length, weight, and height on the heart girth are shown in Table 2. The results show that significantly (P<0.05) presence of clear phenotypic variations between and within these indigenous goats exportable to Akseker export abattoirs (Table 2) were as heart girth significantly (P<0.05) increased by 20.271(CM) centimeters the length-weight (KG) kilograms and height increases by (0.163 CM),), (0.479 KG) and (0.256 CM) respectively.

Table 1-Least Square (Mean ± SE) of phenotypic characters of goats exportable to Akseker and Organic Export Abattoirs respectively.

Export Abattoir	Phenotypic traits	Number	Mean ± SE
Akseker EA	Body Length(CM)	100	0.16298 ± 0.06377
	Body Weight(KG)	100	0.47995 ± 0.08578
	Body Height (CM)`	100	0.25647 ± 0.07975
	Hearth Girth (CM)	100	20.27146± 4.37569
Export Abattoir	**Export Abattoir**	**Phenotypic traits**	**Mean ± SE**
Organic EA	Body Length(CM)	100	0.1306 ± 0.15549
	Body Weight(KG)	100	1.9224 ± 0.30921
	Body Height (CM)`	100	0.2838 ± 0.18142
	Hearth Girth (CM)	100	7.2051± 10.30304

However, there is no evidence showed on the effect of sex, age, body condition, and age of animals with heart girth which may be due to the similarity of collected data or technical problems. The source of the animals was Borena breeds and their meat products were exported to Middle East countries such as Saud Arabia and Dubai. This result shows that there is a strong linear association between the studied variables in goats exported to Akseker Export Abattoirs as indicated in table 2. The linear association between and within length, weight, and height on the heart girth are also shown in table 2 and table 3 respectively for Akseker and organic export abattoirs.

Table 2 - Coefficients associated with regression of live weight (kg), on linear body measurements (cm) of Akseker export abattoirs respectively

Export	Model	Beta	SE	t value	Significant
Akseker	(Intercept)	20.271	4.38	4.63	1.13e-05 ***
	Body Length(CM)	0.163	0.06	2.56	0.01217 *
	Body Weight(KG)`	0.479	0.15	5.60	2.08e-07 ***
	Body Height (CM)	0.256	0.19	3.22	0.00177 **

Table 3 - Coefficients associated with regression of live weight (kg), on linear body measurements (cm) of Organic export abattoirs

Export	Model	Beta	SE	t value	Significant
Organic	(Intercept)	7.2052	10.30304	0.699	0.486
	Body Length(CM)	0.1306	0.155149	0.842	0.402
	Body Weight(KG)`	1.922	0.309214	6.217	0.001***
	Body Height (CM)	-0.281	0.18141	-1.565	0.121

According to the data shows, there is no significant (P-value >0.05) association between and within heart girth, height, and body length in Organic export abattoirs whereas there is there relatively high level of significant variations (P<0.05) only between hearth girth on the body weights. In exportable organic export abattoirs, there is a distinct phenotypic variation; which means when heart girth increases by 7.26 (CM) centimeters, the body weight significantly with a P-value (0.001) increase by 1.92 (Kg) kilograms (Table 3).

Table 4 – Regression Coefficients association between and within body weight (kg), body height (cm), length (cm) and heart girth (cm) on phenotypic evaluation of goats exportable to Organic export abattoirs

Coefficients of Variables	Beta	Std. Error	t value	Pr(>|t|)
Heart Girth (CM)	31.26112	122.623	0.255	0.799
Body length(CM)	-1.38199	2.291	-0.604	0.548
Body Weight(KG)`	1.996738	4.805	-0.416	0.679
Height (CM)`	0.287954	2.466	0.117	0.907
Body Weight(KG) : Height-(CM)	-0.031191	0.074	-0.422	0.674
Body length(CM):Height (CM)	0.007752	0.033	0.238	0.812
Body length(CM);Body Weight (KG)	0.032178	0.069	0.0465	0.643

For the sheep exported to in organic export abattoirs of modern Modjo abattoirs, the data strongly shows that there are no interactions between and within variables as explained in table 4. The source of animals studied for phenotypic evaluation in the organic abattoir was selected from breeds of Afar, Somali, Borena, Arsi bale, and Guji, and their meat product was exported to also the Middle East country of Saudi Arabia and Dubai. The other finding on the goat's phenotypic evaluations of Organic export abattoirs also showed that there is no strong evidence between age, sex, and body condition scores of the animals

which would be resulted from the similarity of data collected and failed to fit the model of multiple logistic regression which was fitted with finding of (21);(26) and (15). The fitness of the model of the simple logistic regression was manipulated using reduced multiple regression based on the scenario of homoscedasticity, and the phenotypic characterizations of goats exported to akseker abattoirs, its graphs confirm that there is slight linearity between dependent variables and independent variables in terms of standard residuals or errors and line of regressions.

4. Discussion

Linear body measurements of animals can be used to estimate live weight equations correlating live weight and linear body measurements have been developed for the studied breeds of goats exportable to Akseker and Organic export abattoirs of Modjo districts (Musa, 2014). Based on the finding, body height, length, and weight have a significant effect on the heart girth of the goats exported to akseker export abattoirs either between or within their same breeds, age, and body conditions for the borena breeds and different significant phenotypic difference. The goats exported to Organic export abattoirs were also collected from different corners of the country such as Affar, Somali land, Borena, Arsi, and Guji with sample populations of 100 goats. The associations between phenotypic characters were studied but the result showed that: Except for the body conditions on the heart girth, there are no interactions between and within other variables as explained in table 3 and 4 in the result sections. As explained in table 3, when body weight increases by 1.922 (KG) the heart girth significantly increases by 7.2052 (CM) units. In the preliminary analysis, interactions of fixed effects were significant ($P < 0.05$) in all cases only for goat populations of Akseker abattoirs and should be accepted. But the model was developed to reduce multiple regressions just to see the fitness of variables and normal distributions for goats populations exported to Organic abattoirs and found to be a non-significant effect on independent variables except for body weight only on the heart girth and this study agrees with (28–30) and (3).

The finding of this study was consistent with those reported by (14) (Musa *et al.*, 2014), (12,25,31): (28), (30),(32) that live body was highly correlated with linear body measurements. In this study, the color and other cultural-related parameters effect are also not studied which may or may have a direct effect on the selection of goat slaughtering for meat consumption as described in (32) and (23). The health status of animals with body conformation was highly ($P<0.001$) significant that body size ranked significant at ($P<0.05$) which this finding is consistent with (15) ; (5) and (21).

5. Conclusion And Recommendations

In Ethiopia, goat body weight, height and length have a direct effect on the heart girth of the goat which would affect the market value of meat and other product of goats. However, from exportable goats to both export abattoirs of the study area, there was no evidence about the effect of breed, sex, age, and body condition score on the heart girth of the goats which could be the result of the similarity of data respectively both as also (28).

In conclusion, many researchers stated heart girth to be the most appropriate and confident parameter in live weight estimations for farm animals. Those who seek better precision can consider the other linear body measurements (body length and wither height) in the prediction equation Heart girth had the highest correlation to live body weight according to t value. A simple regression model using linear body measurements that had a relatively high coefficient of determination could be utilized respectively for both goats exported to both abattoirs. The finding of the present study suggested that the derived equation could be used to estimate the live body weight, height, and length of goats exported to Akseker and organic export abattoirs have distinct variations.

Therefore, important criteria were related to phenotypic characters consisting of body size, apparent health, and body conformation as also indicated by (23). By visual observation, they consider body condition and healthiness. Others are the age of animals and temperament. Considering both heart girth and body length the equation could be used with higher estimation precision. However, the heart girth parameter is the easiest way to use for live weight prediction in field conditions, especially under smallholder farmers. Based on the finding the following recommendations will be forwarded.

- Body weight and rate of gain are among the most economically important and easily measured traits of meat animals.
- This could be used for various purposes such as selection, breeding, marketing, growth evaluation, and thus to make appropriate management decisions.
- The same research efforts need to be undertaken in other breeds of goats.
- Further research is needed to investigate the relation between the body weight and linear body measurements with carcass composition in the same breed and another study area.

Declarations

Funding

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Availability of data and materials

All relevant data are available as supplemental files to the manuscript; raw recording Excel data are available in Additional file 10.

Consent for publication

Not applicable

Authors Contribution

Gebeyehu Alkadir and Dejen Asefa: Prepared, Conceived and designed the experiments and its methodology, Hussein Mohammed: Performed the experiments,

Gebeyehu Alkadir: Analyzed the data, wrote the paper:

Gebeyehu Alkadir and Dejen Asefa & Hussein Mohammed: Critical revision of the manuscript: All authors read and approved the final manuscript.

Ethics approval

The approval on animal handling ethics was received before the commencement of the study. All the animal handling and sample collection methods were performed in accordance with the Addis Ababa University College of Veterinary Medicine Research Ethics (AAU-CVMA-REC) and animal welfare guide for the care and use of animals (Ref. No. 01257/2020).

Competing interests

The authors declare that they have no competing interests.

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Figures

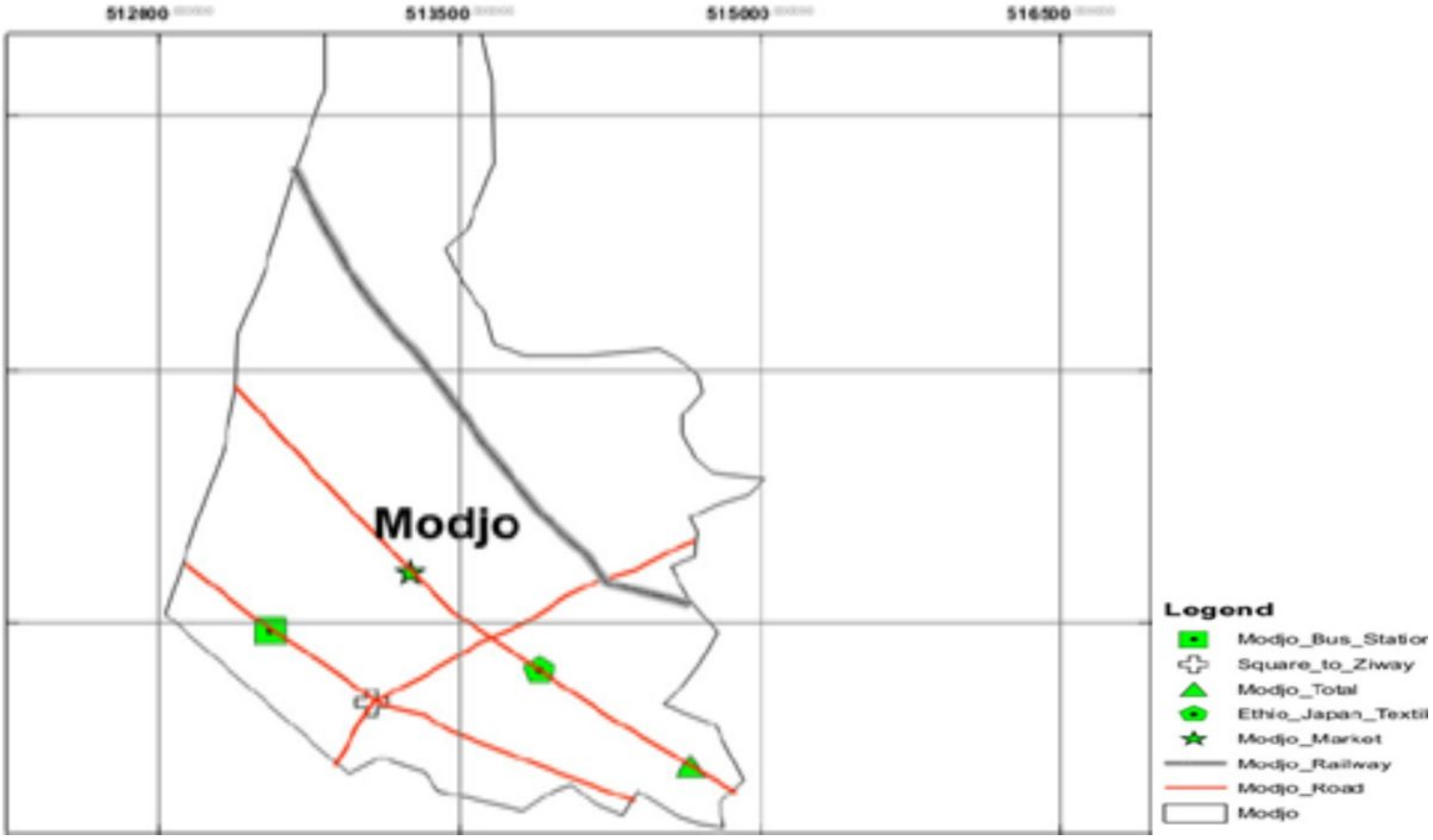

Figure 1

Figure Modjo town; Source ;(16).

Figure 2

When taking Body Length (CM). Note those people viewed in the figure 2-4 are one participants and Authors in the research

Figure 3

When taking Body Height (CM)

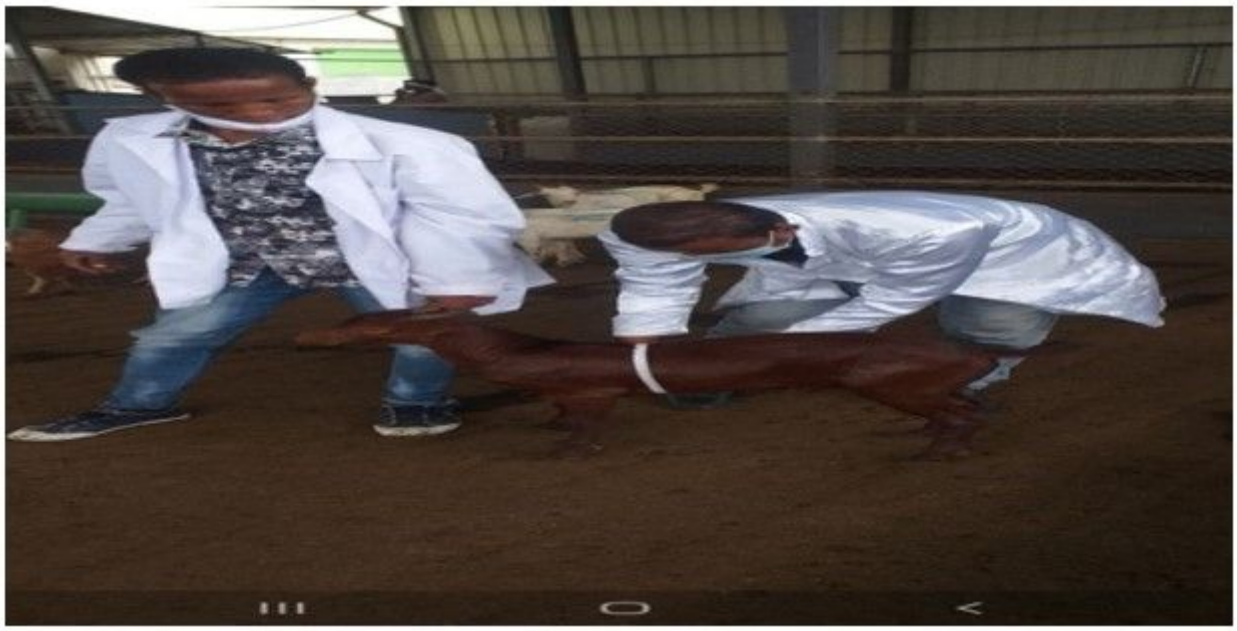

Figure 4

When taking Heart Girth (CM)

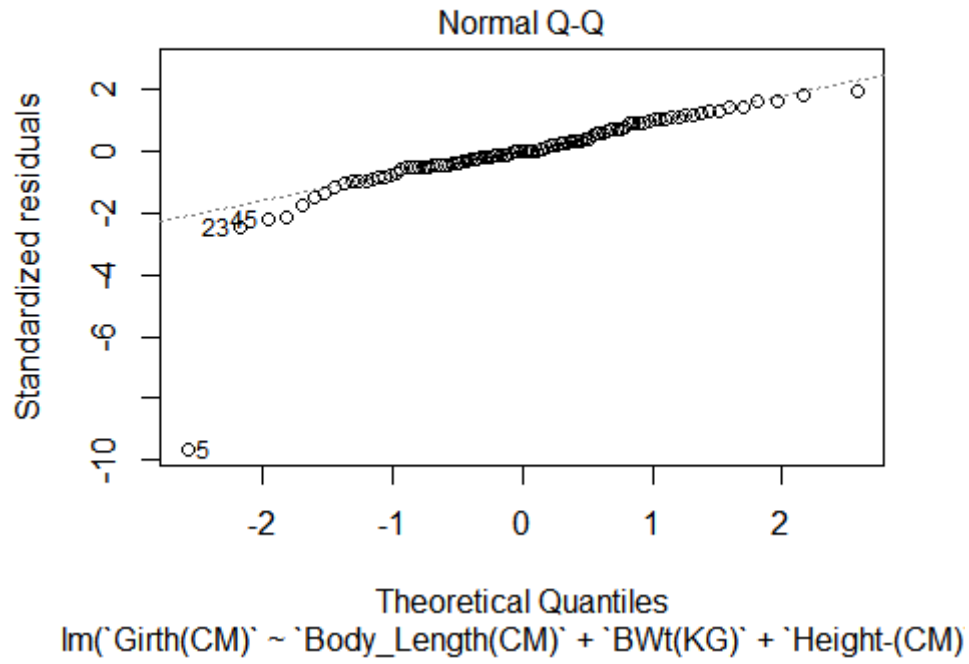

Figure 5

The interactions of the body weight, length, and height would increase normally increases the hearth girth

Source: Output Data analyzed by R statistical software after modeling the interactions for Akseker abattoir

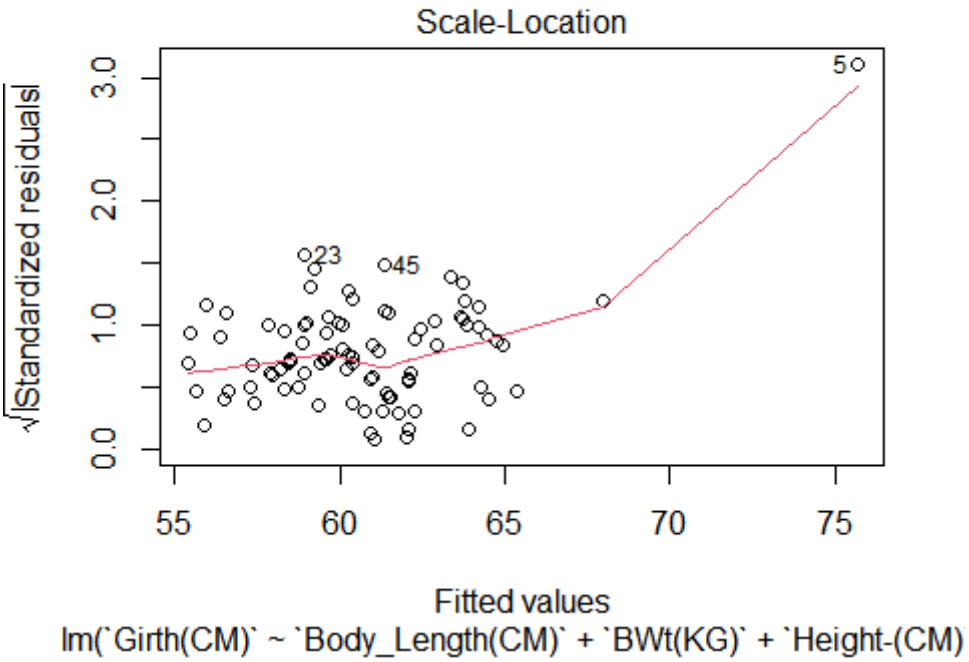

Figure 6

The interactions of the body weight, length, and height would increase normally increases the heart girt.

Source: Output Data analyzed by R statistical software after modeling the interactions for organic abattoir

Supplementary Files

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- GebeyehuDataHExcellRadatacollected.xlsx