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Original Research

Phenotypic Analysis of Native Goats Suitable for Export at the Organic and Akseker Slaughter Houses for the Purpose of Meat Consumption in Modjo Town, Ethiopia

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ABSTRACT

This study was conducted in Organic and Akseker Export abattoirs of Modjo district of Eastern Shoa zone of central Ethiopia with the aim of phenotypic evaluations of indigenous goats exportable to Akseker and Organic Export abattoirs of Modjo modern export abattoirs aimed at improving the community-based breeding strategies of indigenous goats and their phenotypic traits exported to export abattoirs for meat consumption. A total of 200 goats from both export abattoirs were sampled randomly for phenotypic evaluations. 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 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 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. In conclusion, to sustainably utilize these goat populations the production constraints should be solved and selective community-based breeding strategies should be designed and well implemented.

Keywords: Heart girth, Indigenous, Linear Body Measurement, Parameters

1. Introduction

An increase in agricultural productivity is a prevailing motive for farmers and a driving force in Ethiopia's agricultural policy. The government consumed 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[3,4]. 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[5].

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[4]. 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[6] described the domestic goat (*Capra Aegagrus*) as a subspecies of goat domesticated from the wild goat of southwest Asia and Eastern Europe[6] 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 (15) indigenous goat breeds inhabited the lowland, midland, and highland agroecologies of Ethiopia (IBC, 2004). The total population of goats in Ethiopia is reported as 24.06 million of which 99.99% are indigenous goat breeds.

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. 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.

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 (Galal 2005) that favored adaptation and survival rather than production. A comprehensive phenotypic evaluation of Ethiopian goats was done by Farm Africa (FARM Africa 1996) classifying indigenous goats based on their geographic location and the ethnic communities who keep them. Based on the analysis of morphological data along with geographic distribution, fourteen distinct goat populations were identified across Ethiopia and Eritrea (FARM Africa 1996). 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.

The objectives of this study were to evaluate 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. 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[7].

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.

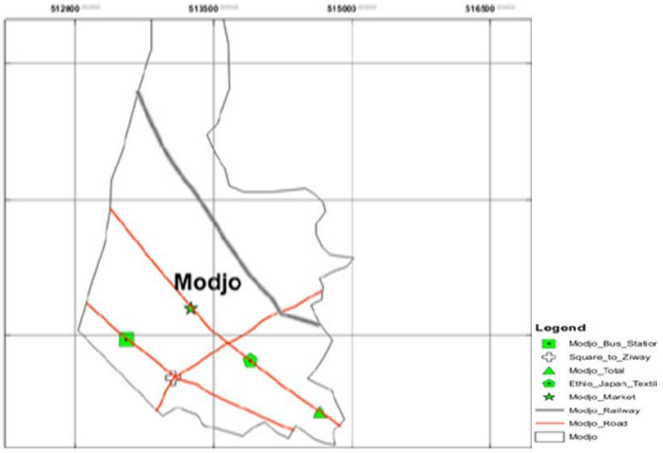

Figure 1: Figure Modjo town; Source.

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 Oromia, Afar, and Somali.

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). 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 Pace and Wakeman (2003).

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[7]. 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 Ayalew and Rowlands (2004).

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.

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 Babale et al.

Figure 2: When taking Body Length (CM).

Figure 3: When taking Body Height (CM).

Figure 4: Heart Girth (CM).

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 (Ethiopian Meat Producer-Exporters Association, Modjo).

2.5. Statistical analyses

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.

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[9] were presented in **Tables 1, Tables 2 and Tables 3** and **Figure 1, Figure 2 and Figure 3**; 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.

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(centimeters)	100	0.16298 ± 0.06377
	Body Weight(Kg)	100	0.47995 ± 0.08578
	Body Height (centimeters)`	100	0.25647 ± 0.07975
	Hearth Girth (centimeters)	100	20.27146 ± 4.37569
Organic EA	Body Length(centimeters)	100	0.1306 ± 0.15549
	Body Weight(Kg)	100	1.9224 ± 0.30921
	Body Height (centimeters)`	100	0.2838 ± 0.18142
	Hearth Girth (centimeters)	100	7.2051 ± 10.30304

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 of Akseker export abattoirs showed significant ($P<0.05$) presence of clear phenotypic variations between and within indigenous goats (**Table 2**) in which the heart girth significantly ($P<0.05$) increased by 20.27 centimeters, and height increases by 0.16 centimeters), body weight increases by 0.48 Kg and length increased by 0.26 centimeters respectively. However, there is no evidence revealed the effect of sex, age, body condition, and age of animals on heart girth. 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(centimeters)	0.163	0.06	2.56	0.01217 *
	Body Weight(Kg)`	0.479	0.15	5.6	2.08e-07 ***
	Body Height (centimeters)	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(centimeters)	0.1306	0.155149	0.842	0.402
	Body Weight(Kg)`	1.922	0.309214	6.217	0.001***
	Body Height (centimeters)	-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 centimeters, the body weight significantly with a P-value (0.001) increases by 1.92 (Kg) (**Table 3**).

Table 4: Regression Coefficients association between and within body weight (Kg), body height (centimeters), length (centimeters) and heart girth (centimeters) on phenotypic evaluation of goats exportable to organic export abattoirs.

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

For the sheep exported to 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. 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.

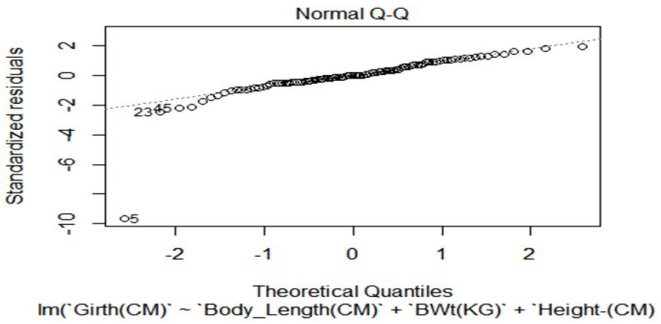

Figure 5: The interactions of the body weight, length, and height would increase normally increases the hearth girth.

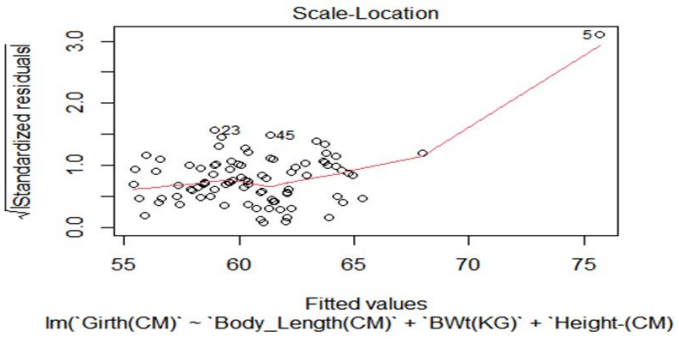

Figure 6: The interactions of the body weight, length, and height would increase normally increases the heart girt.

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[10]. 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 **Table 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[4,11,12].

The finding of this study was consistent with those reported by[8-11,13,14] 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[15]. 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[11].

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[11].

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, with considering important criteria, the following phenotypic characters such as 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.

6. Competing Interests Disclaimer

Authors have declared that no competing interests exist. The products used for this research are commonly and predominantly used products in our area of research and country. There is no conflict of interest between the authors and producers of the products because we do not intend to use these products as an avenue for any litigation but the advancement of knowledge. Also, the research was not funded by the producing company rather it was funded by the personal efforts of the authors.

7. Authors Contributions

The corresponding author GA contributed to the conceptualization and methodology; formal analysis contributed to investigation and writing of the original draft; DA contributed to data curation, validation, writing, review and editing. All authors read and approved the final manuscript.

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9. Competing Interests

The authors declare that we have no competing interests.

10. Availability of data and materials

It is possible to access the data on personnel request from the Corresponding author.

11. Consent for publication

Consent was taken from the small ruminant fatteners located at the place to present their goats for slaughter service.

12. Ethics Approval and Consent to Participate

Approval was not mandatory for this research. Because we do this research without harming the welfare of the animal by measuring their girth, height and weight.

13. Funding

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