INGESSANA GOATS PHENOTYPE, CARCASS AND WHOLESALE CUTS CHARACTERISTICS IN FADAMIA, BAO LOCALITY, BLUE NILE STATE, SUDAN

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ABSTRACT

Two studies were conducted to characterize the phenotype, carcass and wholesale cuts in Ingessana goats in Fadamia, Bao Province, Blue Nile State, Sudan which is about 521km south east of Khartoum. In the first study 250 animals were used to study body weight and measurements and colours at different ages in villages in the area. In the second study 6 males at <1 and 1 year old (three in each age group) were used to study body components and carcass and wholesale characteristics. The data was statistically analyzed according to MSTAT. Body weight (BW) and measurements, except horns and tail length, were increased with age. The correlations between BW and measurements were calculated and different regression equations were used to predict BW from some body weight at different ages with no significant (P>0.05) differences between measured and predicted BW. Animals' colours varied greatly and were mainly black and white (35%). All body components percentages, except skin and small intestines, were higher at <1 year old with no significant difference between the two age groups. Slaughter weight, empty BW (EBW) and hot carcass weight were significantly (P <0.05) higher at1 year old. Dressing percentages were higher on EBW than LBW and were not significantly (P>0.05) different between the two age groups. Carcass muscle, bone, fat and muscle: fat were not significantly (P>0.05) different between the two age groups. Muscle: fat was significantly higher at 1 year old (P<0.05). There were no significant (P>0.05) differences in all wholesale cuts percentages between the two age groups. The percentages of leg and chump, single short forequarter and loin were higher at 1 year old and breast and neck percentages were higher at <1 year old.

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Contribution/ Originality

The paper contributes the first logical analysis of phenotype, carcass and wholesale cuts characteristics of Ingessana goats in Blue Nile State, Sudan. The study also predicted equation for measuring body weight which contributes to the existing literature.

1. INTRODUCTION

Meat demand and prices increased substantially in the Sudan due to increased human population, urbanization and improved nutritional awareness and living standards. It is important to exploit less exploited meat producing animal in the country to reduce the prices. Goats are very important in the Sudan due to high population and production of high quality milk, meat and skin [1]. Goat meat has high nutritive value and low fat [2, 3]. The disputed correlations between cardiovascular diseases, cholesterol and saturated fatty acids increased the demand for low fat meat including goat meat. However, goat meat is the least preferred in the Sudan [2, 4]. Goat production systems are mainly traditional based on rangeland which deteriorated for many reasons and animals are generally neglected with low inputs and outputs. Improving goat meat production will increase its demands and reduce meat prices and increase exports and national income and alleviates poverty and hunger. There are many goat breeds in the Sudan [5]. The Nubian is the main dairy breed and Desert, Nilotic, Tagger and Baggara and Ingessana are classified as meat breeds. Ingessana is the main breed in the Ingessana area in the Blue Nile State and reputed for high quality meat and adaptation to harsh environments, but it is endangered due to haphazard crossing with other breeds. However, there is no information on the breed characteristics. Consequently, this study was conducted to characterize the breed and furnish information on the phenotype, carcass and wholesale cuts characteristics.

2. MATERIALS AND METHODS

Two studies were conducted to characterize Ingessana goats in Fadamia area in the Ingessana area, Blue Nile State, Sudan.

2.1. The First Study: The Phenotypic Characteristics
2.1.1. Location

This study was conducted in Fadamia area in the Ingessana area, Blue Nile State, Sudan. Fadamia is a village in Bao Locality and is about 150km south of Eldamazeen which is the state capital and is about 521km south east of Khartoum. Bao Locality population is about 0.103 million. The state is located between latitudes 9-12° N and longitudes 32-35°E in the rich Savannah zone. The area is mainly mountains with eight important mountains. Maximum and minimum temperatures are 31-32° and 17-21°, respectively. Autumn is from April to October and annual rainfall is 100-1000mm with high plants numbers. There are many seasonal streams and the area is fertile and is the main agricultural site in the state. Cropping and animal production are the main occupations in the area.

2.1.2. Animals

Two hundred and fifty goats at different ages in different villages were used in this study. They were studied at water points and a translator was used to communicate with animal owners who were cooperative. The animals were mainly adult females as owners were interested in keeping productive animals and males were slaughtered or sold at young ages. Animals age was determined using the lower jaw incisors [5]. Body weight was measured using a 50 kg capacity spring balance and the animals were held in a sac and suspended by the spring balance. Body measurements including height at withers (HW), heart girth (HG), body length (BL), abdominal girth (AG), horn length (HL), ear length (EL) and Tail length (TL) were measured using a measuring tape as described by Owen and Norman [6].

2.1.3. Statistical Analysis

Mean BW and measurements were calculated at different age groups and the data was statistically analyzed according to MSTAT. The correlations between BW and measurements were calculated in different age groups as described by Mukherjee, et al. [7]. Linear regression equations were used to predict BW from somebody measurements and mean predicted and measured BW were compared as described by Mukherjee, et al. [7]. Correlations, regression coefficients and t-test were determined according to Statistical Analysis System (SAS).

2.2. The Second Study: Ingessana Goats Carcass Characteristics
2.2.1. Location

This study was conducted in the premises of the Goat Research Centre in Elneshasheba farm in Wad Medani, Gezira State, Sudan.

2.2.2. Animals

Six Ingessana males were bought at random at less than one year and one year old (three in each age group) from Fadamia livestock market and transported by car to Wad Medani. The animals were housed in individual pens, rested, watered and fed and treated with Ivomec against external and internal parasites. They were fed groundnut haulm *ad lib* for a week. Clean drinking water was offered *ad lib*. They were then fastened overnight, weighed at the morning and slaughtered according to Islamic rituals. Blood was collected in a plastic container and weighed for each animal. The heads and legs were separated and weighed separately for each animal. The animals were then skinned and the skins were weighed. The carcass was opened and the viscera were removed and weighed separately and the carcasses were weighed. The elementary tract was weighed full and empty and the gut contents were calculated by difference. Empty body weights were calculated for each animal by subtracting the gut fill from live body weight. Each body component weight was calculated as percentage of EBW for each animal. Dressing percentages were calculated on live and empty body weight.

2.2.3. Wholesale Cuts

Ingessana goats wholesale cuts characteristics were studied by splitting the hot carcasses into two halves along the vertebral column using a saw. One side was divided into six wholesale cuts as described by M.L.C. [8].

Ingessana goat carcass composition was studied by dissecting the wholesale cuts foe each animal into muscles, bones and fat and were weighed and expressed as percentages of EBW. Muscle: bone and muscle: fat were calculated for each animal and age group.

2.2.4. Statistical Analysis

The data was statistically analyzed using MSTAT. Body components and carcass characteristics were compared using student's t- test according to MSTAT.

3. RESULTS

Table 1 shows mean BW and measurements in Ingessana goats in Fadamia area, Sudan.

Body weight and all body measurements, except horn and tail length were increased with age. The mean body weight of goats in the five age groups (<1, 1, 2, 3 and ≥4 years) were recorded to be 9.63, 17.53, 21.58, 25.10 and 28.29 kg respectively. The increased BW and HW were highest between <1 and 1 year old and declined with age. Heart girth and AG increased significantly with age. Table 2 shows the correlation coefficients between BW and body measurements in Ingessana goats. The correlations between BW and HG generally declined with age and were highest at <1 year old.

The correlations between BW and AG were highest at 2 years old and least <1 year old. The correlations between BW and BL were highest at 1 year old (0.63) and least at 3 years old (0.40). The correlations between BW and measurements were generally higher up to 2 years old.

Table 3 shows that different regression equations were used to predict BW from somebody weight in Ingessana goats. The regression equations accurately predicted BW at different ages with no significant differences between measured and predicted BW. Ingessana goat colours varied in Fadamia area. It was mainly black and white (35%) followed by black (19%), white (16%), black, white and brown (11%) and then white and brown (9%). The least colours were grey (5%) and black and brown (5%).

Table 4 shows Ingessana goats body components expressed as percentages of EBW. All body components percentages, except skin and small intestines, were higher at <1 year old. There were no significant differences in all body components percentages between the two age groups.

Table 5 shows Ingessana goats slaughter weight and carcass characteristics. Slaughter weight, EBW and hot carcass weight, 11.73, 9.27 and 5.67 kg respectively were significantly (P <0.05) higher at one year old. Dressing percentages were higher on EBW than LBW in the two age groups. Dressing percentages on EBW (60.00 and 61.52) and LBW (50.00 and 48.33) were not significantly different between the two age groups, respectively.

Carcass muscle, bones, fat and muscle: fat were not significantly different (P>0.05) between the two age groups. Table 6 shows Ingessana goats wholesale cuts as percentages of hot carcass

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weight. There were no significant differences in the percentages of all wholesale cuts between the two age groups. The percentages of leg and chump, single short forequarter and loin were higher at one year old and the percentages of breast and neck were higher at <1 old.

4. DISCUSSION

4.1. Body Weight and Measurements

The increased BW and all body measurements, except tail and horns with age were mainly due to goats proportional growth. Similar results were reported in Tagger goats in Nuba Mountains, Sudan [2, 9]. It was also found in Nubian goats in Elshukaba area [10] and Kenana Sugar Company area [11] and Desert goats in Elobeid area [4] and Bengl goats in India [7]. The highest increase in body measurements at early ages (<1 and 1 year old) was also found in Tagger goats [2] and was attributed to relatively fast growth before puberty [12].

Ingessana goat BW was close to Baggara goat at 3 years old [13]. At four years old Ingessana goat BW was higher than Tagger females in Eldaleng area [2] and mature BW in Rashad area [9]. It was also higher than Nilotic goats and lower than Nubian and Desert goats in the Sudan [14]. All body measurements in Ingessana goat were higher than Tagger in Rashad area [9]. Ingessana goats HW and HG were close to Tagger in Eldaleng area [2] and higher than Tagger in Rashad area [9]. Ingessana goat AG and BL were close to Tagger in Eldaleng area [2]. Ingessana goats BC and HW were lower than in Elshukaba [10]. Ingessana goat BL and EL were lower than Nubian goat in Kenana Sugar Company area [11]. Ingessana goat ears and tails were longer than Tagger [2, 9] and horns were shorter than Tagger [2]. The results suggested that Ingessana and Tagger goats have different body weight and measurements.

4.2. Correlations between BW and Measurements and Predicting Body Weight

The strong correlations between BW and most body measurements were due to proportional growth. These correlations and different linear regression equations predicting BW with no significant differences between measured and predicted BW were also reported in Tagger goats [2, 3], Desert goat [4], Nubian goats [10, 11] and Bengal goats [7].The accurately predicted BW from linear equations is advantageous where weighing machines are not available or difficult to operate and maintain and will improve animal management and marketing.

4.3. Body Components

Ingessana goat body components as percentages of EBW were higher than Desert goats except the stomach, small intestines and kidneys [3]. Ingessana goat percentages of head, legs, skin, heart, stomach, small intestines, kidneys and lungs were higher than Tagger [2]. The non-significant difference in body components percentages at <1 and 1 year old were also found in Desert goats [3] and indicated little changes within this age.

4.4. Carcass Characteristics

The significantly increased slaughter weight, hot carcass weight and EBW with slaughter age were also found in Desert goats in Elobeid area [3] and were due to increased BW and proportional growth. The increased dressing percentages with increasing the slaughter weight were also reported in Sudanese goat breeds [3, 11, 15, 16]. The non-significant differences in muscles, bone and fat percentages with slaughter age were also found in Desert goats [3]. The increased slaughter weight, hot carcass weight, EBW and dressing percentages with slaughter age and non-significant differences in carcass muscles, bone and fat between the two age groups suggested slaughter at 1 year old due to increased percentages and carcass weight when quality is maintained.

4.5. Wholesale Cuts

Wholesale cuts percentages were generally lower in Ingessana than Desert goats [3]. The non-significant differences in wholesale cuts percentages at <1 and 1 year old and improved carcass characteristics with age in Ingessana and Desert goats highlighted the advantages of slaughter at 1 year old. The different wholesale cuts percentages between Ingessana and Tagger in Nuba Mountains [2, 9] suggested that they are different breeds.

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Table-1. Body weight (kg) and measurements (cm) in Ingessana goats in Fadamia, Bao Province, Blue Nile State, Sudan

Parameters	Age (Years)				
	<1	1	2	3	≥4
Body weight	09.63±0.66d	17.53±0.86c	21.58±0.57bc	25.10±0.52ab	28.29±0.67a
Height at withers	52.40±0.95d	57.28±0.63c	61.22±1.06bc	62.81±0.48ab	66.58±0.96a
Heart girth	53.58±0.95d	63.88±0.90c	67.50±0.76bc	71.07±0.51ab	74.07±0.42a
Barrel circumference	63.95±1.42d	79.18±1.25c	85.93±1.31bc	89.10±0.83ab	95.00±0.77a
Body length	36.05±1.43c	38.32±0.75bc	40.19±0.75ab	42.08±0.47a	43.39±0.95a
Ear length	15.02±0.39b	16.04±0.23ab	17.05±0.30a	16.75±0.21ab	16.63±0.26ab
Horn length	03.90±0.33c	05.70±0.43bc	07.78±0.40ab	08.77±0.44ab	10.20±0.45a
Tail length	11.87±0.20b	13.08±0.18ab	13.47±0.20ab	13.77±0.16a	13.63±0.22ab

Different letters within a row denote significant differences at P< 0.05

Table-2. Correlation coefficients between body weight and measurements at different ages in Ingessana goats in Fadamia, Bao Province, Blue Nile State, Sudan.

Parameters	Age (Years)				
	<1	1	2	3	≥4
Heart girth	0.78	0.75	0.73	0.61	0.60
Barrel circumference	0.20	0.64	0.79	0.35	0.67
Body length	0.42	0.63	0.43	0.40	0.45
Height at withers	0.46	0.66	0.15	0.09	0.06

Table-3. Regression equations predicting body weight and predicted body weight at different ages in Ingessana goats in Fadamia, Bao Province, Blue Nile State, Sudan

Age (Years)	Equations	Predicted BW	Measured BW
<1	$Y = -0.142x_1 + 0.297x_2 + 0.111x_3 - 8.811$	10.99±0.95	09.10±0.66
1	$Y = -0.047x_1 + 0.121x_2 + 0.617x_3 - 29.63$	17.64±1.14	17.10±1.61
2	$Y = -0.017x_1 + 0.246x_2 + 0.253x_3 - 15.854$	22.01±0.85	21.40±1.12
3	$Y = -0.239x_1 + 0.091x_2 + 0.433x_3 - 23.982$	25.34±0.83	26.10±1.35
≥4	$Y = -0.426x_1 + 0.455x_2 + 0.218x_3 - 49.441$	28.37±1.25	28.90±1.75

BW= Body weight (kg).

Table-4. Body components (% of empty body weight) at different ages in Ingessana goats in Fadamia, Bao Province, Blue Nile State, Sudan.

Parameters	Age (years)		Significance
	<1	1	
Head	13.50+1.77	13.22+1.73	NS
Skin	09.67+0.98	11.31+0.89	NS
Legs	06.27+0.30	05.97+0.51	NS
Stomach	04.27+0.43	05.07+0.19	NS
Small intestines	02.08+0.44	02.49+0.41	NS
Liver	02.62+0.34	02.57+0.08	NS
Spleen	00.54+0.06	00.52+0.06	NS
Kidneys	00.72+0.13	00.59+0.05	NS
Lungs	02.45+0.35	02.10+0.24	NS
Heart	01.12+0.15	01.01+0.09	NS

NS= Non significant differences at P>0.05

Table-5. Slaughter weight and carcass characteristics in different age groups in Ingessana goats in Fadamia area, Bao Province, Blue Nile State, Sudan.

Parameters	Age (years)		Significance
	<1	1	
Slaughter weight (kg)	07.57+1.03	11.73+0.03	*
EBW	06.23+0.57	09.27+0.33	*
Hot carcass weight (kg)	03.69+0.28	05.67+0.26	**
Dressing %: EBW	60.00+6.12	61.52+3.53	NS
: LBW	50.00+6.01	48.33+2.02	NS
Total carcass muscles (%)	65.0+11.28	65.00+0.16	NS
Total carcass bone (%)	23.00+5.52	24.33+0.88	NS
Total carcass fat (%)	01.00+0.00	01.0+0.00	NS
Muscle: bone	02.78+0.28	02.67=0.12	NS
Muscle: fat	65.00+5.36	65.00+0.94	NS

EBW= Empty body weight, LBW= live body weight.

NS= Non significant differences at P>0.05, *= Significant differences at P<0>05, ** Significant differences at P<0.01

Table-6. Wholesale cuts (% of hot carcass weight) in different age groups in Ingessana goats in Fadamia area, Bao Province, Blue Nile State, Sudan.

Cuts	Age (Years)		Significance
	<1	1	
Leg and chump	29.50+3.54	33.67+0.33	NS
Single short forequarter	32.33+4.92	32.67+0.88	NS
Loin	06.33+0.67	08.67+0.88	NS
Beast end of neck	05.33+0.33	05.33+0.33	NS
Breast	06.33+0.33	06.00+0.58	NS
Neck	11.00+2.31	10.33+2.34	NS

NS= Non significant differences at P>0.05