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Morphostructural characterization and zoometric indices of Sudan females Colombian Creole Hair sheep "OPC"

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ABSTRACT

Objective. This study aimed to describe body measurements and zoometric indices of Colombian creole woolless sheep (OPC), in two of its varieties, Sudan Bayo and Sudan Blanco. **Materials y methods.** This research was carried out in the states of Córdoba, Cesar, and La Guajira. Two farms were visited in Córdoba and Cesar and one in La Guajira. In each state were evaluated 21, 75, and 14 animals, respectively. In 110 Sudan sheep were studied 29 morphostructural variables and body weight; with these variables, 15 zoometric indices were estimated. To the collected information, descriptive statistics were applied through the InfoStat® software. **Results.** Sudan Bayo presented higher values in body weight than Sudan Blanco sheep (40.8 and 40.57 kg), as in the zoometric measurements related to head, limbs, and most of the trunk; for the first sheep variety 83 ewes were used and 27 animals for the second variety. Regarding the zoometric indices, Sudan sheep were characterized for being dolichocranial, dolichocephalic, eumetric, with a thorax of elliptical tendency, with convex rumps, and of longilineal body according to two ethnological indices while brevilineal based on one functional index. **Conclusions.** Through this research, the current morphometric status of Sudan OPC was known in detail, as well as the proportionality between the body regions, whose inclination is towards the meat biotype. This data is important for knowledge, breed characterization, biotype definition, conservation, promotion, and genetic improvement of the OPC.

Keywords. Morphology; morphometry; ewe, landraces; animal genetic resources (*Sources: National agricultural library, AGROVOC*).

RESUMEN

Objetivo. El objetivo de este estudio fue describir las medidas corporales e índices zoométricos de Ovinos de Pelo Criollos Colombianos (OPC), en dos de sus variedades, Sudán Bayo y Sudán Blanco. **Materiales y métodos.** Esta investigación fue llevada a cabo en los departamentos de Córdoba, Cesar y La Guajira, se visitaron dos granjas en cada uno de los primeros dos departamentos y una en el tercero. 21, 75 y 14 animales por departamento fueron evaluados, respectivamente. Se estudiaron 29

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variables morfoestructurales y el peso corporal en 110 ovejas Sudán, y con estas variables evaluadas, se construyeron 15 índices zoométricos. A la información recolectada se le aplicó estadística descriptiva mediante el software InfoStat®. **Resultados.** Las Sudán Bayo presentaron valores superiores a las Sudán Blanco para el peso (40.8 y 40.57 kg), al igual que para todas las medidas zoométricas relativas a la cabeza, las extremidades y la mayoría de las del tronco; para la primera variedad se emplearon 83 ejemplares y para la segunda 27. En cuanto a los índices zoométricos, las Sudán se caracterizaron por ser dolicocraniotas, dolicocéfalas, eumétricas, de tórax con tendencia elíptica, de grupas convexilíneas y de acuerdo a dos índices etnológicos longilíneas, mientras que con base en un índice funcional brevilíneas. **Conclusiones.** A través de esta investigación se conoció de manera detallada el estado morfométrico actual de las OPC Sudán, así como también la proporcionalidad entre las regiones corporales de estas, cuya inclinación es hacia el biotipo cárnico. Esta información es de importancia para el conocimiento, caracterización racial, definición de biotipo, conservación, fomento y mejora genética de los OPC.

Palabras clave: Morfología; morfometría; oveja; razas nativas; recursos genéticos (*Fuentes: National agricultural library, AGROVOC*).

INTRODUCTION

The Sudan Colombian creole woolless sheep (OPC) are, basically, the result of woolless sheep taken to the Caribbean islands from Canarias islands (1), and in a smaller amount, of sheep from continental Africa (2). These groups were crossbreed and subjected to a long period of natural selection, resulting in the creation of different sheep populations, of which stand out in Colombia Sudan and Etiope, both well adapted to the low tropic. Sudan OPC developed a good adaptation to the conditions of the Colombian low tropic (2), providing agri-food security to farmers. Moreover, it has shown a marked meat potential, if it is considered that the conditions under which such meat production has operated are far from those considered optimal. Equally, they have been characterized for their relevance in social and cultural events.

Sudan sheep have been endangered from 2005 to date. The growth of ovine production in Colombia since the early 21st century and the ignorance of OPC importance have allowed, in production systems that use creole sheep, the indiscriminate introduction and crossbreeding of foreign breeds with OPC. These foreign breeds are improved for meat production in other environmental conditions, but no for the adaptation traits such as disease resistance and reproductive characteristics.

The exposed situation is serious because the delimitation of OPC as a breed is not clear. Although from the genetics (2) and morphometry (3) it has been suggested that Sudan and Etiope sheep could be classified as different populations in terms of breed, there are also studies from both areas in which there is no discrimination between these OPC populations (4-7). This reflects that there is no unified criterion as to whether the Sudan and Etiope are one breed with two subbreeds, or if they are two different breeds.

One of the initial activities to begin conservation and promotion of Sudan sheep is to define their classification as a breed or subbreed. For this, it is previously necessary to do a quantitative morphological characterization, which is constituted by the morphostructural characterization and the zoometric indices estimation (8). Both were implemented in this research to know the current status of these OPC specifically, their dimensions, body proportions, and productive inclination. Later it would contribute to the creation of a breed standard and to more objective knowledge of the zootechnical potential of these sheep, information that finally could help to the breed recognition of Sudan sheep and their genetic improvement.

MATERIALS AND METHODS

Type of study. This was a descriptive research, cross-sectional, and non-probabilistic sampling for convenience.

Location. Sudan Bayo sheep were in Valledupar (Cesar; 10º07’37.3’’ NL - 73°39’45.4’’ WL and 10º07’01.4’’ NL - 73º33’02.2’’ WL), Montería and Ciénaga de Oro (Córdoba; 8º34’15.7’’ NL - 75º56’54.5’’ WL and 8º52’43.1’’ NL - 75º42’12.3’’ WL). Sudan Blanco animals were in San Juan del

Cesar (La Guajira; 10º49'46.0'' NL - 72º56'53.8'' WL) and Valledupar (Cesar; 10º25'36.6'' NL - 73º21'16.0'' WL). The mentioned places in La Guajira and Cesar are considered Very Dry Tropical Forest while the said places in Córdoba are considered Dry Tropical Forest.

Study animals. Sudan OPC are initially described in 1977 from the phaneroptic, it was mainly expressed that Sudan sheep have a yellow coat color (Figure 1) that sometimes can be white (Figure 2), have convex rectilinear profile, horn absence, short and horizontally directed ears, as well as dark and clear pigmented hooves (2). Noticeably, Sudan Blanco sheep are considerably reduced if contrasted with Sudan Bayo, in population size terms.

Although there is no consensus about if Sudan and Etiope are one breed, two subbreeds or two breeds, Vivas (2) and Flórez et al (3) studies suggest that these two zoogenetic resources, which integrate the OPC group, could be considered different in breed terms.

Figure 1. Sudan Bayo sheep.

Figura 2. Sudan Blanco sheep.

Animal management and evaluated traits. A total of 87 Sudan Bayo and 23 Sudan Blanco ewes were evaluated. To be chosen had to comply with the Sudan OPC description found in the literature (2), an age no lower than two years, a fasting period greater than 12 hours, lack of anatomical abnormalities, as well as lack of crossbreeding and evident pregnancy.

To implement the quantitative morphological evaluation of the Sudan OPC, the reports by Popoola (9), Morales-de la Nuez (10), and Bravo and Sepulveda (11) were taken into account both in morphostructural variables and zoometric indices. The evaluated traits were:

Morphometric variables. LCB, head length; PCB, head depth; LCN, cranial length; LCR, face length; ACB, head width; CAN, cranial width; TOR, ear size; TOJ, eye size; ACR, withers height; AD, shoulder height; AES, sternum height; AG, rump height; ANC, tail height; LCP, body length; DDE, dorsal – sternal diameter; AEN, shoulder width; DB, bicostal diameter; AIL, rump width; AIQ, ischium width; LG, rump length; PT, thoracic perimeter; LCO, tail length; PR, knee perimeter; PMC, cannon bone perimeter; PMT, metatarsal perimeter; PME, fetlock perimeter; PCU, pastern perimeter; PCO, coronary – band perimeter; and PCV, hock perimeter. Body weight (PC) was added to this group, due to its productive importance and high relationship with morphostructural variables.

Ethnological zoometric indices. ICR, cranial index (=(CAN/LCN)*100); ICE, cephalic index (=(ACB/LCB)*100); ICL, corporal index (=(LCP/PT)*100); ICM, compactness index (=(PC/ACR)*100); ITO, thoracic index (=(DB/DDE)*100); IDR, shoulder-withers height index (=(AD/ACR)*100); IDP, shoulder-pelvic height index (=(AD/AG)*100); and IPV, pelvic index (=(AIL/LG)*100).

Functional zoometric indices. IPR, thorax relative depth index (=(DDE/ACR)*100); ICO, relative shortness index (=(ACR/LCP)*100); IPT, transversal pelvic index (=(AIL/ACR)*100); IPL, longitudinal pelvic index (=(LG/ACR); IER, relative thickness index of the metacarpus (=(PMC/ACR)*100); IMT, thoracic metacarpal index (=(PMC/PT)*100); and dactylocostal index (=(PMC/DB)*100).

Cephalic variables were measured through a thickness compass except for ACN, TOR, and TOJ, which were measured with a vernier caliper. In the trunk variables, the heights were taken with a zoometric staff; PT, LCO, and LCP were measured with a measuring tape whilst the rest of the traits of this region were evaluated with a thickness compass. All the measurements of the limbs were taken with a measuring tape. For the body weight, a portable scale was used.

Analysis of results. Once estimated, both morphostructural variables and zoometric indices were applied descriptive statistics, specifically, average, standard deviation, minimum and maximum values. This was done through InfoStat® software version 2016I (12).

RESULTS

Morphostructural characterization. In table 1, descriptive statistics are described for 30 evaluated variables. The first trait is PC, which in Sudan Blanco was lower than Sudan Bayo by a difference of 0.23 Kg; the average body weight of Sudan Blanco was 40.57 Kg. In the morphostructural variables of the cephalic region, it was observed that Sudan Bayo females always presented higher averages than Sudan Blanco.

Sudan Blanco showed a higher average value for the heights than Sudan Bayo, slightly; tail height was an exception to this. The situation initially mentioned in this paragraph was repeated for the AEN, AIQ, and LCO. Regarding the rest of zoometric variables of the trunk, Sudan Bayo had higher averages than Sudan Blanco; these measures are related to the length and width of the body and rump size. In the evaluated circumferences of the extremities, Sudan Bayo OPC presented higher numbers than Sudan Blanco.

Zoometric indices. In order to determine the body proportionality of OPC individuals, and at the same time their productive inclination, the relationship degree between some variables of the different body regions was estimated through the calculation of eight ethnological and seven functional indices. The descriptive statistics for such zoometric indices can be found in table 2.

The first ethnological index studied was ICR, according to which Sudan sheep have a dolichocranial appearance because the skull length predominates versus its breadth. The same analogy is valid for the ICE, but taking into account the LCB and ACB, an index that catalogs Sudan as dolichocephalic.

Based on ICM, the population format was determined as eumetric. According to the obtained values through the analyses of ITO, Sudan was classified as with a thorax of elliptical tendency and longilineal. In the same way, based on ICL, Sudan ewes were classified as longilineal due to their measures were higher than 88.

Through the IDR, it was observed that, on average, Sudan Bayo sheep presented a slight dorsal depression. Regarding IDP, the rump in both Sudan Bayo and Sudan Blanco ewes was higher than the dorsum, but Sudan Blanco presented a more horizontal back. As the last ethnological index IPV was calculated, it was obtained that Sudan sheep present a convex rump.

Getting ahead the functional indices, IPR pointed Sudan Bayo with deeper thorax than Sudan Blanco when compared each group with their length of legs. According to ICO, Sudan ewes were classified as brevilineal. The average IPT values of Sudan were below, but not far away, to what is considered as optimal for meat production while for IPL they presented numbers that are desirable in meat aptitude animals. IER showed regular values for meat production.

According to IMT, Sudan Blanco are slightly taller of legs and lighter than Sudan Bayo, proportionally talking, but well proportioned in both ways. IMT reflects an apparent good dairy functionality, as IDO does as well; this last index is typically used for dairy aptitude.

Table 1. Descriptive statistics values of the morphostructural variables in Sudan Bayo and Sudan Blanco OPC.

Morphostructural variables (cm)	Sudan sheep	AVR	SD	Max.	Min.
Body weight*	Bayo	40.8	5.71	58	27.5
	Blanco	40.57	8.13	56.5	27
Head Length	Bayo	20.4	1.05	23.1	16.4
	Blanco	20	0.86	22.2	18.5
Head Depth	Bayo	14.59	0.72	16.3	13
	Blanco	14.23	0.87	15.4	12.55
Cranial Length	Bayo	12.1	1.1	16.25	9.5
	Blanco	10.81	0.92	13.35	9.8
Face Length	Bayo	15.92	1.06	19	12.5
	Blanco	15.49	0.98	17.45	13.25
Head Width	Bayo	11.87	1.06	19.95	10.35
	Blanco	8.46	1.07	12.05	7.45
Cranial Width	Bayo	8.55	0.34	9.25	7.6
	Blanco	8.22	0.44	9.35	7.45
Ear Length	Bayo	11.79	0.87	14.1	9.55
	Blanco	11.68	1.01	13.75	9.95
Eye Length	Bayo	2.83	0.21	3.4	2.4
	Blanco	2.7	0.24	3.1	2.2
Withers Height	Bayo	67.21	2.95	77.7	59.1
	Blanco	67.72	4.32	76.7	60.1
Shoulder Height	Bayo	67.14	2.86	74.9	59.6
	Blanco	68.07	4.15	76	59.7
Sternum Height	Bayo	41.22	3.66	58.2	31.4
	Blanco	41.35	3.5	49	35.7
Rump Height	Bayo	68.29	2.68	77.2	62.5
	Blanco	68.54	3.52	74.7	61.3
Tail length	Bayo	60.37	3.19	71.6	54.4
	Blanco	59.59	4.36	69.5	50.1
Body Length	Bayo	74.73	4.07	86	63.3
	Blanco	72.36	4.98	82.5	63
Dorsal-sternal Diameter	Bayo	28.29	1.57	32	25
	Blanco	28.16	2.62	33.4	23.2
Shoulder Width	Bayo	14.84	1.32	17.65	10
	Blanco	14.94	2.11	18.4	10.2
Bicostal Diameter	Bayo	17.59	1.74	21.8	14.1
	Blanco	17	2.88	21.6	10.8
Rump Width	Bayo	16.52	1.25	19.9	13.8
	Blanco	15.44	1.75	19	12
Ischium Width	Bayo	6.26	0.83	8.2	4.3
	Blanco	6.32	0.69	8	5.1
Rump Length	Bayo	20.82	1.28	28	17.5
	Blanco	20.46	1.56	23	16.9
Thoracic Perimeter	Bayo	80.71	4.67	94	65.7
	Blanco	80.62	8.48	97.4	64.2
Tail Length	Bayo	33.02	3.79	41.7	22.6
	Blanco	33.28	6.7	43.5	16
Knee Perimeter	Bayo	12.6	0.69	14	10.7
	Blanco	11.98	0.85	13.4	10.2
Cannon Bone Perimeter	Bayo	7.46	0.43	8.75	6.1
	Blanco	7.19	0.57	8.2	5.9
Metatarsal Perimeter	Bayo	8.65	0.53	10.1	7.4
	Blanco	8.37	0.71	9.4	6.9
Fetlock Perimeter	Bayo	11.77	0.68	13.4	10.4
	Blanco	11.36	0.72	12.5	9.85
Pastern Perimeter	Bayo	10.28	0.66	11.8	8.9
	Blanco	10.03	0.76	11.8	8.5
Coronary-Band Perimeter	Bayo	15.61	0.98	18	13.2
	Blanco	15.5	1.1	17	13.4
Hock Perimeter	Bayo	17.09	0.92	19	15
	Blanco	16.55	1.28	18.7	13.6

*Unit of measure in kilograms; AVR = Average; SD = Standard Deviation; Max. = Maximum; Min. = Minimum.

Table 2. Descriptive statistics values of the zoometric indices in Sudan Bayo and Sudan Blanco OPC.

	Zoometric indices	Sudan sheep	AVR	SD	Max.	Min.
Ethnological Indices	Cranial Index	Bayo	71.11	5.71	82.35	52.62
		Blanco	76.39	5.91	87.62	64.04
	Cephalic Index	Bayo	58.27	5.41	97.32	48.86
		Blanco	42.31	5.08	58.78	37.16
	Body Index	Bayo	92.67	5.53	115.68	81.88
		Blanco	90.27	6.66	107.03	83.24
	Compactness Index	Bayo	60.6	7.42	80.67	40.5
		Blanco	59.4	9.89	77.29	42.08
	Chest Index	Bayo	62.18	5.11	73.61	52.78
		Blanco	60.16	7.19	73.97	44.81
	Shoulder-Withers height Index	Bayo	99.96	3.4	108.12	85.89
		Blanco	100.69	2.72	106.18	96.57
	Shoulder-Pelvic Height Index	Bayo	98.33	2.27	102.15	85.88
		Blanco	99.29	1.91	103.21	96.07
	Pelvic Index	Bayo	79.52	5.91	95	55
		Blanco	75.56	7.27	89.2	62.5
Functional Indices	Thorax Relative Depth Index	Bayo	42.11	2.14	47.14	37.11
		Blanco	41.59	2.4	45.79	36.15
	Relative Shortness Index	Bayo	90.15	5.43	107.27	75.29
		Blanco	93.5	4.49	103.23	87.1
	Transversal-Pelvic Index	Bayo	24.6	1.73	30.29	20.38
		Blanco	22.76	2.24	26.09	19.48
	Longitudinal Pelvic Index	Bayo	31	1.91	41.24	25.07
		Blanco	30.25	1.64	33.48	26.87
	Relative Thickness Index of the Metacarpus	Bayo	11.12	0.72	13.10	9.04
		Blanco	10.61	0.59	11.92	9.38
	Thoracic Metacarpal Index	Bayo	9.26	0.7	12.18	7.82
		Blanco	8.95	0.45	9.63	8.11
	Dactylocostal Index	Bayo	42.81	4.48	52.67	33.03
		Blanco	43.13	5.45	54.63	34.92

AVR = Average; SD = Standard Deviation; Max. = Maximum; Min. = Minimum.

DISCUSION

Morphostructural characterization. Regarding data gathered for PC in other studies conducted with OPC, Arredondo et al (4) found in females from Quindío and Valle del Cauca (34.4 kg) values that are below those found in Sudan ewes of the current study. Higher average numbers than those found in this study for LCB were reported in OPC with 27.5 cm (4) and Pelibuey Mexicano with 21.88 cm (13); the same analogy can be made for ACN of Pelibuey Mexicano females (11.17 cm; 13). For LCN, the opposite was found since Pelibuey Mexicano presented a lower value (6.53 cm; 13) than Sudan ewes. The morphostructural head variables are important from the ethnological point of view, due to these are not very influenced by environmental conditions; it is fundamental to take them into account for a breed standardization (14).

Respecting the trunk morphostructural variables concerning to heights, Biagiotti et al (15) reported in Santa Inés higher values than in Sudan ewes for ACR (71.35 cm) and AG (71.37 cm). On the other hand, lower mean heights were found in females of: Pelibuey mexicano (ACR = 65.18 and AG = 64.55 cm; 16), Katahdin (ACR = 67.14 and AG = 66.62 cm; 16), Dorper (ACR = 65.14 and AG = 64.98 cm; 16), and in OPC females from Sucre (AES = 35.1, AD = 63.6

and ANC = 59.1 cm; 7), Quindío and Valle del Cauca states (ACR = 63.3 and AG = 63.3 cm; 4).

Concerning the trunk morphometrical variables relative to rump, some studies with lower means to the ones found in the current research for LG were found in OPC (19.9 cm; 4), Pelibuey Mexicano (19.2 cm; 16), and Pelibuey Cubano sheep (20.27 cm; 17). Higher means than the current research mean for the AIL were reported in studies done with Katahdin (18.38 cm; 16), Dorper (19.02 cm; 16), and Pelibuey Mexicano (17.63 cm; 13).

About the other trunk zoometric measurements, Sudan PT was bigger than the PT of OPC females from Quindío and Valle del Cauca (79.2 cm; 4) and lower, but not very distant, than what was reported in OPC from Huila (82.7 cm; 6), Santa Inés (86.39 cm; 15), and Katahdin (84.85 cm; 16). A similar situation to the one before was found for DDE, AEN, and DB, in Pelibuey Mexicano (DDE = 31.16 and AEN = 16.98 cm; 13) and Canaria sheep (DDE = 33.77 and DB = 25.23 cm; 18).

The morphometrical trunk variables are very important in the morphostructural evaluation; in this region, meat selection criteria are applied. The trunk features condition the first meat production impression of the individual, which is based in the compactness grade, bulky of the trunk, depth and arched of the ribs, rump length and width, degree of muscular development of the rump, and the buttock profile. These aspects influence from the carcass yield to the digestive, respiratory, and reproductive capacity (14).

In regard to the limbs, higher numbers than those found in the current study for PMC were found in Pelibuey Mexicano (8.74 cm; 16), Katahdin (9.69 cm; 16), Dorper (9.82 cm; 16), and Canaria sheep (8.01 cm; 18). On the other hand, in OPC (7.3 cm; 4) and Black Belly ewes (7.4 cm; 19) were reported higher means than in Sudan Blanco, but lower than in Sudan Bayo sheep.

Herrera and Luque (14) expose that through the PMC, the productive inclination can be determined since the bigger the thickness of the individual, the greater the weight. Thus, there would exist more tendency towards a meat-producing aptitude.

Zoometric indices. Ethnological indices are related to the breed classification of animals. Based on the data of this section, it is obtained that:

For ICE, it was found in OPC females from Sucre a mean of 43.5 (7), value that is higher than the one obtained in Sudan Blanco results, but that is below of the Sudan Bayo sheep mean. Conversely, in OPC from Quindío and Valle del Cauca the ICE was considerably lower than that found in this research (36.21; 4).

The ITO average suggested that Sudan ewes were longilineal (stretched, narrow, and elongated; ≤85) as Canaria sheep (73.96; 18). Creole sheep from western Formoseño in Argentina presented a mean of 186.15 (20), value that classifies this population as brevilineal (shortened, wide, and thick individuals ≥ 89). Contrary to the current research, Arredondo et al (4) classified the OPC of their study as brevilineal based on ICL (81.60), because they found a mean lower to 86 for this index.

It should be noticed that Arredondo et al (4) objectively determined that the degree of back horizontality of their OPC gave rise to a straight or horizontal dorsal line. However, what was found in that study does not match with what was determined in this research, where a lumbar back line ascended towards the rump, which is typical of animals with poor selection like Sudan OPC sheep. This condition has an undesirable impact on meat aptitude animals, because the external iliac tuberosities raise and contribute to a greater inclination of the pelvis, thus producing a shortening of the semitendinosus and semimembranosus muscles (14).

Values below 100 for IPV are typical of convex rumps, which means that the length predominates over the width, as it happened with Sudan ewes evaluated in this research. The same condition was reported in rumps of OPC (75.9; 7) and Araucana sheep (81.08; 11). The pelvic index is relevant because it guides the structure of the rump and is related to the reproductive capacity of the breed.

Through the functional indices, it is diagnosed the productive aptitude of an animal population, obtaining in this study that:

In the IPR, the values obtained for the Sudan were below 50, values above that number are desirable for meat production; an average higher than 50 was found in the Canaria breed (53.2; 18). In OPC from Quindío and Valle del Cauca

(46.16; 4) a value higher than that estimated in the Sudan ewes was determined. In creole Araucanas sheep an index of 40.23 (11) was found, lower to all those mentioned before.

Through the ICO, Sudan can be cataloged as brevilineal because they present values below 95. However, these results are not concordant with the ones obtained in ITO and ICL, due to the type of morphostructural variables used to estimate these indices, which are different. Hence, the correct interpretation of this result is: despite in ethnological terms, Sudan OPC have a thorax (ITO) which tends to be stretched, narrow, and elongated (longilineal), as well as its trunk (ICL), these animals from the functional point of view and in terms of body appearance in a general way (ICO) tend to get closer to a rectangle, predominant form in meat-producing aptitude animals (brevilineal).

Another important aspect to highlight is that when the authors analyzed ITO, ICL, and ICO, going beyond the arithmetic average of the population in general, it was found that in Sudan Bayo the 9.3 (ICL) or 88.51% (ICO) of ewes are brevilineal, the 18.6 (ICL) or 10.34% (ICO) are mediolineal, and the 100 (ITO), 72.09 (ICL), or 1.15% (ICO) are longilineal. Similar behavior was appreciated in the Sudan Blanco sheep, where 39.13 (ICL) or 68.18% (ICO) were brevilineal, 21.74 (ICL) or 31.82% (ICO) mediolineal, and the 100 (ITO) or 39.13% (ICL) longilineal. Here it can be appreciated that independently of the estimated index, it is possible to find in Sudan OPC through the same index individuals that can be classified in different categories of the baronian systematics.

Thus, it is recommended that before concluding from a populational average a classification based on the baronian systematic, first it is necessary to determine the percentage of animals that are longilineal, brevilinal or mediolineal.

Moreno et al (7), Angel and Ramirez (6), and Arredondo et al (4) agree to conclude that OPC are of brevilineal appearance. The authors of the present study agree with this conclusion in general terms, especially because a functional index determines this brevilineal condition, that is to say from a productive perspective.

For IPT, Canaria sheep from Spain got a higher mean (28.28; 18) compared to Sudan ewes, like the Araucan sheep from Chile (29.55; 11). Nevertheless, all these populations have numbers below the minimum desirable value for meat production (33); thus, it can be deduced that the AIL of these sheep does not reach the third part of ACR.

Respecting the IPL, Sudan ewes presented values below 37. Numbers below 37 are considered desirable for meat production. A lower mean was found in other OPC sheep (IPL = 29.6; 7).

The IMT is a motor aptitude index and is responsible for indicating the relationship between body volume and bones, which suggests that Sudan ewes do not have problems of overload in the aplomb. In addition, it reaffirms that these OPC are of eumetric tendency, as Moreno et al (7) concluded in OPC; nevertheless, Angel and Ramirez (6) and Arredondo et al (4) classified OPC sheep as ellipometric.

Finally, the IDO is an index of dairy aptitude that relates the body mass with the strength of the limbs; values between 40-45 indicate a good functionality for this aptitude. The results obtained in Sudan ewes are inside this range, and a lower mean for IDO was found in Canaria sheep (31.59; 18).

The authors do not consider that the results obtained in Sudan sheep suggest a tendency towards milk-producing aptitude, what occurs is that the indices involved with this aptitude are estimated based on the PMC, starting from the referent that animals with thin metacarpus are of milk-producing tendency (14). Although it is true that there is a relationship between thin PMC and milk-producing aptitude, creole populations develop a metacarpus that is not thick due to adaptability issues. This enables the appreciation of values suggesting an apparent milk aptitude that does not necessarily imply a true inclination towards that mentioned production.

The differences found in Sudan sheep at the level of the variables and indices with respect to the other breeds discussed, are essentially attributed to the influence of management, climatological, and genetic factors. The first aspect is a short-term event, and the second is of greater relevance in evolutionary processes while the last refers to the genetic component of other breeds. Regarding this last, animals of other studies were generally of different breeds than OPC and influenced by animal breeding plans, which usually puts foreign breeds at an advantage, with respect to its morphostructural potential. In relation to the differences found

when comparing with other OPC populations, they were not mostly marked and are mainly explained by management and environmental conditions, which, although similar, were unequal.

It should be noticed that Sudan ewes have presented results relatively good for meat production if compared with other woolless breeds more widespread or improved. This is reflected in that more than 40% of these OPC are above the mean found for the body weight of Pelibuey Mexicano females (41.13 kg; 16) and, in higher percentage, above the average of the body weight of Pelibuey Cubano (35.78 kg; 17) and Black Belly sheep (35.4 kg; 19).

Finally, it can be concluded based on what was found, that Sudan sheep are characterized for being: dolichocranial, dolichocephalic, of convex rumps, of an ascending dorsolumbar line towards the rump with depression at dorsal level in part of the Sudan Bayo, of harmonic body volume regarding the bone system, of middle limbs for both thickness and length, of eumetric format and a weight around 40 kg, for being of bigger size Sudan Bayo than Sudan Blanco, for being longilineal animals from the ethnological indices, but functionally brevilineal, as well as functionally they are characterized by presenting a moderate trend towards meat aptitude.

The exposed before is important because apart from giving an update of the current morphostructural status of Sudan, it is the first publication that covers the productive inclination of these OPC specifically. Aspects that will be in function of contributing to consummate a definition of the breed status of Sudan, which in turn will encourage producers to breed and improve these OPC, as well as the interest of different parts in conducting more research about this, finally leading to the promotion and conservation of this animal genetic resource, which is threatened by uncontrolled hybridization of its genetic material with foreign breeds. It is suggested to carry out future studies regarding morphology with a larger population sample, to corroborate and complement the obtained results.

Conflict of interests

The authors of the current study declare that there is no conflict of interest with the publication of this paper.

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