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Validation of the Kinovea® software program for obtaining zoometric measurements in swine: Comparison with traditional methods

Validación del programa informático Kinovea® para la obtención de medidas zoométricas en cerdos: Comparación con métodos tradicionales

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Abstract

Zoometry has proven to be a valuable tool for differentiating individuals within and between populations. The objective of this study was to validate the use of the Kinovea® V2023.1.1 (KV) software to obtain zoometric measurements. 50 crossbred swines (Duroc x Landrace x Yorkshire) aged over eight months were used, seven morphometric variables were measured with three stick zoometers and photographs were taken in the lateral plane to evaluate the morphometric measurements in KV and the rear elevation was used a cross as a reference measurement to calibrate the KV. The independent Student's T test was applied and no significant difference (P>0.05) was found between the two methods. The results of manual measurements by stickzoometers were: height at the withers 75.9 ± 4.85 cm, rump 81.14 ± 5.25 cm and tail rise 73.2 ± 5.35 cm; longitudinal diameters 106.9 ± 8.44 cm and sternal dorsum 42.7 ± 4.07 cm; head lengths 31.38 ± 3.69 cm and rump 34.66 ± 4.08 cm. The results of measurements obtained with KV were similar: height at withers 75.9 ± 4.85 cm, rump 82.24 ± 6.11 cm, tail rise 74.50 ± 6.26 cm; longitudinal diameters 108.87 ± 11.46 cm and sternal dorsum 44.07 ± 4.78 cm; head lengths 31.00 ± 5.10 cm and rump 34.89 ± 3.87 cm. It is concluded that the use of Kinovea® is feasible to obtain body measurements in pigs without resorting to invasive methods that cause stress to the animal.

Keywords: biometry; photogrammetry; biomechanics; animal science; calibration.

Resumen

La zoometría ha demostrado ser una herramienta valiosa para diferenciar individuos tanto dentro como entre poblaciones. El objetivo de este estudio fue validar el uso del programa informático Kinovea® V2023.1.1 (KV) para obtener medidas zoométricas. Se utilizaron 50 cerdas mestizas (Duroc x Landrace x Yorkshire) con más de ocho meses de edad, se midieron siete variables morfométricas con tres zoómetros de bastón, se tomaron fotografías en plano lateral para evaluar las medidas morfométricas en KV y se utilizó la alzada a la cruz como medida de referencia para calibrar el KV. Se aplicó la prueba T de Student independiente y no se encontró diferencia significativa (P>0,05) entre los dos métodos utilizados. Los resultados de medidas manuales por zoómetros de bastón fueron: alzada a la cruz 75,9 ± 4,85 cm, grupa 81,14 ± 5,25 cm y nacimiento de cola 73,2 ± 5,35 cm; diámetros longitudinales 106,9 ± 8,44 cm y dorso esternal 42,7 ± 4,07 cm; longitud de la cabeza 31,38 ± 3,69 cm y grupa 34,66 ± 4,08 cm. Los resultados de medidas obtenidas con KV fueron similares: alzada a la cruz 75,9 ± 4,85 cm, grupa 82,24 ± 6,11 cm, nacimiento de cola 74,50 ± 6,26 cm; diámetros longitudinales 108,87 ± 11,46 cm y dorso esternal 44,07 ± 4,78 cm; longitud de la cabeza 31,00 ± 5,10 cm y grupa 34,89 ± 3,87 cm. Se concluye que el uso de Kinovea® es factible para la obtención de medidas corporales en cerdos sin recurrir a métodos invasivos y que provoquen estrés al animal.

Palabras clave: biometría; fotogrametría; biomecánica; zootécnia; calibración.

Introduction

Pigs (*Sus scrofa domesticus*) play an importan role in livestock production. According to the National Institute of Surveys and Statistics (INEC, 2024), in Ecuador, in 2023, the swine population was estimated to be 983,999, distributed along the country's regions, with 67.89% of the population in the Andean region, 28.54% in the Coastal region, and 3.57% in the Amazon region. The province of Manabí is first in production in the Coastal region and third in the country, with 9.61% of total national production, after the provinces of Santo Domingo, with 17.74%, and Imbabura with 12.41%, respectively.

Pork zoometrics is a brand of animal science that studies the measurement of different body parts of pigs. These measurements can be qualitative or quantitative, and from this data, different zoometric indicators can be obtained (Armijos-Tituana et al., 2022; Estrada-León et al., 2023). For this reason, the morphomoetric characterization of swines is crucial for the preservation of zoogenetic resources, because the data that is obtained from the characteristics of a population allows to differentiate it from others, highlighting the specific values that make the population unique (Olmedo et al., 2021).

Traditionally, the animal body measurements are done manually using diverse instruments, one of these is the stick zoometer, which, despite its easy use, the forced contact with animals is not free from complications, risks and inconveniences (Ribas et al., 2023). These challanges include the risk of injuries for workers and animals because of the contact with retention structures, the stress induced by the evaluated animal and the measurement erros due to constant movement from (Salamanca-Carreño et al., 2022).

On the other hand, the studies carried out Contino-Esquijerosa et al. (2017) and Hernández et al. (2020) emphasized the technological advances that have revolutionized the field of health and well-being of animals, obtained from accurate diagnoses and innovative therapies, with the application of software, with which is possible to evaluate animal characteristics, allowing to measure distances, angles, coordinates and space-time parameters.

In recent years, many studies have corroborated the photogrametric techniques, which have provided accurate data compared to the object or context of study; Salazar-Vidal et al. (2012) mentioned the use of the PhotoModeler® software on horses, which allowed for accurate high quality measurements; on the other hand, Torres-Pérez et al. (2016) used the TEMA® software with videogrammetry, which required to purchase a licence to use. Likewise, Gaudioso et al. (2014) highlighted that these techniques allowed for more accurate measurements in less times and to store data for future measurements, which improved the reliability of zoometrics. Moreover, the offered operational and economical advantages, and reduced the stress in animals during the measurements.

According to Torres-Pérez et al. (2016) the Kinovea® V2023.1.1 (KV), is an open-access, open source app, used for gesture analysis and sport techniques, employed mostly by sport trainers, and in the case of animals, it has been used to explore, quantify and analyze morphometry, biomechanics, and locomotion. Therefore, the application of photogrammetry is a tool that helps to obtain morphometric measure in any animal species without pressuring the animal for too long and avoid stressing them. Based on the previous exposition, the objective of this study was to evaluate the effectivness of the KV software for obtaining zoometric data from swine.

Materials and methods

The study was carried out at two pork farms in the Bolivar municipality, province of Manabi: the first one, the Unidad de Docencia, Investigación y Vinculación, Hato Porcino in the Escuela Superior Politécnica Agropecuaria de Manabí Manuel Félix López, located at El Limón sector, Calceta parish, at the coordinates 00°49'27.9" S 80°10'47.2" O, at 15 masl, wherein 35 animals were tested; the second one, the "Nueva York" farm, located in the Quiroga parish, coordinates 0°46'50" S and 80°8'59" O, at 100 masl, where the remaining 15 animals were tested. All the pigs were Duroc x Landrace x Yorkshire crossbreeds, aged over 8 months old.

The study was experimental and quantitative. There were different zoometric stick made of alluminum, hand-made, and of different sizes: 2.00 m (long stick), 1.20 m (medium-sized stick) and 0.80 m (short stick). The chosen animals were restrained with a metal rope to control their constant movement and improve their posture. They were stood on a cement floor to avoid variations in the position and distortion while being measured and photographed. Once the animal was relaxed, it was subjected to morphometric measures with the zoometric stick, and photos were taken from the side with a Nikon D3300® camera for high resolution photos, on a 50 cm tripod over a cement floor, at a distance of 2 m from the animal in an illuminated space.

A single sheet was registered, the seven morphometric variables, the same that were defined by Arredondo et al. (2021) and Esmeraldas et al. (2023) and, classified according to which zoometric stick was used.

With the short zoomometer, the length of the rump (LGR) was measured, the distance between the tip of the hip and the tip of

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the buttock (external iliac tuberosities); and the length of the head (LCZ) from the external occipital protuberance to the tip of the snout; with the medium zoomometer, the height at the withers (ALC) was measured, the vertical distance from the ground to the highest point of the animal's withers; height at rump (ALG) was measured, the vertical distance from the ground to the point where the loin region joins the rump (external iliac tuberosity); height at base to tail (ANC) was measured, the distance between the ground and the base of the tail implantation; dorsal-sternal diameter (DSD) distance between the point of greatest decline of the cross and the greatest point of curvature of the sternum, and finally with the long zoometer the longitudinal diameter (LD) distance from the scapulohumeral joint to the tip of the buttock was measured.

After the measurements were manually taken and the animals were photographed from the side, the data from the zoometers was tabulated and processed on an Excel 2016 sheet. In tandem, the photopraghs were exported to the KV software, which was calibrated considering the LH values of each animal; this value was chosen because it is a highly stable morphological value compred to other corporal measurements, and it is useful to distinguished between different swine species (Revidatti, 2009; Sañudo, 2009). Following the calibration, the anatomical points were located on the photograph and the distance between them was measured according to each morphological variable; this data set was also tabulated on an Excel sheet, to compare them to the manual measurements.

The mean, standard deviation, maximum and minimum values, and variation coefficient were calculated for each variable, the assumptions of normality with the Shapiro-Wilks test and homogeneity of variances with the Levenne test. However, although some variables did not meet at least one of the assumptions, the Student's t-test for independent samples was applied, considering Zimmerman's explanation (1998) who pointed out that the non-parametric methods do not always constitute acceptable substitutes of parametric methods like the Student T test, when the do not satisfy the parametric assumptions. The data was analyzed using the InfoStat sofware (2020).

Results and discussion

The age average for female specimens was 13.5 ± 5.18, which presented variations between 6.39 y 11.29% for the manual measurements and 6.39 y 12.88% for KV, showing an uniform degree of uniformity between variables. It was considered that, if the populations showed a coefficient of variation (CV) lower than 5%, the variability was low, which suggested a high homogeneity in the population; if the CV laid between 5 and 15%, the variability was moderate; and, if the CV was higher than 15%, the variability was high (Salamanca-Carreño et al., 2022).

Table 1. Value description and coefficient of variation.

Variable	Manual					Kinovea®					P-value
	Average (cm)	D E (cm)	C V (%)	Min (cm)	Max (cm)	Average (cm)	D E (cm)	C V (%)	Min (cm)	Max (cm)	
HW	75.90	4.85	6.39	65.00	85.00	75.90	4.85	6.39	65.00	85.00	-
	81.54	5.87	7.20	68.00	95.00	83.74	6.91	8.26	69.57	97.78	0.0902
ANC	73.30	5.10	6.96	64.00	82.00	75.30	6.32	8.39	61.89	85.05	0.0895
DL	106.90	8.44	7.90	87.00	125.00	108.87	11.46	10.53	86.49	131.89	0.3300
DDE	42.70	4.07	9.54	35.00	52.00	44.08	4.78	10.85	31.48	55.09	0.1236
LCZ	31.38	3.69	11.76	25.00	42.00	31.00	5.10	16.44	20.64	44.72	0.6744
LGR	34.66	4.08	11.77	26.00	43.00	34.89	3.87	11.09	26.22	46.94	0.7715

Abbreviations: ALC= height at withers; ALG= height at rump; ANC= height at base of tail; DL= longitudinal diameter; DDE= diameter of the back-sternal; LCZ= length of the head; LGR= length of the rump; SD= standard deviation; CV= coefficient of variation; Min= minimum value; Max= maximum value; P-value= probability value.

The highest variation was found in the LH and the LC variables for both kind of measurements, and a similar behavior was found in a study carried out on locally-produced swine in the province of Loja (Armijos-Tituana et al., 2022) and it was observed that these variables showed higher variation in comaprison with other zoometric measurements. This variation might be caused by the racial proportion of the animals, because the distance between anatomical points in each race were unique, thus, the morphometric characteristics were expressed according to the shape and size of the mixed.

It was observed that when comparing the averages of each variables, between both types of measuremens, there were no significant differences (P>0.05), and they did not provide significant data to deny a null hypothesis, in which it was assumed that the manual and KV measurements were the same. These results were analogous to the study by Salazar-Vidal et al. (2012) which demonstrated that the use of this photo-analysis software offered accurate and reliable measurements of animal morphology, with little error in comparison with the manual measurements.

In this study, the average for the height from the rump was 75.90 ± 4.85 cm, comparable, though higher, to the reported by Hernández et al. (2020) for the Yucatán hairless mexican swine, with 59.57 cm for females. The LC was the referential variable to calibrate the KV. The manual measurements for the croup length was 81.14 ± 5.25 while the KV® measurements were slightly higher at 82.42 ± 6.11 cm compared to previous studies, Arredondo et al. (2021) reported an average of 61.3 cm for the colombian swine; Escobar (2012) found 35.1 cm for the locally produced ecuadorian swine and Jáuregui-Jiménez (2017) obtained 50.8 cm for the guatemalan swine.

Manual measurements of the height at the base of the tail showed an average of 73.2 ± 5.35 cm and with KV the average was 74.56 ± 6.22 cm; these results are slightly higher than those reported by

Anchundia (2023) in the municipalities of Bolívar and Junín, an average of 58.33 ± 5.68 cm. The longitudinal diameter in the pigs studied showed an average of 109.8 ± 4.47 cm with a range of 87 cm to 125 cm. The measurements obtained from KV® showed a relatively higher average of de 110.84 ± 4.89 cm and a range of 86.49 cm to131.89 cm. These results were lower than those obtained by Montenegro (2012) for Pampa Rocha swines from Uruguay, with an average of 99 cm for males and 102 cm for females.

The result of the dorsum-sternum diameter obtained manually had an average of 42.7 ± 4.07 cm while with KV the average was 43.45 ± 4.49 cm, values that are higher than those reported for New Guinea pigs by Hernández-Baca et al. (2017) who showed values between 37.84 cm and 30.13 cm and those indicated by Jáuregui-Jiménez (2017) for Guatemalan pigs which were 23 cm in males and 24 cm in females. For head length, manual measurements in females were 31.33 ± 3.69 cm and with KV 31.50 ± 3.10 cm, values that approach 32.0 cm, close to that reported by Hurtado et al. (2005) for the Venezuelan Creole pig.

The manually measured rump length presented a mean of 34.66 cm ± 4.08 with a range of 26 cm to 46 cm, while the KV measurements indicated a slightly higher mean of 34.89 ± 3.87 cm and a range of 22.6 cm to 46.94 cm; these results were consistent with the data of Estupiñán-Véliz et al., (2009) who reported an average of 30.08 ± 3.12 cm in Creole pigs from Ecuador. Vargas-Burgos et al. (2016) suggested that the observed differences could be related to genetic and environmental variability. Salazar-Vidal et al. (2012) concluded that traditional zoometric techniques were subject to a high level of error due to the difficulty in handling the tools on the sampled animals.

CONCLUSION

Measurements performed manually and with KV are similar, confirming that the use of the photogrammetric method can effectively replace manual tools, avoiding stressing the animal, highlighting its practicality and reliability in zoometric measurements in pigs. Future research should focus on automating the acquisition of measurements and comparing results with more advanced methods. This would not only validate current results, but would also open new possibilities for the use of accessible technologies in livestock farming.

CONFLICT OF INTEREST

The authors declare that they have no conflicts of interest in this publication at any stage.

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Declaration of contribution according to CRediT

Andreina Monserrate Cedeño-Muñoz: methodology, research, formal analysis, original draft-writing**,** drafting-review and editing. **Arianna Abigail Rivera-González:** formal analysis, original draft-writing, drafting-review and editing**. Carlos Octavio Larrea-Izurieta:** conceptualization, formal analysis, methodology, research, original drafting, drafting-revi and editing.