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Presence or Absence of Earlobes Reveals Different Biometric Structure among the *Peluca* Hen from Guatemala

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Authors' contributions

This work was carried out in collaboration between both authors. Both authors interpreted the data, critically revised the manuscript for important intellectual contents and approved the final version.

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ABSTRACT

Background and Objective: Earlobe, a head furnishing trait, is a non-putative trait in *Peluca* hen ("naked-necked" hen), a local breed from Guatemala. The objective of this study is to determine if presence or absence of earlobe is linked to a body linear trait.
Materials and Methods: Quantitative data collected on 311 mature hens belonging to *Peluca* breed were subjected to analyses for two different phenotypic subsets according to presence/absence of earlobes (212 with earlobes and 99 without earlobes). Measured morphometric traits were 18: Weight, Perimeter, Length, Width and Height of Body, Wing Length, Leg Length, Lengths of Head, Beak and Face, Length and Width of Shank, Metatarsal Perimeter, Dorso-sternal Height, Bicostal Length, Withers Height, and Thoracic and Abdominal Perimeters. A Principal Component Analysis was applied to the study of variable between both groups to explore the relationship between traits.
Results: body length and height, and abdominal and thoracic perimeters were the most discriminative traits between groups. "Non-lobe" group presented significative higher values only for body length.

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Conclusion: Presence/absence of earlobes describe a different body structure within the *Peluca* hen. Moreover, as this represents no adaptative response, presence or absence of earlobe must be considered to be more related to the productive aptitude rather than different ecotypes. This association of earlobe with some body traits is important since it can ease the task of selecting productive characteristics of the "Peluca" hen.

Keywords: Biotype; body linear measurement; body weight; creole; local breeds.

1. INTRODUCTION

Morphometry can be used to develop breeding strategies via optimization of body traits to achieve maximum performances and economic returns [1,2,3]. Body measurements, which give significant information on morphologic structure and development ability of animals, are influential factors on determining animals that are appropriate for the desired efficiency [1,2,3]. The phenotypic information can serve also as a basis for designing appropriate conservation, breeding and selection strategies [4]. In this regard, several authors point out that the use of multivariate analysis tools can be especially useful for describing local animal populations, allowing them to be managed as specific genetic resources [1,2,5].

South and Mesoamerican livestock are still largely in the hand of smallholders. Native chickens possess several valuable characters that are not found in exotic (commercial) chickens and are totally appropriate for traditional low input-low output traditional farming systems. The genetic resource base of indigenous chicken in Mesoamerican countries is rich and form the basis for genetic improvement and development of locally adapted breeds [6,7]. Characterization of these indigenous animal resources is a necessary pre-requisite for indigenous breed development and improvement of rural poultry [1,8,3]. Non artificial selection of traits in villages has been provided a unique and powerful resource for phenetic diversity [7], such diversity being important to survive in resource-limited production systems with hostile environmental settings [9,10]. So native breeds provide a unique food resource to respond to the present and future needs of livestock production in low-input countries [9,10]. In this sense, the costs and poor adaptation associated to exotic chicken has been a fortunate barrier for their introduction into the rural production.

Local chicken breeds are very important because of many valuable characteristics such as diseases resistance, production in harsh environment, ability to use low quality forage and cultural values [1,2,5]. So, without plans to improve and strengthen the current conservation activities, there could be risk of extinction leading to total loss of this genetic material. Guatemala is characterized by the coexistence of two production systems: rudimentary village poultry and industrial poultry at its infancy, the latter facing scarcity of inputs to fully be exploited.

This study was conducted to measure body weight and morphometric traits of *Peluca* hen ("naked-necked" hen), a native population from Guatemala [11] which is not recognized officially, although many researches has been done on it [5]. *Peluca* hen is characterized by a very variable phenotypic landscape, showing striking morphological variations in plumage colour and pattern, comb shape, earlobe presence, skin and wattles colour, etc. [11,5], although she is always naturally devoid of feathers on its neck and vent. *Peluca* presents both and 'Asiatic' conformation as 'Mediterranean' features [11]. Mallia [11] offers an exhaustive description of this hen and the management system. Normally chicken of different types subsist on scavenging and mating is uncontrolled and random [11]. Animals are good scavengers as well as foragers, have good maternal qualities, and are hardier when compared to the exotic breeds, having also high survival rates with minimal care and attention [11].

Peluca breed has a high potential for improving the standard of living and the nutritional needs among the rural Guatemala habitants. This rural poultry in the area of study represents a promising extensive or scavenging management system. Hence determining the knowledge of body measurements may have an interest in improving breed knowledge appropriately. The earlobe is a feather-bared structure on the skin of the face just below the ear, the outline of which is marked by a slight thickening of the tissues [12]. As a part of skin structure on the face without feathers and below the ear, earlobe is a conspicuous trait [13]. In any case, plumage patterns (with at least 8 different colour patterns) have not been considered, as we think that their selection are interesting only for poultry fanciers and so merely linked to mere ring competitions.

The objective of this study is to determine if presence or absence of earlobe are correlated to body linear traits. Understanding the relationship among traits is very important since traits are able to influence the preference of the consumers and market price as well [14]. The information to be gained in the study will be especially helpful in planning future breeding programs and conservation strategies of prospective local chicken biotypes, especially addressed to local communities.

2. MATERIALS AND METHODS

2.1 Sampling Procedure

Data collection was carried out during 2019 in different indigenous communities from Jocotán, Camotán, San Juan Ermita and Olopa municipalities, in the Mayan Ch'orti region in Chiquimula, Southeastern Guatemala. Purposive sampling was used to select wards and villages with large numbers of local chickens based on the information. A final sample of 311 mature females (212 with earlobes and 99 without earlobes) was studied. Presence or absence of earlobe was assessed visually and registered.

2.2 Data Collection

Measures of live weight and morphometric traits were taken using a weighing scale and a measuring tape. The measured morphometric traits were 18, some of them of economic importance: Weight (BOW), Perimeter (BOPE), Length (BOL), Width (BOWD) and Height (BOH) of body, Wing Length (WIL), Leg Length (LEL), Lengths of Head (HDL), Beak (BEL) and Face (FAL), Length (SHL) and Width (SHW) of Shank, Metatarsal Perimeter (MTP), Dorso-Sternal Height (DEH), Bicostal Length (BIL), Withers Height (WIH), and Thoracic (THP) and Abdominal Perimeters (ABP), following common biometrical procedures described in detail in previous works [15,16,3]. Data were taken using a plastic rule, calliper and flexible to measure linear traits whereas a weighing scale was used to determine live body weight. Data are available upon request to first author.

2.3 Statistical Analysis

One-way Non-Parametric Multivariate Analysis of Variance (NPMANOVA) using Mahalanobis distances (Bonferroni p-corrected values) was applied for multivariate comparison, while Mann-Whitney *U* test was used for univariate comparison. A between-groups Principal Component Analysis (PCA) from var-covar matrix were conducted. PCA is a multivariate technique used mainly to reduce the dimensionality of data and to explore the relationship between traits in a dataset. This analysis aimed to find a way to condense (summarize) the information contained in several original variables into a smaller set of new composite dimensions or variants with a minimum loss of information. Statistical procedures were done with software PAST v. 2.17c [17] with the significance level established at 0.05.

3. RESULTS AND DISCUSSION

One-way NPMANOVA reflected highly significative statistical differences between two groups (F=4.151, *p*=0.0001). They indicate the existence of two subsets within the *Peluca* population, with some different architectural patterns between lobed and non-lobed animals.

In PCA, first two Principal Components explained a 60.2% of the total observed variance (Fig. 1 and Table 1). As there appeared only positive

Table 1. Eigenvalues for principal components (PC) in the principal component analysis from var-covar matrix in a sampling of 311 females (212 with earlobes and 99 without earlobes)

PC	Eigenvalue	% variance	% cumulative variance
1	30.3379	36.7440	36.7440
2	19.3420	23.4260	60.1700
3	11.6210	14.0750	74.2450
4	5.7301	6.9401	81.1851
5	4.5161	5.4698	86.6549
6	2.7103	3.2826	89.9375
7	2.3149	2.8038	92.7413
8	1.7620	2.1341	94.8754
9	1.1359	1.3758	96.2512
10	0.9852	1.1932	97.4444
11	0.6997	0.8475	98.2919
12	0.5329	0.6454	98.9373
13	0.3212	0.3890	99.3264
14	0.2109	0.2554	99.5818
15	0.1645	0.1993	99.7811
16	0.0714	0.0865	99.8675
17	0.0656	0.0794	99.9469
18	0.0431	0.0522	99.9991

loadings (Fig. 2) traits are referred to size. Most discriminative traits were Body Length (BOL) and Height (BOH), and Abdominal (ABP) and Thoracic (THP) Perimeters (Table 2), which jointly differentiated both groups (F=5.06, *p*=0.0005).

Separately, only thoracic perimeter showed no statistical differences (*U*=9818, *p*=0.357) (Fig. 3). Thus, body length, body height and abdominal perimeter represent a different potential selection criterium considered separately (Table 3), the two later being higher in eared group. Thus, it would be possible that presence/absence of earlobes describe different morphologies within the in the *Peluca* hen. Traits can be considered not to be adaptive, so it is possible to select different bodied animals according to presence/absence of earlobes, which can be clearly seen, and not using empirical points. As management is always identical for all animals (keepers do not play attention to this character) it can be supposed we cannot differentiate two different biotypes. The association among characters is important since it eases the task of describing the phenotypic characteristics of selection groups in particular combinations [14].

Table 2. Loadings for two first principal components, which explained a 60.2% of the total observed variance. Most discriminate traits (>[0.3]) appear in bold. Most discriminative traits were Body Length (BOL) and Height (BOH), and Abdominal (ABP) and Thoracic (THP) Perimeters

	PC1	PC2
ABP	0.3631	0.6646
BeL	0.0202	0.0133
BIL	0.0652	0.1176
BoH	0.3604	0.0371
BoL	0.6224	-0.6462
BoP	0.2510	0.0979
BoW	0.0392	0.0535
DEH	0.0525	0.0522
FAL	0.0581	0.0102
HdL	0.0476	0.0118
HdW	0.0272	-0.0063
LeL	0.1254	-0.0389
MTP	0.0479	0.0207
SHL	0.0979	-0.0089
SHW	0.0196	0.0897
ThP	**0.3137**	0.2635
WIH	0.2966	0.1585
WIL	0.2411	-0.0726

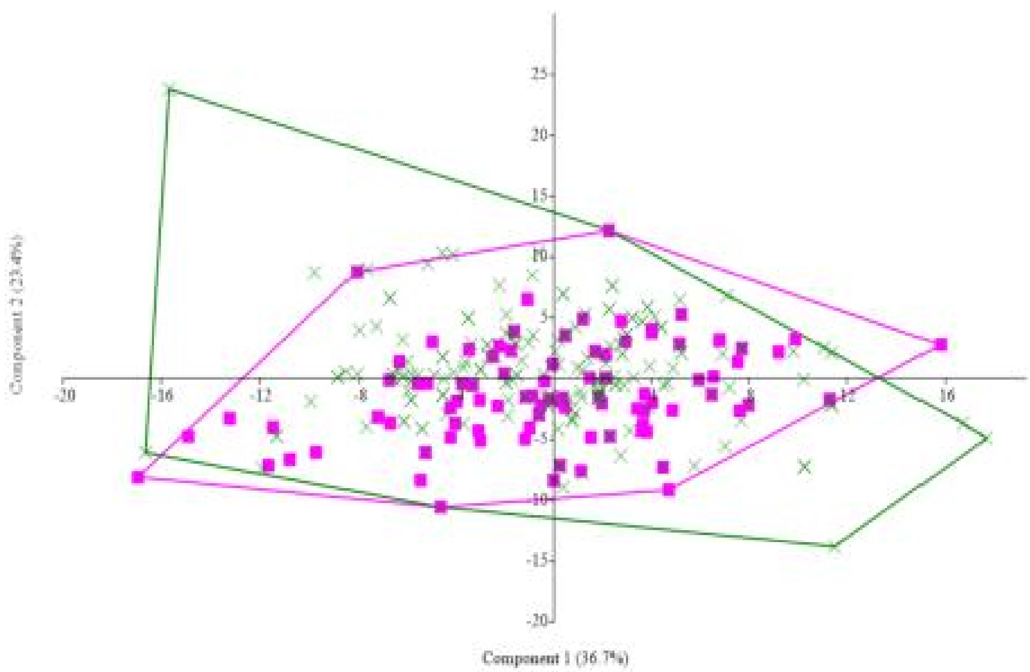

Fig. 1. Principal component analysis from var-covar matrix in a sampling of 311 females (212 with earlobes x and 99 without earlobes ■ of *Peluca* hens. First two principal components explained a 60.2% of the total observed variance

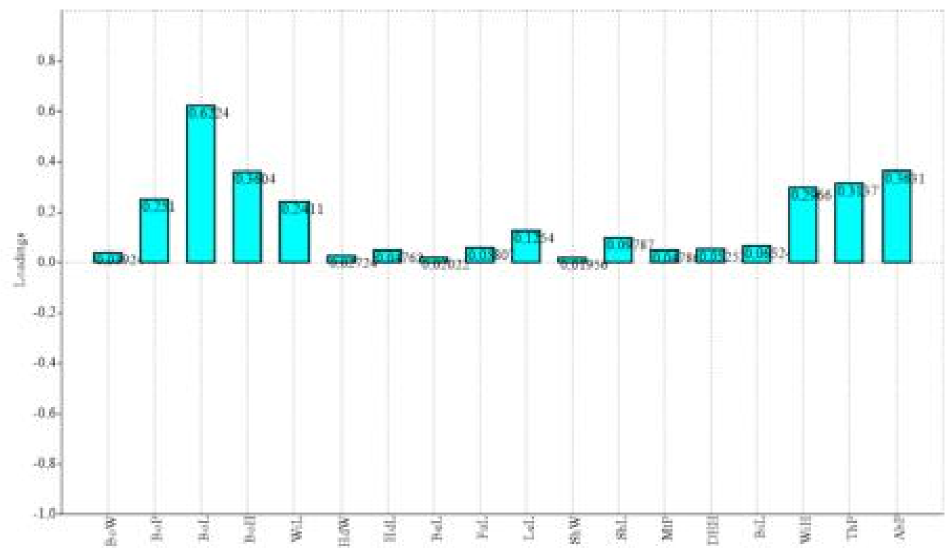

Fig. 2. Loadings for Principal Component 1 which explained a 36.7% of the total observed variance. The measured morphometric traits were 18: Weight (BOW), Perimeter (BOPE), Length (BOL), Width (BOWD) and Height (BOH) of body, Wing Length (WIL), Leg Length (LEL), Lengths of Head (HDL), Beak (BEL) and Face (FAL), Length (SHL) and Width (SHW) of Shank, Metatarsal Perimeter (MTP), Dorso-Sternal Height (DEH), Bicostal Length (BIL), Withers Height (WIH), and Thoracic (THP) and Abdominal Perimeters (ABP). Most discriminative traits were Body Length (BOL) and Height (BOH), and Abdominal (ABP) and Thoracic (THP) Perimeters

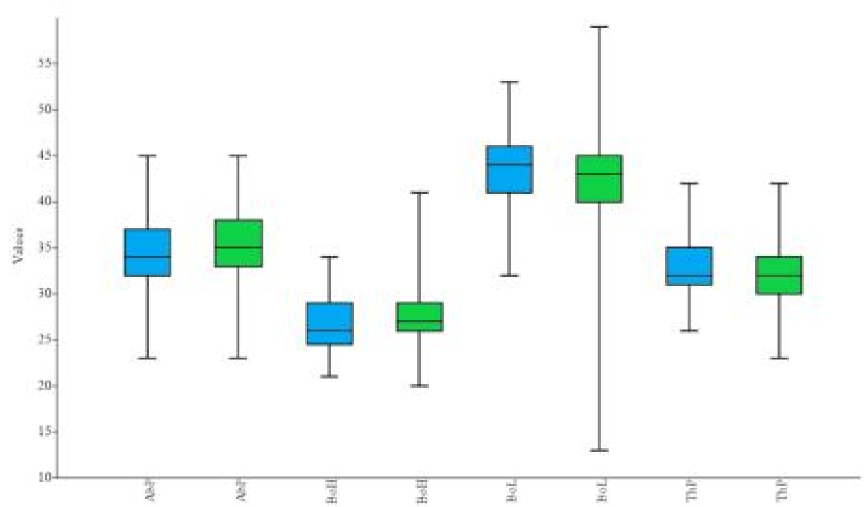

Fig. 3. Box-whisker diagram for the values of length of body length (BOL) and height (BOH), abdominal (ABP) and thoracic (THP) perimeters. Only thoracic perimeter showed no statistical differences (*U*=9818, *p*=0.357) for non-earlobe (blue, n=99) and earlobe (green, n=212) groups. Each rectangle is divided by a horizontal segment indicating where the median is positioned. The whiskers have an extension limit, which in the case under study did not present any out-of-range data. Non-earlobe group presented higher values only for length of body

Table 3. Main descriptive statistics for abdominal perimeter, body height and body length between non-earlobe (n=99) and earlobe (n=212) groups, the two later being higher in eared group. Measurement in cm, except for coefficient of variation (%)

	Non-Ear-lobe	Ear-lobe	Non-Ear-lobe	Ear-lobe	Non-Ear-lobe	Ear-lobe
	Abdominal perimeter	**Abdominal perimeter**	**Body height**	**Body height**	**Body length**	**Body length**
Min	23	23	21	20	32	13
Max	45	45	34	41	53	59
Mean	33.9	35.4	26.7	27.2	43.5	42.6
Standard deviation	4.30	3.52	3.15	2.89	3.62	4.93
Coefficient of variation	12.7	9.9	11.8	10.6	8.3	11.6

4. CONCLUSION

Presence/absence of earlobes in the *Peluca* hen describe different body morphologies. As they are not due to an adaptative response, they could be related to body architecture rather than different ecotypes. The information to be gained in the study would be helpful especially in planning future breeding programs and conservation strategies of prospective local Guatemala hen population. Further studies involving morphometric, production and molecular analyses are important for exhaustive characterization. Such information will form a basis for conservation, selection and sustainable improvement strategies for the identified prospective local chickens. Creole hens play major role for the rural poor and marginalized section of the people with respect to their subsidiary income and also provide them with eggs and meat. This is why detailed knowledge of local breeds are needed to improve human nutrition and increase incomes.

CONSENT

The study involved taking body measurements from pigeons with the consent and in the presence of the breeders. The data was collected in fancies and animal owners agreed to be involved in the project (As there is no national specific legislation for body measurements, no approval was necessary. This study was carried out in live animals but with non-traumatic handling procedures, so no Ethics committee agreement was considered necessary).

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CONFLICT OF INTERESTS

Authors have no financial or personal relationships with other people or organizations that could inappropriately influence their work. We declare also there are no competing interests regarding the publication of this paper.

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