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Article

Methods for classifying coefficients of variation in experimentation with poultrys

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Abstract

The aim of this work was to evaluate the coefficient of variation (CV) and to establish classification ranges for the main variables evaluated in experimentation with poultrys through different methods. The CV data of different response variables observed in poultry articles (broilers, laying hens, roosters and quails) published in five national journals were tabulated in a Microsoft Excel 2010® worksheet. Afterwards, they were subjected to normality evaluation through the Shapiro-Wilk method, and later the following data of the descriptive statistics were utilized: maximum value, minimum value, range, mean, median, standard deviation, midquartile, first quartile, third quartile, interquartile range, and pseudo sigma. According to the values obtained in the descriptive statistics of the CVs of each variable, classification ranges were elaborated for these values, considering six different forms of classification, adapted from the consulted literature. The results indicated that the classification ranges established for CVs in experiments with poultrys are different from those recommended in statistical textbooks. It is possible to utilize midquartile, pseudo sigma, mean and standard deviation through different methods in order to classify the CVs, but the use of the standard deviation promotes incoherent classifications in certain variables, and promotes increase in the amplitude between the lowest and the highest CV value obtained for the classification ranges.

Keywords: performance, descriptive statistics, spreadsheet

Introduction

The variability of the experimental data (or dispersion) may be quantified through the range, variance, standard deviation and coefficient of variation, among others (Bastos & Duquia, 2007). Of these, the most described by Brazilian researchers is the coefficient of variation (CV), which corresponds to the standard deviation expressed as percentage of the mean (Mohallem et al., 2008) and allows to compare different works involving the same response variable and, consequently, to quantify the accuracy of the researches (Judice et al., 2002).

According to Toebe et al. (2014) the planning of the experiment also depends on different factors such as the utilized material, location, management, statistics and level of precision. In this way, one must consider that the variability of an experiment also changes according to the worked species or culture.

Based on essays performed in agricultural experimentation, Pimentel-Gomes (2009), elaborated the following classification of the coefficient of variation: *low*, when lower than 10%; *average*, when from 10% to 20%; *high*, when from 20% to 30%; and *very high*, when higher than 30%. However, this classification is questionable. Being so wide, it does not take into account the nature of the studied culture, and does not distinguish the nature of the evaluated character

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(Garcia, 1989; Costa et al., 2002).

In poultry essays, there is little reference of CV values indicating the classification range as to its degree of accuracy (Mohallem et al., 2008). In this manner, the knowledge and classification of the coefficient of variation of an animal species has great relevance, since it guides the researchers through a range of values, offering validity to the experiments (Snedecor & Cochran, 1980).

The CV classification performed in experiments with Eucalyptus and Pinus, defined by Garcia (1989), was based on the mean and on the standard deviation for CV values, although the author did not report in his study whether or not he evaluated the normality of the data for this classification. However, other authors took into account that the data presented an approximately normal distribution, as in the experiments with rice (Costa et al., 2002), tomato (Cruz et al., 2012) and soybean (Carvalho et al., 2003). When the CVs did not satisfy the normal distribution, Costa et al. (2002) suggested the use of the midquartile (Md Interq.) and pseudo aigma (PS) statistics, which, according to these authors, are more resistant values than the mean and the standard deviation, but, when normal, these two methodologies provide equivalent classifications.

The aim of this work was to determine the classification ranges of the values of coefficient of variation of the main response variables studied in poultry essays (broilers, breeder hens, laying hens and quails), through different methodologies, adapting the criteria proposed by Garcia (1989) and Costa et al. (2002) to define the classification ranges of the coefficient of variation.

Material and Methods

The coefficient of variation data were obtained through bibliographical review of the articles concerning poultry (broilers, breeders, laying hens, roosters and quails) published within 1999 and 2014 in the journals: *Arquivo Brasileiro de Medicina Veterinária e Zootecnia*, *Pesquisa Agropecuária Brasileira* and *Revista Brasileira de Zootecnia*; published between 2000 and 2014 in the journals: *Revista Brasileira de Ciência Avícola*; and published between 2003 and 2014 in the journal: *Revista Ciência e Agrotecnologia*. Some of the observed variables which present greater frequency in the articles were selected, especially: live weight (g and kg), weight gain (g and kg), feed intake (g and kg), feed conversion, mortality (%), viability (%), carcass yield (g and %) and chest yield (g and %), egg production (%), egg weight (g), egg mass (g), feed conversion ratio per egg mass (FCRem) and feed conversion ratio per dozen eggs (FCRdz).

To test the normality of the data, a routine was used in the SAS language (*Statistical Analysis System*), utilizing the Shapiro-Wilk test (Shapiro & Wilk, 1965), since, according to Öztuna et. al (2006), it would be the best adherence test to normality.

For the CV values of each response variable were determined: Maximum Value, Minimum Value, Range, Mean, Median, Midquartile, Standard Deviation, First Quartile, Third Quartile, Interquartile Range and Pseudo Sigma. For this determination, the spreadsheet was used as a tool to assist in obtaining the values indicated in Table 1.

The two main methods of CV classification were proposed by Garcia (1989) and Costa et al.

Table 1. Microsoft Excel * 2010® formulas for obtaining the descriptive statistics variables

Function	Formula
Max	= MAXIMUM (x_1:x_n)
Min	=MINIMUM((x_1:x_n)
Range	=MAXIMUM(x_1:x_n)-MINIMUM (x_1:x_n)
m	=MEAN(x_1:x_n)
Md	=MED(x_1:x_n)
Md Interq.	= (QUARTILE.EXC(x_1:x_n;1)+ QUARTILE.EXC(x_1:x_n;3))/2
s	=STADEV.A(x_1:x_n)
Q_1	=QUARTILE.EXC(x_1:x_n;1)
Q_3	=QUARTILE.EXC(x_1:x_n;3)
IQR	= QUARTILE.EXC(x_1:x_n;3) - QUARTILE.EXC(x_1:x_n;1)
PS	= QUARTILE.EXC(x_1:x_n;3) - QUARTILE.EXC(x_1:x_n;1)/1,35

Max: Maximum value; Min: Minimum value; Amp: Range; m: Mean; Md: Median; Md. Interq.: Midquartile; s: Standard deviation Q_1: First Quartile; Q_2: Third Quartile; IQR: Interquartile Amplitude; PS: Pseudo Sigma. *Formulas may vary depending on the Excel version.

(2002). For Garcia (1989), through the mean of the coefficients of variation (m) and the standard deviation (s) it is possible to construct the classification range of the coefficient of variation, but he did not mention whether or not these data presented normal distribution. However, Costa et al. (2002) proposed the utilization of the statistics of midquartile (Md. Interq.) and pseudo sigma (PS), considering these to be more resistant values than the mean and the standard deviation for the data that did not present normal distribution.

In this manner, six different methodologies adapted from the definitions of Garcia (1989) and Costa et al. (2002) were defined, as described in Table 2, in order to define the classification ranges of the coefficients of variation of the surveyed variables in the articles published in the evaluated journals.

Table 2. Criteria of classification of CV, following adaptation of the propositions by Garcia (1989) and Costa et al. (2002)

CV Classification Criteria	Classification
CV ≤ (A- 1B)	Low
(A-1B) < CV ≤ (A+1B)	Average
(A+1B) <CV≤ (A+2B)	High
CV > (A+2B)	Very high

Using the classification criteria of the coefficient of variation of Table 2, six distinct methods were established, namely:

Method 1: adaptation of the methodology by Costa et al. (2002), in which **A** is the median, and **B** is the pseudo sigma (PS);

Method 2: methodology proposed by Costa et al. (2002), in which **A** is the midquartile (Md. Interq.) and **B** is the pseudo-sigma (PS);

Method 3: adaptation of the methodology by Garcia (1989) and Costa et al. (2002) in which **A** is the mean (m), and **B** is the pseudo sigma (PS);

Method 4: adaptation of the methodology proposed by Garcia (1989), where **A** is the median (Md) and **B** is the standard deviation (s),

Method 5: adaptation of the methodology by Costa et al. (2002) and Garcia (1989), in which **A** is the midquartile, and **B** is the standard deviation (s);

Method 6: methodology proposed by Garcia (1989) where A is the mean (m), and B is the standard deviation (s);

These methods were applied for each response variable under study. The classification ranges of each variable were defined by the six methods. Negative CV values within the classification ranges were considered incoherent. The amplitude between the lowest and highest value obtained in the classification ranges of each variable was also defined. An average classification range was defined for the performance and production variables of the poultrys, except for mortality, based on the tabulation of all mean, median and midquartile values, as well as the standard deviation and pseudo sigma, analyzed jointly.

Results and Discussion

1005 (one thousand and five) articles were registered, of which 30.95% did not present CV data, and 69.05% did present CV. Of the 694 articles with CV, 5,469 CV values were obtained in 13 responses variables chosen. Table 3 presents the results referring to the descriptive statistics for the selected response variables, and the Shapiro-Wilk normality test. The Shapiro-Wilk test was not significant (Table 3) for the studied variables, pointing that the data set of the coefficients of variation extracted from the journals had normal distribution. Mohallem et al. (2008) and Farias Filho et al. (2010) did not find normal distribution for most performance variables in broilers and egg production in laying hens, respectively. However, the data volume worked by the authors was well below those of the present study.

It was also observed, in Table 3, that most of the variables presented high ranges, except for viability and carcass yield. The values of standard deviation for the variables were all close, with an average value of 3.46±1.06, except for mortality (70.71%), since it is a variable that can be influenced either for treatment-related as for non-controlled factors.

Mortality presented CV with high values. The value referring to range was 453.17% (Table 3) and to pseudo-sigma was 41.99% (Table 4).

High values for this variable were also verified by Mohallem et al. (2008) when evaluating essays with broilers. However, they did not consider it as a good precision variable, due to the large range of the CVs, not performing a classification for it. In its place they indicated the use of viability (100% - mortality), for presenting more stable characteristics, inducing a lower experimental error.

The viability presented range of 12.28% (Table 3) and pseudo-sigma of 2.07% (Table 4), these values being more stable, corroborating with the above-mentioned authors.

The weight gain variable presented a high value for range, 87.89%. This was also verified by Mohallem et al. (2008) and the justification presented for this fact is the great diversity of researches, since the experimental designs were not specified, nor were extreme data eliminated, which in this variable was around five values with extremely high CV, when compared to the other 962 CV values observed.

Table 3. Shapiro-Wilk test (SW) and descriptive statistics: maximum value (Max), minimum value (Min), range, mean (m), standard deviation (s) of the coefficients of variation in experimentation with poultry

Variable	Nº of values	Max	Min	Range	m	s	Shapiro-Wilk	
							SW	Pr (r<W)
				Broilers				
LW	486	23.53	0.13	23.40	3.99	2.86	0.773^{ns}	0.0001
WG	967	88.44	0.55	87.89	4.57	4.83	0.398^{ns}	0.0001
FI	1250	26.66	0.35	26.31	4.20	2.51	0.817^{ns}	0.0001
CPoultry	1132	39.96	0.62	39.34	4.70	3.56	0.769^{ns}	0.0001
Mort.	139	453.17	0	453.17	66.40	70.71	0.734^{ns}	0.0001
Viab.	87	12.72	0.44	12.28	3.88	2.39	0.912^{ns}	0.0001
Carc.	247	12.81	0.61	12.20	3.08	2.15	0.784^{ns}	0.0001
Chest	222	38.97	1.35	37.62	5.22	4.25	0.532^{ns}	0.0001
				Laying				
EggProd	248	30.4	1.21	29.19	7.00	4.60	0.836^{ns}	0.0001
EggWei	268	21.72	0.22	21.50	3.32	2.10	0.727^{ns}	0.0001
Egg Mass	177	21.72	2.06	19.66	6.85	3.52	0.912^{ns}	0.0001
FC KG/MO KG/MO	68	23.77	1.95	21.82	6.66	3.60	0.817^{ns}	0.0001
FC KG/DZ	178	34.67	0.57	34.10	7.07	5.11	0.812^{ns}	0.0001

* = p<0.0001; ns= p>0.0001. LW: Live Weight/poultry; GP: Weight Gain/poultry; FI: Feed Intake/poultry; CPoultry: Feed Conversion/poultry; Mort: Mortality; Viab: Viability; Carc: Carcass Yield; Chest: Chest Yield; EggProd: Egg Production; EggWei: Egg Weight; Egg Mass; FC KG/EM: Feed Conversion KG/egg mass; FC KG/DZ: Feed Conversion KG/ dozen eggs.

Table 4. Median (Md), Midquartile (Md. Interq.), 1° quartile (Q_1), 3° Quartile (Q_3), Interquartile Range (IQR) and Pseudo Sigma (PS) of the response variables studied in the experiments with poultry

Variable	Md	Md. Interq.	Q_1	Q_3	IQR	PS
			Broilers			
LW	3.20	3.55	2.30	4.80	2.50	1.85
WG	3.61	3.91	2.68	5.14	2.45	1.81
FI	3.56	3.87	2.65	5.09	2.44	1.81
CPoultry	3.63	4.14	2.40	5.89	3.49	2.58
Mort.	45.65	52.33	23.99	80.67	56.68	41.99
Viab.	3.27	3.47	2.07	4.87	2.80	2.07
Carcass	2.43	2.70	1.70	3.70	2.00	1.48
Chest	4.54	4.42	3.21	5.63	2.42	1.79
			Posture			
EggProd	5.94	6.31	3.84	8.80	4.96	3.67
EggWei	2.75	3.01	2.17	3.86	1.69	1.25
EggMass	6.12	6.63	4.43	8.83	4.40	3.26
FC/KG/MO	6.00	6.10	4.58	7.63	3.05	2.26
FC KG/DZ	5.74	6.10	3.85	8.35	4.50	3.33

LW: Live Weight/poultry; WG: Weight Gain/poultry; FI: Feed Intake/poultry; CPoultry: Feed Conversion/poultry; Mort: Mortality; Viab: Viability; Carc: Carcass Yield; Chest: Chest Yield. EggProd: Egg Production; EggWei: Egg Weight; Egg Mass; FC KG/EM: Feed Conversion KG/egg mass; FC KG/DZ: Feed Conversion KG/ dozen eggs.

According to the data in Table 4, the midquartile values were slightly higher than the Md values, and lower than the Mean (m) values. According to Costa et al. (2002) the midquartile is represented as follows: Midquartile = (Q1 + Q3) / 2, where Q1 is the first quartile and Q3 is the third quartile, which delimit 25% of each extremity of the distribution, and the pseudo-sigma, PS = IQR / 1.35. The IQR (interquartile range) has the following formula: IQR = Q3 - Q1, which indicates how far the data are distanced from the median (Mohallem et al., 2008). When the IQR is divided by 1.35 the result obtained produces the standard deviation that would have been expected to have a normal distribution (Costa et al., 2002). In this manner, it would eliminate the problems in function of eventual *outliers*, as previously mentioned for the CV of the weight gain variable, beside other variables that also present extreme CVs.

These dispersion measures are relevant because they would eliminate some very extreme values of the CV sample of each variable, which would probably be associated to the increase of the error and, consequently, alteration of the normal distribution.

The response variables: live weight, weight gain, feed intake, feed conversion (Table 5) and viability (Table 6) presented low values for the interval of the classification ranges in each method proposed in the study. According to the classification proposed by Pimentel-Gomes (2009), the low CVs are those less than 10%, and very high CVs are those which present values higher than 30%, ergo there is a disparity of information, since this is not verified in Table 5. However, according to Mohallem et al. (2008), the classification range of Pimentel-Gomes (2009) is based on agricultural variables, whereas in poultry there will be relatively less uncontrolled variables.

Table 5. Classification of the Coefficients of Variation for the response variables: live weight, weight gain, feed intake, feed conversion/poultry, according to the criteria established in Table 2, and using the six methods based on Garcia (1989) and Costa et al. al. (2002)

Method	Low	Medium	High	Very high
		Live Weight		
1	CV≤ 1.35	1.35<CV≤ 5.05	5.05<CV≤ 6.91	CV> 6.91
2	CV≤ 1.70	1.70<CV≤ 5.40	5.40<CV≤ 7.26	CV> 7.26
3	CV≤ 2.13	2.13<CV≤ 5.84	5.84<CV≤ 7.70	CV> 7.70
4	CV≤ 0.34	0.34<CV≤ 6.06	6.06<CV≤ 8.91	CV> 8.91
5	CV≤ 0.69	0.69<CV≤ 6.41	6.41<CV≤ 9.26	CV> 9.26
6	CV≤ 1.13	1.13<CV≤ 6.85	6.85<CV≤ 9.70	CV> 9.70
		Weight Gain		
1	CV≤ 1.80	1.80<CV≤ 5.42	5.42<CV≤ 7.24	CV> 7.24
2	CV≤ 2.09	2.09<CV≤ 5.72	5.72<CV≤ 7.54	CV> 7.54
3	CV≤ 2.75	2.75<CV≤ 6.38	6.38<CV≤ 8.20	CV> 8.20
4	CV≤ -1.22	-1.22<CV≤ 8.44	8.44<CV≤13.26	CV> 13.26
5	CV≤ -0.92	-0.92<CV≤ 8.74	8.74<CV≤13.56	CV> 13.56
6	CV≤ -0.26	-0.26<CV≤ 9.39	9.39<CV≤14.22	CV> 14.22
		Feed Intake		
1	CV≤ 1.75	1.75<CV≤ 5.37	5.37<CV≤ 7.18	CV>7.18
2	CV≤ 2.06	2.06<CV≤ 5.68	5.68<CV≤ 7.49	CV> 7.49
3	CV≤2.39	2.39<CV≤ 6.01	6.01<CV≤ 7.82	CV>7.82
4	CV≤ 1.04	1.04<CV≤ 6.07	6.07<CV≤ 8.59	CV> 8.59
5	CV≤1.36	1.36<CV≤6.39	6.39<CV≤8.90	CV>8.90
6	CV≤1.68	1.68<CV≤6.71	6.71<CV≤9.23	CV>9.23
		Feed Conversion/Poultry		
1	CV≤1.05	1.05<CV≤ 6.21	6.21<CV≤8.80	CV>8.80
2	CV≤ 1.56	1.56<CV≤ 6.73	6.73<CV≤ 9.31	CV> 9.311
3	CV≤ 2.11	2.11<CV≤ 7.28	7.28<CV≤ 9.86	CV> 9.86
4	CV≤ 0.06	0.06<CV≤ 7.19	7.19<CV≤10.76	CV>10.76
5	CV≤ 0.58	0.58<CV≤7.71	7.71<CV≤11.27	CV>11.27
6	CV≤1.13	1.13<CV≤ 8.26	8.26<CV≤11.83	CV>11.83

Method 1: Adaptation of the methodology by Costa et al. (2002), where A is the median, and B is the Pseudo Sigma (PS); **Method 2** : Methodology proposed by Costa et al. (2002), where A is the midquartile (Md. Interq.), and B is the pseudo-sigma (PS); **Method 3**: Adaptation of the methodology by Garcia (1989) and Costa et al. (2002) where A is the mean (m), and B is the Pseudo Sigma (PS); **Method 4: A**daptation of the methodology proposed by Garcia(1989), where A is the median (Md) and B is the standard deviation (s); **Method 5:** Adaptation of the methodology by Costa et al. (2002) and Garcia (1989), where A is the midquartile (Md Interq), and B is the standard deviation(s); **Method 6:** Methodology proposed by Garcia (1989) where A is the mean (m), and B is the standard deviation (s).

In Table 5, the weight gain variable presents negative values in the classification of the CVs for methods 4 (considering median and standard deviation), 5 (considering midquartile and standard deviation), and 6 (considering mean and standard deviation). The three above-mentioned methods present the standard deviation (s = 4.83) higher than the median (Md = 3.61) in method 4, than the midquartile (Md. Interq. = 3.91) in method 5, and than the mean (s= 4.57) in method 6. The standard deviation presented a 166.9% increase compared to pseudo sigma due to the data set with extreme minimum and maximum values. The range of negative values, in the classification of the coefficient of variation, is a consequence of the standard deviation presenting a value higher than the median, midquartile and mean, making these methods less reliable. Costa et al. (2002) proposed to use the midquartile instead of mean, and pseudo sigma instead of the standard deviation. Therefore, methods 1, 2 and 3, that used pseudo-sigma, and 5, that used midquartile, had positive values in their classification ranges. This is probably associated with the fact that the CV data of weight gain presented very large outliers, although with normal statistical distribution.

In Table 6, the mortality variable also presented negative values in the classification ranges in methods 4, 5 and 6. In method 4, the negative value occurred because the median value (Md = 45.65) was lower than the value of the standard deviation (s = 70.71); in method 5, the value of the midquartile (Md. Interq. = 64.33) was lower than the standard deviation (s = 70.71) and in method 6 the mean value (m= 66.40) was also lower than the standard deviation (s = 70.71). The three methods have in common the use of the standard deviation, and in case of very high outliers, they significantly alter the standard deviation, generating the discrepant values. The values presented in the CV classification range are very high values that do not approximate of what was proposed by Pimentel-Gomes (1991) and Garcia (1989).

For Mohallem et al. (2008), the classification of the CVs on mortality was defined since according to the authors, it would present incoherent (negative) data, becoming indispensable for the researcher to understand that this is a variable which presents high CVs by its very nature, that is, the mortality of poultrys during the experiment will not necessarily be associated to the treatments, thus causing high deviations and consequently high coefficients of variation.

The carcass yield (Table 4) presents the lowest midquartile (2.7%), and this reflects in its very narrow classification range (Table 6). The fact that this variable has the lowest midquartile, and consequently a narrow classification range was also observed by Mohallem et al. (2008).

The variable egg weight (Table 7) shows the lowest CV values, corroborating with data from Faria Filho et al. (2010), indicating higher accuracy in all methods, since according to Cargnelutti Filho & Storck (2007) the lower the CV, the greater the precision of the experiment and vice versa, and the higher the precision, the higher the experimental quality.

In the very high classification range for egg weight, the CV values were between 5.24 and 7.51% when compared to the methods, according to Table 7. These values disagree with the proposed by Pimentel-Gomes (2009), who establishes that when the CV value is less than 10% it is considered low. It is noteworthy that Pimentel-Gomes (2009) was based on agronomic parameters. Faria Filho et al., (2010) found a smaller range varying in the high classification, from 3.98 to 5.04%.

The variables: egg production, egg mass, feed conversion ratio per egg mass, feed conversion ratio per dozen eggs, in the very high classification, present CV higher than 10% in all six classification methods (Table 7). The same occurred in the essay by Leal et al. (2014) in the very high classification, with the following values obtained for each variable: egg production: 14.22%; egg mass: 14.55%; FCEM: 15.90% and FCDz: 13.02%. In this manner, the values found would be classified as average, if the Pimentel-Gomes proposal (2009) was adopted, which thus classify values between 10 and 20%.

When evaluating all data and classifications of CVs for all methods, we can indicate that unlike what Costa et al. (2002) stated, the most important is not the verification of normality for choosing to use the mean and standard deviation, since in the present study all the CVs of the classified variables presented normality, and the classifications using the midquartile and pseudo sigma were equivalent the other forms utilizing standard deviation, mean or median, except for weight gain and mortality.

When re-evaluating the data on weight gain and mortality, it was possible to detect that approximately 0.3 and 4.3% of the CV values, respectively, were extreme and distant values from the last nearest value (outliers). By removing them it was noticed that the classification data did not present negative values, even if the data remained without the normal distribution. This indicates that the most important would be to verify the outliers and to remove them than necessarily verify the normality.

When all the classification ranges were compared, there were amplitudes between the lowest and highest CV values of the range (Table 8), varying according to the pseudo sigma or the standard deviation. The amplitude within the classification ranges was lower in all variables when using pseudo sigma (method 1, 2 and 3), compared to the ranges that used standard deviation (method 4, 5 and 6), since independently of the use of mean, median or midquartile, the values were similar.

Generalizing the considerations about the classification range values, it would be possible to define, from the average data, a more comprehensive range for a greater number of values considering the set observed in all the methods, so that for broiler performance (feed intake, feed gain, feed conversion, viability, carcass yield and chest yield) and laying data (egg production, egg weight, egg mass, feed conversion ratio per egg mass, feed conversion ratio per dozen eggs), CV values lower than 2.23% would be considered low; average within 2.24 and 7.95%; high within 7.96 and 10.81%, and very high above 10.82%.

Table 6. Classification of the Coefficients of Variation for the response variables: mortality, viability, carcass yield and chest yield, according to the criteria established in Table 2, and utilizing the six methods based on Garcia (1989) and Costa et al. (2002)

Method	Low	Medium	High	Very high
		Mortality		
1	CV≤ 3.66	3.66<CV≤ 87.64	87.64<CV≤ 129.62	CV> 129.62
2	CV≤10.34	10.34<CV≤ 94.32	94.32<CV≤136.30	CV> 136.30
3	CV≤ 24.42	24.42<CV≤108.39	108.39<CV≤150.37	CV>150.37
4	CV≤ -25.06	25.06<CV≤116.36	116.36<CV≤187.07	CV>187.07
5	CV≤ -18.38	18.38<CV≤123.04	123.04<CV≤193.75	CV> 193.75
6	CV≤ - 4.31	-4.31<CV≤137.11	137.11<CV≤207.82	CV>207.82
		Viability		
1	CV≤ 0.41	0.41<CV≤ 6.13	6.13<CV≤ 8.98	CV> 8.98
2	CV≤ 0.61	0.61<CV≤ 6.33	6.33<CV≤ 9.18	CV> 9.18
3	CV≤ 1.02	1.02<CV≤ 6.74	6.74<CV≤ 9.59	CV>9.59
4	CV≤ 0.88	0.88<CV≤ 5.66	5.66<CV≤ 8.05	CV>8.05
5	CV≤1.08	1.08<CV≤ 5.86	5.86<CV≤ 8.25	CV> 8.25
6	CV≤ 1.49	1.49<CV≤6.27	6.27<CV≤ 8.66	CV> 8.66
		Carcass Yield		
1	CV≤0.95	0.95<CV≤3.91	3.91<CV≤ 5.39	CV> 5.39
2	CV≤ 1.22	1.22<CV≤ 4.18	4.18 <CV≤ 5.66	CV> 5.66
3	CV≤ 1.60	1.60<CV≤ 4.56	4.56<CV≤ 6.04	CV> 6.04
4	CV≤ 0.28	0.28<CV≤ 4.58	4.58<CV≤ 6.74	CV> 6.74
5	CV≤ 0.55	0.55<CV≤ 4.85	4.85<CV≤ 7.01	CV> 7.01
6	CV≤ 0.93	0.93<CV≤ 5.24	5.24<CV≤ 7.39	CV> 7.39
		Chest Yield		
1	CV≤ 2.75	2.75<CV≤6.33	6.33<CV≤8.12	CV> 8.12
2	CV≤ 2.63	2.63<CV≤ 6.21	6.21<CV≤ 8.00	CV>8.00
3	CV≤ 3.43	3.43<CV≤ 7.01	7.01<CV≤ 8.80	CV>8.80
4	CV≤ 0.29	0.29<CV≤ 8.79	8.79<CV≤13.04	CV> 13.04
5	CV≤ 0.17	0.17<CV≤ 8.67	8.67<CV≤ 12.92	CV> 12.92
6	CV≤ 0.97	0.97<CV≤ 9.47	9.47<CV≤ 13.72	CV> 13.72

Method 1: Adaptation of methodology by Costa et al. (2002), where A is the median, and B is the Pseudo Sigma (PS); **Method 2** : Methodology proposed by Costa et al. (2002), where A is the midquartile (Md. Interq.), and B is the Pseudo Sigma (PS); **Method 3**: Adaptation of the methodology by Garcia (1989) and Costa et al. (2002) where A is the mean (m), and B is the Pseudo Sigma (PS); **Method 4:** Adaptation of the methodology proposed by Garcia (1989), where A is the median (Md) and B is the standard deviation (s); **Method 5:** Adaptation of the methodology by Costa et al. (2002) and Garcia(1989), where A is the midquartile (Md Interq), and B is the standard deviation (s); **Method 6:** Methodology proposed by Garcia (1989) where A is the mean (m), and B is the standard deviation (s).

Table 7. Classification of Coefficients of Variation for the response variables: egg production, egg weight, egg mass FC kg/mo, FC kg/dz, according to the criteria established in Table 2, and using the six methods based on Garcia (1989) and Costa et al. (2002).

Method	Low	Medium	High	Very High
		Egg Production		
1	CV≤ 2.27	2.27<CV≤ 9.61	9.61<CV≤ 13.29	CV>13.29
2	CV≤ 2.64	2.64<CV≤ 9.99	9.99<CV≤ 13.67	CV> 13.67
3	CV≤ 3.33	3.33<CV≤ 10.67	10.67<CV≤ 14.35	CV>14.35
4	CV≤ 1.34	1.34<CV≤ 10.54	10.54<CV≤ 15.14	CV> 15.14
5	CV≤ 1.72	1.72<CV≤ 10.92	10.92<CV≤ 15.51	CV> 15.51
6	CV≤ 2.40	2.40<CV≤ 11.60	11.60<CV≤ 16.20	CV> 16.20
		Egg Weight		
1	CV≤ 1.50	1.50<CV≤ 3.99	3.99<CV≤ 5.24	CV> 5.24
2	CV≤ 1.76	1.76<CV≤ 4.26	4.26<CV≤ 5.51	CV> 5.51
3	CV≤ 2.07	2.07<CV≤ 4.57	4.57<CV≤ 5.82	CV>5.82
4	CV≤ 0.65	0.65<CV≤ 4.84	4.84<CV≤ 6.94	CV> 6.94
5	CV≤ 0.92	0.92<CV≤ 5.11	5.11<CV≤ 7.20	CV> 7.20
6	CV≤ 1.22	1.22<CV≤ 5.41	5.41<CV≤ 7.51	CV> 7.51
		Egg Mass		
1	CV≤ 2.86	2.86<CV≤ 9.38	9.38<CV≤ 12.64	CV> 12.64
2	CV≤ 3.37	3.37<CV≤ 9.89	9.89<CV≤ 13.15	CV> 13.15
3	CV≤ 3.59	3.59<CV≤ 10.11	10.11<CV≤ 13.37	CV>13.37
4	CV≤ 2.60	2.60<CV≤ 9.64	9.64<CV≤ 13.16	CV>13.16
5	CV≤3.11	3.11<CV≤ 10.15	10.15<CV≤ 13.67	CV> 13.67
6	CV≤ 3.33	3.33<CV≤ 10.37	10.37<CV≤ 13.89	CV>13.89
		Feed conversion ratio per egg mass		
1	CV≤ 3.74	3.74<CV≤ 8.26	8.26<CV≤ 10.52	CV> 10.52
2	CV≤ 3.84	3.84<CV≤ 8.36	8.36<CV≤ 10.62	CV> 10.62
3	CV≤ 4.40	4.40<CV≤ 8.93	8.93<CV≤ 11.19	CV> 11.19
4	CV≤ 2.40	2.40<CV≤ 9.60	9.60<CV≤ 13.19	CV> 13.19
5	CV≤ 2.50	2.50<CV≤ 9.70	9.70<CV≤ 13.29	CV>13.29
6	CV≤ 3.07	3.07<CV≤ 10.26	10.26<CV≤ 13.86	CV> 13.86
		Feed conversion ratio per dozen eggs		
1	CV≤ 2.40	2.40<CV≤ 9.07	9.07<CV≤ 12.40	CV> 12.40
2	CV≤ 2.76	2.76<CV≤ 9.43	9.43<CV≤ 12.76	CV> 12.76
3	CV≤ 3.74	3.74<CV≤ 10.40	10.40<CV≤ 13.74	CV>13.74
4	CV≤ 0.63	0.63<CV≤ 10.84	10.84<CV≤ 15.95	CV> 15.95
5	CV≤ 0.99	0.99<CV≤ 11.20	11.20<CV≤ 16.31	CV>16.31
6	CV≤ 1.97	1.97<CV≤ 12.18	12.18<CV≤ 17.28	CV>17.28

Method 1: Adaptation of the methodology by Costa et al. (2002), where A is the median, and B is the Pseudo Sigma (PS); **Method 2** : Methodology proposed by Costa et al. (2002), where A is the midquartile (Md. Interq.), and B is the Pseudo Sigma (PS); **Method 3**: Adaptation of the methodology by Garcia (1989) and Costa et al. (2002) where A is the mean (m), and B is the Pseudo Sigma (PS); **Method 4:** Adaptation of the methodology proposed by Garcia(1989), where A is the median (Md) and B is the standard deviation (s); **Method 5:** Adaptation of the methodology by Costa et al. (2002) and Garcia(1989), where A is the midquartile (Md. Interq.), and B is the standard deviation(s); **Method 6:** Methodology proposed by Garcia (1989) where A is the mean (m), and B is the standard deviation (s).

Table 8. Amplitude of the ranges of Coefficients of Variation (CV) defined in tables 5, 6 and 7 through the different methods.

Variables/ Methods	**Amplitude of CV ranges**					
	1	**2**	**3**	**4**	**5**	**6**
Live Weight	5.56	5.56	5.57	8.57	8.57	8.57
Weight Gain	5.44	5.45	5.45	14.48	14.48	14.48
Feed Intake	5.43	5.43	5.43	7.55	7.54	7.55
Feed Conversion	7.75	7.751	7.75	10.7	10.69	10.7
Mortality	125.96	125.96	125.95	212.13	212.13	212.13
Viability	8.57	8.57	8.57	7.17	7.17	7.17
Carcass Yield	4.44	4.44	4.44	6.46	6.46	6.46
Chest Yield	5.37	5.37	5.37	12.75	12.75	12.75
Egg Production	11.02	11.03	11.02	13.8	13.79	13.8
Egg Weight	3.74	3.75	3.75	6.29	6.28	6.29
Egg Mass (EM)	9.78	9.78	9.78	10.56	10.56	10.56
Feed Conversion/MO	6.78	6.78	6.79	10.79	10.79	10.79
Feed Conversion/dozen egg	10	10	10	15.32	15.32	15.31

Method 1: Adaptation of the methodology of Costa et al. (2002), where A is the median, and B is the Pseudo Sigma (PS); **Method 2** : Methodology proposed by Costa et al. (2002), where A is the midquartile (Md. Interq.), and B is the Pseudo Sigma (PS); **Method 3**: Adaptation of the methodology by Garcia (1989) and Costa et al. (2002) where A is the mean (m), and B is the pPeudo Sigma (PS); **Method 4:** Adaptation of the methodology proposed by Garcia(1989), where A is the median (Md) and B is the standard deviation (s); **Method 5:** Adaptation of the methodology by Costa et al. (2002) and Garcia (1989), where A is the midquartile (Md. Interq.), and B is the standard deviation (s); **Method 6:** Methodology proposed by Garcia (1989) where A is the mean (m), and B is the standard deviation (s).

Conclusions

It is possible to use the midquartile, pseudo sigma, mean and standard deviation for classification of the CVs, but the use of standard deviation promotes inconsistent classification ranges in certain variables.

In general, the coefficients of variation for poultry performance (feed intake, weight gain, feed conversion, viability, carcass yield and chest yield) and laying data (egg production, egg weight, egg mass, feed conversion ratio per egg mass, feed conversion ratio per dozen eggs) may be considered low when CV values are lower than 2.23%; average within 2.24 and 7.95%; high within 7.96 and 10.8%, and very high above 10.82%.

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