BEWARE OF THE CV

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There are limitations to the usefulness of using the coefficient of variation (CV) in alpaca breeding programs. These limitations are discussed and an alternative to using the CV is introduced.

The CV and the standard deviation of fibre diameters (SD) are both measures of uniformity. The SD is an absolute measure whereas the CV is derived from the SD and is relative to the average fibre diameter (FD).The wool industry uses the CV to compare the uniformity of fleece bales and to determine the spinning fineness (SF). This is determined by a formula based on the FD and CV so that when the CV is 24%, the SF is the same as the FD. However for every change of 5% either up or down from 24% there is a 1 micron change either up or down in the SF compared to the FD. Buyers use the CV to compare bales that have a similar FD and processors use the SF rather than the FD.

The FD and SD are independent measurements based on the diameters of the fibres in the tested sample. The CV however is not an independent measurement. This is because it is obtained by dividing the SD by the FD and expressing the answer as a percentage (CV = [(SD/FD) x 100] %).
The SD is the range of fibre diameters either side of the FD that encompasses 34% of the fibres in a sample. It therefore indicates the range of fibre diameters that together includes 68% of the fibres. If the SD is 4µ then 68% of all the fibres will be between (FD – 4)µ and (FD +4)µ. This range is independent of the FD and will be the same for a particular SD regardless of the FD. The SD is therefore an absolute measure of uniformity.

When the FD is low the range of fibre diameters for a particular SD will represent a larger percentage of the FD than when the FD is high. This is the opposite to another type of uniformity referred to as tolerances. This generally refers to the accuracy in size to which items are manufactured and in this case smaller items are usually made to finer tolerances than larger items.

The CV is an expression of this absolute uniformity as a percentage of the FD and is therefore relative to the FD. This relative uniformity can make it difficult to compare fleeces from alpacas of different ages since the FD usually blows out at a faster rate than the SD. Thus, as an alpaca ages, its CV usually decreases. This gives the impression that the uniformity is improving whereas its absolute uniformity is actually becoming worse. Unless the rate of the declining CV can be determined and related to the age of the alpaca, it is difficult to determine whether or not it is better than another. The relevance of the SD and FD in a particular situation will determine whether or not the CV is useful when assessing alpacas. This can probably best be demonstrated in the following examples.

Suppose two samples each have an SD of 4µ and one has an FD of 20µ and the other 24µ. The 20µ sample will have a CV of 20% and an SF of 20-0.8=19.2µ. The 24µ sample will have a CV of 16.7% and an SF of 24-1.5=22.5µ. Based on the CV's, the 24µ sample appears to be the more uniform and that is the case relative to the FD's. In absolute terms however they both have the same uniformity and most breeders would choose the alpaca with the lower FD which also has the lower SF. In this case the FD has more relevance than the CV.
What if the two samples have the same FD of say 20µ; what happens then? If one has a CV of 15%, its SD will be (20x15)/100=3µ and its SF 18.2µ. If the other fleece has a CV of 20% then its SD will be 4µ and its SF 19.2µ. The first sample with a CV of 15% will be more uniform than the sample with a

CV of 20%. The same conclusion could just as easily have been arrived at by comparing their SD's. In this situation where both samples have the same FD, even though the SF is different, the CV is just as relevant as the SD in a breeding program and either could be used.
Let's take a third example in which both samples have the same CV and therefore their SF will differ from their FD by the same amount. Suppose a fleece sample has an FD of 15µ and an SD of 3µ. Its CV will be 20% and its SF 14.2µ. If the histogram was symmetrical about the mean then 68% of the fibres would be between 12 and 18µ. This is a range of 6µ. If the second sample has an FD of 30µ and an SD of 6µ it will also have a CV of 20% but an SF of 29.2µ. However most of its fibres will lie between 24 and 36µ and the range will be 12µ. Even though the CV has remained the same, the FD is twice as thick and the range of diameters has doubled. So which is the more uniform sample here? Both samples have the same uniformity relative to the FD but the first sample, in absolute terms, is far more uniform than the second sample. In this case having a low FD and SD is far more relevant than the CV.

The difficulties associated with comparing alpacas on the basis of their CV should be apparent from the above examples. If one of your breeding objectives is to reduce medullation in the fibres then it is necessary to reduce both the FD and SD (Kingwell, 2010) and since the two values are independent of each other and equally important then the absolute uniformity, as determined by the SD, has more relevance than the CV.

When comparing fleeces, I suggest you use the FD and SD rather than the CV and remember that second fleeces often have a higher FD but a lower SD than the first fleece. This results in the second fleece CV being lower than the first. A convenient way to compensate for this is to use what I call the Score of Uniform Micron (SUM). It is the sum of the FD and SD and our alpacas are graded each year according to this score (SUM = FD + SD).
If the fleece score is no higher than 21 then the comfort factor (CF) will usually be 100%. If it is no higher than 23 the CF will usually be at least 99% and if the score is less than 26 the CF will usually be at least 95% (Kingwell, 2012). There is however no correlation between CV and CF.

I suppose you're wondering why I go to the trouble of calculating the SUM when I could just as easily use the CF. There are several reasons for this. Firstly, I am primarily breeding for low and relatively stable FD and SD and even though there is a strong correlation between the sum of these two values and the CF, I find it convenient to use the SUM since it is a direct expression of my breeding objectives. It also means that the SUM is a way of expressing the CF in terms of microns rather than a percentage. This is useful when a number of alpacas all have the same CF of 100% since they can still be compared by using the SUM. The SUM takes over when the CF is 100%.

So by all means use the CV to assess your alpacas but remember, it probably doesn't mean very much unless the FD's are similar.

REFERENCES

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