Theoretical considerations on a one-parameter approach to compare actual and estimated compositions of multi-component diets

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Introduction The composition of ingested herbage mixtures can be estimated using the alkane technique (Dove & Moore, 1995), with the accuracy of the estimate assessed by linear regression of estimated and actual proportions of the dietary components (Dove, 1992). However, although the linear regression might not differ from the line of equality, large discrepancies may occur within individual components (Hoebee *et al.*, 1998). This paper presents an approach to compare actual and estimated diet compositions using only one parameter.

Describing the problem The χ^2-test ($\Sigma((o_i-e_i)^2/e_i)$, with *o* and *e* being observed and expected frequency of component *i*, is commonly used to statistically compare expected and observed distributions. In grazing situations animals may completely avoid some species, although this may not be detected by visual observation. Consequently, those species will be included as potential components in the estimate of diet composition. In balance trials simulating such selective intake, the accuracy of the resulting estimate of diet composition cannot be analysed by the χ^2-test, because the denominator for the component selected against becomes zero.

Solution Estimates of diet composition are not independent for each dietary component, since the proportions of all components have to add up to 1. Thus, let individual dietary components be the dimensions of a multi-dimensional space. The constraint of diet composition (all proportions sum up to 1) results in a (n-1)-dimensional object, which represents all combinations of dietary components possible (including single-component diets). Therefore, this object contains both estimated as well as actual diet. The 'distance' (*D*) between estimated and actual diet can be calculated according to Pythagora's theorem as the square root of the sum of the squared differences between the estimated and known proportion of each component:

$$D = \sqrt{\sum_{i=1}^{n} (a_i - e_i)^2}$$

with *a* and *e* representing actual and estimated proportions respectively, of dietary component *i*. It should be noted that *D* is a theoretical parameter of the 'similarity' of actual and estimated diet composition, thus conclusions about individual components cannot be drawn directly.

Discussion Although Distance *D* indicates the degree of similarity between actual and estimated diet composition, it is not a statistical test of differences. In contrast to the Mean Discrepancy ($MD=D*\sqrt{(1/n)}$), which yields the (absolute) difference between the actual and estimated proportion averaged across all dietary components, *D* is independent of the number of components (Table 1). A value of *D* of 70 g/kg is suggested as a limit for assuming diet similarity. This corresponds to a maximum difference in a single dietary component of 70 g/kg (or in diets of up to four species, 50-60 g/kg), if this difference is compensated equally by all other components (Table 1). Note, that *D* accounts only for absolute differences between actual and estimated proportions, a possible inclusion of relative differences requiring further research.

Table 1 Differences between actual and estimated proportion of dietary components (g/kg) and resulting *Distance (D)* and *Mean Discrepancy (MD)*[#]

Case	Dietary component				D	MD
	1	2	3	4		
(1)	+49.5	-49.5	/	/	70	49.5
(2)	+49.5	0	-49.5	/	70	40.4
(3)	+57.2	-28.6	-28.6	/	70	40.4
(4)	+60.6	-20.2	-20.2	-20.2	70	35.0

[#] Due to the mathematics of calculating *D* and *MD*, the unit for both parameters are g/kg

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