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Limitations of Expressing Organochlorine Levels in Eggs on a Lipid-Weight Basis

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Literature citations of organochlorine residue levels of environmental samples are expressed on a wet-weight, dry-weight or lipid-weight basis; however, there appears to be an increasing trend to express the results on a lipid-weight basis. The eggs of birds have been used widely to assess levels of organochlorine pollutants accumulated in the wild and through experimental exposure. In this note the limitations of expressing the results of analysis of eggs on a lipid-weight basis are discussed.

PREVOST and MORIN (1846) first noted the presence of lipid in the avian egg and its importance as a source of energy for the embryo was discussed by PARKE (1877). Later, ROMANOFF (1932), determined the extent of utilization of lipid by chicken embryos during incubation. The importance of the changes in lipid content during incubation from the point-of-view of residue analysis was raised by STICKEL et al. (1973) but they did not discuss this point in detail and their caution seems largely to have been ignored.

In the course of our work on the effects of pollutants on the reproduction of the Herring Gull (Larus argentatus) we made measurements of the organochlorine levels in the combined yolk and albumen and in the developing embryo at various states of natural incubation (GILMAN et al. 1978). Since both the lipid and the water content were measured it was possible to use these data to illustrate the lipid and water levels in these two components of the egg at various stages of incubation (Table 1). Additional data from eggs collected before incubation had commenced and at the stage when the first cracking of the shell occurred prior to the hatching (GILMAN 1978) are also shown in Table 1.

The data show clearly that the percentage of lipid in the combined yolk and albumen does not alter significantly during incubation. Thus if traces of yolk and albumen are extracted from shell fragments of broken eggs (cf Brown Pelican, Pelecanus occidentalis, eggs from Anacapa, RISEBROUGH 1972) or extracts from blown eggs are used (cf Peregrines, Falco peregrinus, PEAKALL 1974), the results should not be biased by the degree of incubation when the results are expressed on a lipid weight

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TABLE 1

Changes in the water and lipid content of yolk plus albumen, embryo and total contents of Herring Gull eggs during incubation.

Degree of incubation (days)	Sample size	Yolk plus Albumen[1]		Embryo[1]		Total egg contents[1]	
		% water	% lipid	% water	% lipid	% water	% lipid
7 - 8	14	70.2 ± 2.0	9.1 ± 0.9	89.5 ± 3.6	3.2 ± 1.9	70.5 ± 2.6	9.0 ± 1.0
14 - 16	12	67.6 ± 2.6	9.3 ± 1.0	89.2 ± 1.8	1.8 ± 0.8	69.7 ± 2.0	8.2 ± 0.7
20 - 21	14	66.1 ± 6.1	11.1 ± 1.2	85.3 ± 1.2	2.4 ± 0.5	69.4 ± 2.3	6.5 ± 0.8
26 - 28	8	62.1 ± 6.6	10.7 ± 1.6	82.9 ± 2.2	3.2 ± 0.6	69.3 ± 2.9	4.1 ± 1.0
0	20	-	-	-	-	74.9 ± 1.8[2]	8.5 ± 0.8[2]
Term	20	-	-	-	-	76.5 ± 2.6[2]	4.9 ± 0.9[2]

[1] Figures are arithmetic means and standard deviation.

[2] Data from Gilman (1978).

basis. However, if the total egg contents are homogenized and analyzed, then the picture is very different. While the lipid content of the combined yolk and albumen remain relatively constant at 9-11% and that of the embryo at 2-3%, the ratio of the two components is continuously shifting as the embryo grows. The decrease of the lipid levels in the total eggs is over 50% (Table 1). In contrast the changes in water content are trival. Although the water content of both the yolk and albumen and the embryo decrease during incubation, there is little overall change in the percent water content of the total egg. This results from the larger contribution that water makes to the total egg weight, the fact that lipid content as well as water content declines with incubation and because the embryo, which increases in weight during incubation, has a higher percent water content than the yolk and albumen.

Using the above information it is possible to calculate the apparent change in the level of a stable, lipophilic contaminant during the course of incubation. The assumption is made that no metabolism of the contaminant occurs during incubation. The figures in Table 2 are obtained by arbitrarily setting the quantity of contaminant at 100 ppm on a wet-weight basis and using this value to calculate all subsequent concentrations.

TABLE 2

Changes in residue levels caused by calculations, based on wet weight, dry weight, and lipid weight, during incubation of eggs of Herring Gulls.

Degree of incubation (days)	Residue level Wet Weight	Dry Weight	Lipid Weight
7	100[1]	338	1110
14	105	348	1280
21	110	375	1710
28	123	398	3010
0	100[1]	398	1780
Term	126	534	2560

[1] Initial wet weight value set arbitrarily at 100 ppm.

Residue levels calculated on a lipid-weight basis varied between 143% and 298% through incubation; those expressed on a wet-weight basis varied between 23% and 26%, and those expressed on a dry-weight basis varied between 18% and 34%. We caution against the use of lipid weight as a basis for expressing pollutant levels in whole egg analysis unless the degree of incubation is known and stated.

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