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Evaluation of a Kit for Estimating Organic Matter Concentrations in Bottom Soils of Aquaculture Ponds

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Abstract.—The Hach CEL/700 Organic Matter Laboratory provided estimates of organic carbon concentrations in pond soil samples comparable to those obtained by the commonly-used Walkley-Black method. Dry ashing at 350–400 C tended to overestimate soil organic matter concentrations, and this procedure requires too much equipment and laboratory expertise for use on most aquaculture farms. The Hach kit can provide practical aquaculturists a simple and reliable method for measuring organic matter in pond soils. Samples from brackishwater ponds should be treated with mercuric sulfate to prevent chloride interference and overestimation of organic matter.

Commercial aquaculturists, and especially shrimp farmers, are concerned about the concentrations of organic matter in pond bottom soils. Excessive amounts of organic matter can result in deterioration of pond bottom condition and have negative effects on the survival and growth of aquatic animals (Boyd 1995). Ayub and Boyd (1994) evaluated methods of measuring organic matter concentrations in pond soils and suggested that the sulfuric acid-potassium dichromate oxidation or Walkley-Black method and the dry ash procedure could be used on aquaculture farms to provide useful results. Both procedures require various types of laboratory equipment and some experience with analytical methods. The Hach Chemical Company, Loveland, Colorado, USA offers a kit (CEL/700 Organic Matter Laboratory) that is complete for making soil carbon analyses provided a balance capable of weighing to the nearest 0.01 g is available. This kit has possibilities for use in pond aquaculture, and a study was conducted to determine if the kit results were as reliable as those of the Walkley-Black and dry ash methods.

Soil samples for use in these comparisons had been stored from earlier studies and included 10 samples from the bottoms of freshwater fish ponds, six samples from proposed sites for shrimp farms, and 10 samples from the bottoms of brackishwater shrimp ponds. The samples had been dried at 60 C, pulverized to pass a sieve with 0.15-mm openings and stored dry in sealed plastic bags for 6 to 12 mo. Analyses were made by three methods: 1) the Hach CEL/700 Organic Matter Laboratory following the instruction book; 2) the standard Walkley-Black procedure consisting of oxidation of soil organic matter in 1.0 N potassium dichromate and concentrated sulfuric acid with back titration of excess dichromate by standard ferrous sulfate (Nelson and Sommers 1982); and 3) dry ashing for 24 h at 350–400 C with organic matter taken as the weight loss during ashing (Jackson 1958). Separate moisture determinations (102 C) were made on samples to adjust results to a moisture-free basis.

The Hach procedure provided results similar to those of the Walkley-Black method (Fig. 1). The slope of the regression line did not differ from 1.0 ($P > 0.05$) and the y-intercept was not different from 0 ($P > 0.05$) when tested according to the t-test method of Draper and Smith (1966). However, at low carbon concentrations, the Hach procedure tended to give somewhat higher results than the Walkley-Black method (Table 1). Good agreement between the two procedures is not surprising. Both rely upon dichromate oxidation of organic matter without external heating, and the amount of carbon in the samples is estimated from the amount of dichromate consumed during oxidation of organic matter. The quantity of dichromate consumed was calculated from the amount of dichromate initially added

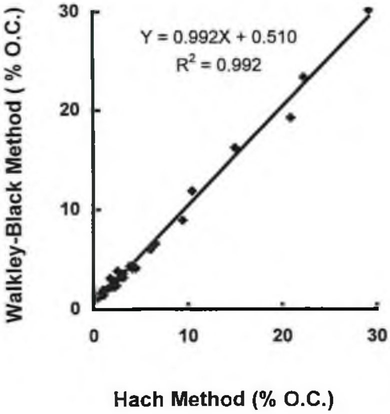

FIGURE 1. *Relationship between soil organic carbon concentrations measured by the standard Walkley-Black procedure and the Hach CEL/700 organic matter laboratory.*

less the quantity remaining after oxidation. In the Walkley-Black method, excess dichromate is determined by back-titration, but colorimetry is used to estimate excess dichromate in the Hach procedure.

Estimates of soil organic carbon obtained by dichromate oxidation typically are converted to soil organic matter values by multiplication by a factor of 2.0, because soil organic matter usually contains about 50%

TABLE 1. *Precision estimates for two methods of determining percentage soil organic carbon. Entries are based on seven replicate determinations of each sample.*

Method	Range	Mean	Standard deviation	Coefficient of variation (%)
	Low carbon concentration			
Hach	0.78–2.35	1.39	0.58	42.0
Walkley-Black	0.90–1.13	1.02	0.09	8.6
	Medium carbon concentration			
Hach	9.21–10.33	9.73	0.37	3.8
Walkley-Black	6.81–8.78	8.15	0.65	8.0
	High carbon concentration			
Hach	15.65–17.21	16.29	0.63	3.9
Walkley-Black	12.22–14.25	13.2	0.78	5.9

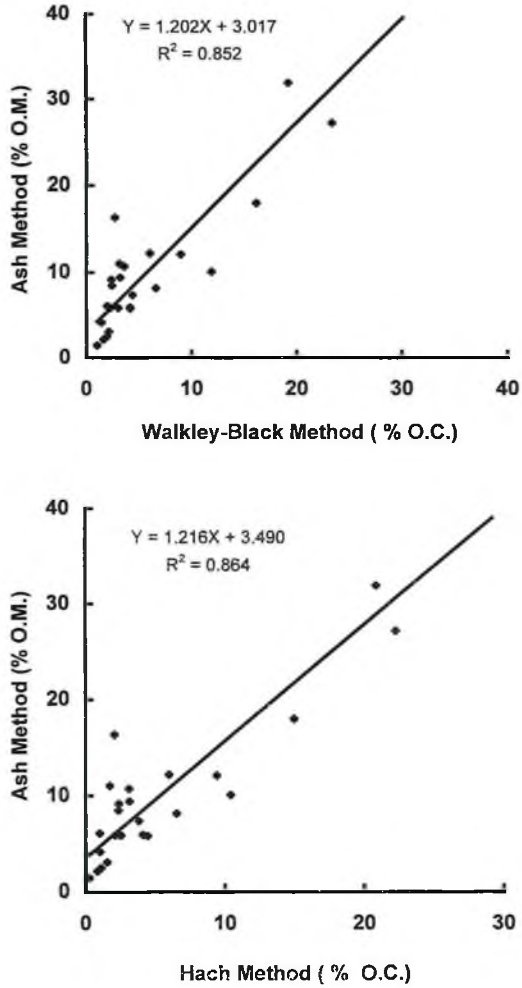

FIGURE 2. *Relationships between soil organic carbon concentrations measured by the standard Walkley-Black method and the Hach CEL/700 organic matter laboratory (X variables) and by dry ashing at 350 to 400 C for 24 h.*

carbon (Nelson and Sommers 1982). The dry ash method provides direct estimates of soil organic matter. There were good correlations between the organic carbon concentrations measured by both the Walkley-Black and Hach methods and the organic matter estimates obtained by dry ashing (Fig. 2), but the organic matter concentrations obtained by dry ashing were less than twice the organic carbon values measured by dichromate oxidation. This reveals that dry ashing at 350–400 C did not cause factory substitute for the standard sieve and mortar and pestle used in laboratories can be found with a little ingenuity.

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