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The condition index and organic content of small oyster spat

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The condition index of bivalves is measured by relating either the weight or volume of the meat to some aspect of the shell. Separation of the meat and shell by dissection in small spat is impracticable and this paper examines the value of an ashing technique to obtain a ratio of ash weight to organic matter weight. The results were consistent and the calculated condition index was closely related to an index obtained by dissection. Ashing dissected spat showed that 35 to 59% of the organic matter is in the shell.

Introduction

The condition of bivalves is normally expressed as the ratio between the wet or dry weight of the meat and either the dry weight of the shell or the volume of the internal cavity between the two shells (Walne, 1970). It is impracticable to estimate a condition index based on volume in small spat with a live weight of less than 100 mg. Spat as small as 15 to 20 mg wet weight can be dissected to provide a shell weight: meat weight ratio but it is tedious to carry out and liable to error, due to small fragments of shell becoming mixed with the meat. It is impracticable to dissect smaller spat on a routine basis. Nevertheless, there is a necessity for a method which, for comparative purposes, readily measures the meat content of batches of spat.

We initially examined three approaches to the problem using dried spat. These were: to dissolve the shell with 1·0 N hydrochloric acid and weigh the dried meat; dissolve the meat with 10% aqueous solution of sodium hypochlorite or potassium hydroxide and weigh the shell: or burn off the organic matter in a furnace and weigh the ash. Ashing the material in a furnace required less operator time and gave more consistent results than the other methods. We therefore decided to concentrate on the ashing method and the results of experiments in standardizing the technique are presented in this paper.

Methods

In these tests the spat of *Ostrea edulis* L. and *Crassostrea gigas* Thunberg (mean live weight 10–50 mg) were used. Samples were oven dried overnight at 95°C as required. The dried sample was cooled in a dessicator and then reduced to a fine powder in a ball mill. The powder was oven dried and stored in a dessicator until required. Aluminium boats were made from foil as needed. These were placed in the furnace overnight to burn off any organic material, cooled and weighed. As standard we used a round boat 16 mm in diameter but other shapes and sizes were tested. Samples of spat powder were added to the boats, oven dried at 95°C overnight, cooled in a dessicator and weighed. The samples were then ashed for five hours, allowed to cool in a dessicator and weighed.

Since the two variables estimated are the total dry weight and ash dry weight, it is appropriate to define the condition index as

$$\frac{\text{Dry ash weight}}{\text{Total dry weight}} \times 100$$

and this is the index used in this paper.

Results

Replication and comparison of ashing at 450°C *and* 500°C. A large sample of dried and milled spat powder was prepared. Five trials, with triplicate samples in each trial, were made at furnace temperatures of 450°C and 500°C using samples of 0·4 to 1·4 g of dried powder. The first three trials were made at 500°C, the furnace temperature was then reduced to 450°C for three trials, the temperature was then increased to 500°C for two trials and, finally, reduced to 450°C for the last two trials.

The mean of the triplicate condition indices (Table 1) were all very close with no consistent difference

Table 1. Estimates of condition index from the sample. Each determination is the mean of triplicate samples

Determination	Temperature °C 450°	500°
1	94·9	98·8
2	94·9	94·7
3	94·8	94·8
4	94·3	94·8
5	94·5	94·6
Mean	94·68	94·74

Table 2. The condition index of *O. edulis* spat estimated from various sizes of sample ashed in 16 mm aluminium boats. Two batches of spat, A and B, were used and two trials were made with each

Batch of spat	A		B	
Trial	1	2	3	4
Furnace temperature °C	500°	450°	450°	450°
Approximate size of sample (mg)				
50	92·9	95·1	94·6	94·4
100	93·2	94·4	94·4	94·5
250	94·4	94·7	94·5	94·9
500	94·3	94·8	94·8	94·7
1 000	94·6	94·9	94·7	94·7
2000	95·0	95·0	–	–

between the two temperatures. The 10 means had a range of 94·3 to 94·9 and an overall mean of 94·7. We concluded that 450°C was a suitable oven temperature.

Weight of sample. Four separate trials using two batches of spat were made. The results (Table 2) show that samples of 50 to 1000 mg are satisfactory when ashed at 450°C. It seems unlikely that the two smallest samples at 500°C were insufficiently ashed as the data suggest and those results were probably due to a lack of homogeneity in the powder. We concluded that a dry weight sample of 100 to 250 mg was satisfactory.

Shape and size of aluminium boat. Circular and rectangular aluminium foil boats were prepared, each in three different sizes. The condition index was estimated in two trials with each estimate in triplicate. Approximately the same weight of sample was used in each boat irrespective of size. The results (Table 3) show that all dishes give similar results.

Table 3. The mean condition index of two batches of triplicate samples ashed at 450°C in boats of different size. In trial 1 the sample size was 0·4–0·5 g and in trial 2 it was 0·2–0·3 g. Average of all means is 93·7

Shape	Base area (mm²)	Size (mm)	Condition index 1	2
Circular	201	16·0 diameter	93·9	93·9
	415	22·0 diameter	93·9	93·6
	755	29·0 diameter	93·8	93·4
Rectangular	207	25·9 × 08	93·9	93·7
	510	28·4 × 18	93·6	93·7
	784	28·0 × 28	93·7	93·6

Table 4. The mean condition index of triplicate samples of spat powder ashed at 450°C in 16 mm aluminium boats in different positions in the furnace

Position in furnace	Trial 1	2	3	Mean
Back	93·9	94·3	94·0	94·1
Middle	93·9	94·2	94·0	94·0
Front	94·0	94·3	94·1	94·1

Position in furnace. In three trials using triplicate samples the condition index was estimated in samples ashed at 450°C at the back, middle and front of the furnace. The results (Table 4) show that there was no difference between the indices estimated in these positions.

Powdering. One sample of *Ostrea edulis* of live weight 6·5 mg was divided into two sub-samples of 75 animals. After drying the sub-samples were powdered either in a pestle and mortar or in a ball mill. Triplicate samples were then ashed and the mean condition index was 90·63 and 90·10 respectively. Both methods gave an acceptably homogeneous sample.

Distribution of organic matter between shell and meat. The condition estimates made on larger animals does not usually include the organic content of the shell, but in the ashing technique described in this paper the total ash and organic matter is considered. We therefore examined the distribution of organic matter by dissecting out the meat and determining the ash content of the meat and shell separately.

In the first series of estimates (Table 5) batches of 100 spat of *O. edulis* and *C. gigas* were examined. In each batch triplicate samples of 25 individuals were dried and ashed in the usual way, while the

Table 5. Partitioning the ash and organic matter between shell and meat in six samples of oyster spat. The mean dry weight and percentage ash (= condition index) in the whole animal was estimated in three replicate samples of 25 animals. The partitioning was estimated in one sample of 25 animals and the last column shows the percentage ash (= condition index) calculated from these samples

Species	Sample	Mean dry wt (mg)	% ash in whole animal (condition index)	% total ash in shell	% total ash in meat	% total organic matter in shell	% total organic matter in meat	% ash from dissected animals (condition index)
	1	22·4	92·5	98·6	1·36	49·7	50·3	93·4
O. edulis	2	26·3	94·4	98·6	1·37	58·3	41·7	92·2
	3	14·1	92·8	97·2	2·75	37·0	63·0	91·7
C. gigas	1	14·5	91·9	98·5	1·49	47·8	52·2	94·0
	2	30·1	96·5	98·9	1·08	58·8	41·2	95·1
	3	13·0	92·2	96·1	3·90	36·9	63·1	88·0

Table 6. Partitioning the ash and organic matter between shell and meat in three samples of *Ostrea edulis*. Each condition index in whole animals was estimated from three powder sub-samples prepared from 75 spat. Each condition index in dissected animals was estimated from three replicate samples of 25 animals. In 1a, 2 and 3 the ash content of the shells of the dissected spat were determined in whole shells. In 1b the shells were ground before placing in the furnace

Sample	Mean dry wt (mg)	% ash in whole animal (condition index)	% total ash in shell	% total ash in meat	% total organic matter in shell	% total organic matter in meat	% ash from dissected animals (condition index)
1a	6·5	90·1	98·0	2·0	35·3	64·6	88·4
1b	6·5	90·1	97·8	2·2	35·9	64·1	88·1
2	10·4	91·8	96·9	3·1	38·9	61·1	90·2
3	9·4	90·9	98·0	2·0	38·4	61·6	90·8

remaining 25 spat were dissected and the shells accumulated on one tray and the meats on another. After drying these were also ashed. In the second series of estimates (Table 6) 75 spat were dried together, powdered and three sub-samples taken for ashing in the usual way while triplicate samples of 25 spat from the same batch were used for dissection.

The results show that the ash weight condition index estimated from dissected spat was close to but usually a little lower than the same index estimated from the whole animal. The data from the dissected spat allowed of the calculation of the more usual condition index

$$\frac{\text{Dry meat weight}}{\text{Dry shell weight}} \times 1000$$

A comparison of these two indices from the same samples is given in Figure 1. From this it appears that there is a reasonable linear relationship between the two methods of estimating condition.

In spat of the size which we have been examining 36 to 59% of the organic matter is in the shell. Therefore the condition index which is obtained from the

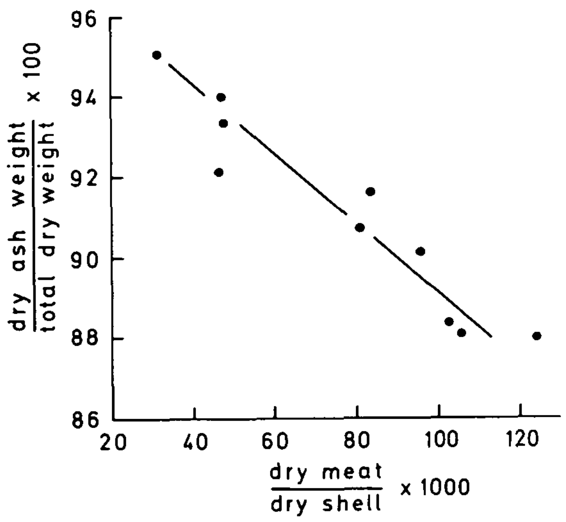

Figure 1. Relation between two condition indices. Each point represents a different sample of oyster spat. The trend line has been fitted by Bartlett's 3-point method.

ash weight is affected both by the organic matter in the shell and in the meat but nevertheless Figure 1 shows that the changes in meat weight are sufficient to affect the condition index.

Discussion

These data show that very consistent estimates of a condition index for small bivalve spat can be obtained by an ashing procedure. The size of the sample is probably influenced by the degree of homogeneity which can be obtained in the dry powdered spat. We found that, when using a ball mill, an individual sub-sample of not less than 100 mg was satisfactory. Triplicate determinations therefore require 300 to 350 mg of dried spat to be powdered. The dry weight of oyster spat is 40 to 60% of the live weight. A standard determination will therefore require 0·75 to 1·0 g of live weight material. After the appropriate weighing and drying, ashing for five hours at 450°C in a circular aluminium boat 16 mm in diameter is a satisfactory technique.

The organic content of the shell varied between 3·0% and 5·2% in the shells we examined but, because of the great weight of the shell, this fraction is 35% to 59% of the total organic matter in the animal. In comparison the shell of adult *Crassostrea virginica* from North Carolina contained 3·04% organic matter (Price et al., 1976) which was 72% of the total organic matter in the animal. Bernard (1974) estimated that the organic content of *C. gigas* shell in British Columbia is 2%. As the major part of the organic matter in the shell is protein (Wilbur, 1972) an analytical procedure which examines ground whole spat for organic matter, as in this paper or for protein by Kjeldahl analysis (Holland and Hannant, 1974), will not be directly comparable with studies made on larger animals where the meat is analysed separately from the shell.

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