Prediction of the weight of mussel and clam meat by image analysis

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INTRODUCTION

Greenshell mussels are an important exported seafood in New Zealand (more than $NZ 200 Million in 2011). One form of the product is ultra high pressure treated meat. Clams are also a valued bivalve in New Zealand. The estimation of the weight of the meat would allow automated classification of these valuable products. There are visual attributes such as color that are important for quality for both these shellfish, either in the shell, or shucked. Therefore machine vision / image analysis can perform many operations simultaneously for this industry.

OBJECTIVE

Our objective was to determine the correlation between the calibrated view area of the meat of the two shellfish and their weight..

MATERIALS AND METHODS

Shellfish

Greenshelled mussel (*Perna canaliculus*) meat, previously ultra-high-pressure treated and frozen, was obtained from a local fish market. Clams (*Austrovenus stutchburyi*) were obtained cooked in-shell from a local market. They were shucked, by hand.

Image acquisition and analysis

The meat was placed in a light box (Figures 1 and 2), and the "two image" method was used to acquire images (Alçiçek and Balaban, 2012). The LensEye software (Engineering & Cyber Solutions, Gainesville, FL) was used to analyze each image.

Since the area of the black reference square was known (see Figure 1), the view areas in pixels of the shellfish meat were converted to cm^2. The average colors (L*, a*, b*) of the individual pieces were also calculated.

Equation fitting

The following equations were fitted to the view area versus weight of the individual pieces:

Linear:

$$Y = A + B X$$

Power:

$$Y = A X^B$$

Polynomial:

$$Y = C_0 + C_1 X + C_2 X^2$$

Where X = view area (cm^2), and Y = weight (g).

The software TableCurve 3D (version 3.01, AISN Software, Florence, OR, USA) was used for this purpose.



Figure 1. Example of mussel meat images.



Figure 2. Example of clam meat images.

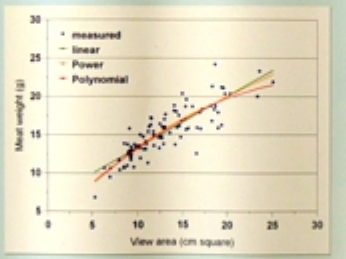


Figure 3. Equation fitting to view area vs weight. Mussel meat.

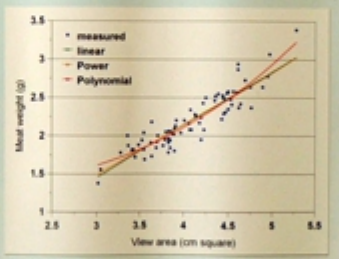


Figure 4. Equation fitting to view area vs weight. Clam meat.

Table 1. Equation fitting results to view area vs weight.

		Mussels		Clams	
Linear= Y= A+ BX		Value	SD	Value	SD
	A	6.62	1.15	-0.62	0.3
	B	0.67	0.08	0.69	0.07
	R^2	0.73		0.83	
Power= $Y=A X^B$		Value	SD	Value	SD
	A	3.31	1.19	0.38	1.2
	B	0.60	0.07	1.25	0.13
	R^2	0.76		0.83	
Polynomial	C_0	2.84		2.14	
	C_1	1.24		-0.68	
	C_2	-0.02		0.17	
	R^2	0.0.74		0.84	

RESULTS

Table 1 presents the results of equation fitting to the experimental view area versus weight data. The results are also displayed in Figures 2 and 3.

The best fit for the mussel meat was the power curve, with an R^2=0.76. The best fit for the clam meat was the polynomial curve, with an R^2 = 0.84.

DISCUSSION

It can be seen that there is some scatter in the data, as reflected by the relatively low R^2 values for the fits. Comparing these R^2 values to previously published data for whole fish (Alaska pollock, R^2 = 0.99; rainbow trout: R^2 = 0.98; and 4 species of wild Alaskan salmon: R^2 = 0.98) it can be concluded that the shape of whole fish is much more "regular" than that of mussel and clam meat.

The shellfish in this case was cooked (clams), or ultra-high-pressure treated (mussels) which firms up the meat, and therefore reduces the "scatter" of the view area data.

The low R^2 values indicate that there may be better methods to predict the weight of the shellfish meat. Image analysis / machine vision can still be used to e.g. sort the meat by color, or to detect visual defect such as off-colors.

The "two image" method was proven to be very easy to use and accurate in segmenting images for subsequent analysis.

CONCLUSION

The weight of mussel and clam meat can be predicted by measuring their view area using image analysis. However, the accuracy of the prediction is not as high as in the case of other materials.

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