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Consumer Acceptability of Melanosis Levels in Western Rock Lobster by Visual Evaluation

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ABSTRACT

A number of food products undergo browning due to enzymatic reactions that occur during processing and storage. The browning reaction has an important influence on food quality and is therefore of great importance to the food industry. The objectives of the research were to identify a visual evaluation method for determining consumer acceptability and to use the method to conduct a consumer study on acceptability of melanosis levels in western rock lobster.

Twenty photographs of lobsters containing melanosis at various stages were selected according to the colour intensity and the area of blackening. Four extra photographs having no indication of melanosis was used as a blind control. Sixty-nine volunteers assessed the degree of acceptability of melanosis level with respect to area, colour intensity and overall acceptability on a graphic line scale. A spectrophotometer was also used to measure the colour intensity of all the photographs used in the study. The correlation between the visual colour evaluation and instrumental methods was demonstrated. There were significantly difference among samples when evaluation of area, colour intensity and overall acceptability.

Consumer acceptability of melanosis levels in western rock lobster is based on area and colour intensity. Melanosis levels were found to be accepted only when occurring in a small area with low intensity. The results obtained from the consumer study showed a high correlation with spectrophotometer colour measurement (r=0.71) which indicated that the instrumental data were related to the sensory perception.

Key words: western rock lobster, melanosis, consumer acceptability, colour intensity, visual evaluation

INTRODUCTON

Seafood, particularly crustaceans, is susceptible to the development of discolouration which caused by enzymatic browning reactions was intensively studied. This discolouration causes a blackening in colour in crustaceans (Jang *et al.*, 2003). The development of black pigmentation causes appearance changes in the crustaceans. Appearance is the major attribute which consumers consider before selecting food (Haard and Simpson, 2000). Many people considered lobsters including Western Rock Lobster (WRL) to be a luxury food. The western rock lobster (*Panulirus cygnus*) is the single most valuable fishery species to be caught off the shores of Australia (Chubb and Barker, 2002).Throughout Australia, the western rock lobster fishery is the most valuable

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commercial fishing industry with an annual average value of over AUD$300 million from year 1999 to 2003 (Department of Fisheries, 2001; ABARE, 2004). The majority of the WRL catch is processed in various forms, such as, cooked and frozen raw WRL. Chen *et al*. (1991) reported that WRL was less prone to post-harvest blackening of the shell compared with other rock lobster species. However, WRL is very susceptible to post-processing melanosis of the flesh (Johnson and Evans, 1991). Areas of WRL that are prone to post-processing melanosis include the zones that are high in hemolymph, such as the heart, major arteries and the surrounding tissue. An enzyme polyphenoloxidase (PPO) is responsible for melanosis in crustacean species such as crab, lobster and shrimp (Yan *et al*., 1990). PPO by using the substrates phenols and oxygen catalyzes two basic reactions; the hydroxylation of the phenol to the o-position next to an existing hydroxyl group and the oxidation of the diphenol to obenzquinones. These are then oxidised by nonenzymatic means to brown-black pigments known as melanosis (Kim *et al*., 2000).

Melanosis leads to the less acceptability by consumers. Therefore it causes the possibility of big financial losses to the WRL industry. These findings became big problems in the marketing of the products. Melanosis reduces the value of WRL catch for Australia exporting market. The quantity of WRL wasted due to spoilage by melanosis formation is high. The aim of this research is to establish levels of melanosis in western rock lobster by visual examination.

MATERIALS AND METHODS

Sample

The photographs of lobsters containing melanosis at various stages were obtained from FRDC project 2001/235 databases (Williams, 2002). The levels of melanosis in WRL were recorded by taking a series of photographs using a high-resolution digital camera. By using a specialised digital image analysis software program known as "Scion Image" (Scion Corporation, 2004), the percentage area and colour intensity of melanosis was determined. Of all WRL samples in the database showing melanosis, the area ranged from 0.11-21.32 %. The colour intensity of melanosis was determined from the RGB colour scale (0= white, 255= black) with average pixel density ranging from 105.6-219.9. Twenty photographs were selected according to the colour intensity (degree of blackening) and the overall area of blackening. Four extra photographs of a WRL lobster having no indication of melanosis were used as blind controls. Two versions of the photograph were printed using the same printer and the same paper stock.

The first versions photographs, size A5 which are half an A4 sheet size were used for visual sensory evaluation. The second versions photographs, a full size A4 sheet were used for Minolta spectrophotometer colour measurement.

Five different area sizes and four different colour intensity ranges considered to be 20 photographs, were used. Each sample photograph was coded with a random three-digit number. A blind control sample photograph with no melanosis formation was selected and printed four times using 4 different codes shown in Table 1.

Sample presentation

The photograph samples were grouped into 4 sets for presentation. Each set had 6 photographs; 5 photographs that were randomly selected to represent all five different areas and four different intensities and a control photograph was added in every set. A Balance Block Design (Sidel and Stone, 1976) master sheet was developed to enable blind labelling of the samples and randomisation of presentation order. Each set of 6 photographs were placed in an envelope and presented to the panellist with an evaluation sheet

Table 1 Three digit coded number for 20 sample photographs selected according to color intensity and overall area of blackening.

% Area	Intensity			
	105-155	156-180	181-190	191-220
	Pale	Grey	Dark	Black
0.5-3.9	570, 175	139	812	623
4.0-7.9	826, 291	213	385	497
8.0-10.9	-	863	327	501
11.0-14.9	710	374	972	621
15.0-21.0	-	928	457	409
Control	540	839	428	147

numbered with the session code. After finishing each set, the photographs were shuffled and put back into the envelope to ensure that the next panelist avoided the order of evaluation as carried out by the previous panelist. After the session was completed the data was decoded from the master sheet and entered into the database for each panelist.

Measuring colour

The A4 photographs had their colour measured using CIE L* a* b* on a Minolta reflectance spectrophotometer. The measurement gives the colour scale of the melanosis in term of L* a* b* values. For this study only the L* value was used in analysis due to the digital image analysis only determining the colour intensity in term of dark and white only (L*). Each sample was carefully scrutinized by visual means to determine the darkest and lightest areas. The two areas were then measured using the spectrophotometer for all 24 photographs. After this the photographs were shuffled to mix them and the two areas were measured again. After completion, this was carried out one more time so that, in all 3 measurements were made of each area. The purpose of this is to ensure a reproducible result from the spectrophotometer colour measurement. The values of L* were recorded and the averages from three measurements at both areas were calculated. The L* value obtained can be compared to the intensity values determined by digital image analysis and converting intensity to L* by using the formula (Yam and Papadakis, 2004):

$$L^* = \frac{\text{Intensity}}{255} \times 100$$

Sensory evaluation procedure

In this study the consumer panel of 69 people who like WRL were chosen for evaluating the acceptability of melanosis levels in western rock lobster. Hedonic rating scale is used to measure the degree of liking or disliking for the western rock lobster samples. The required number of participants, in consumer panel recruited from volunteer adults in Curtin University and the surrounding community. Interested individuals were asked to complete a pre-screening questionnaire that requested details of time availability, health, visual acuity and food eating habits.

An evaluation form in the study has three 10-centimetre line scales, which the panelists have to rate acceptability of the sample according to 3 criteria: area of blackening, colour intensity and overall acceptance of melanosis level in western rock lobster. The unstructured line scale has advantages of providing a continuous scale without numbers which eliminates possible bias for particular numbers (Stevens and Galanter, 1957). The line scale which is word anchored at both ends will yield greater product differences than the typical category scale (Beaten, 1946). They are also highly discriminatory because they allow the

panelist infinite points at which to place their mark.

The melanosis level was evaluated on a line scale, which was anchored in the middle as neutral, and both end points with the extreme value of liking and acceptability. In this study the panelist is required to place a vertical mark across the line at the point which best reflects the magtitude of his or her perceived intensity of colour, area and overall acceptability of melanosis level occurring in the WRL samples. The marks from line scales are converted to numbers by manually measuring the position of each mark on each scale using a transparent overlay. The data was then analyzed by using SPSS version 11 for Windows software package.

Statistical analysis

Data obtained from a scaling procedure may not be suitable for parametric testing. End effects and the fact that the scale may have an unequal interval, psychologically, can distort a distribution of scores from normality. End effects will further destroy the assumption of equal variance of population (homoscedasticity), which is often required (O'Mahony, 1982). Because data from a scaling procedure can break the assumptions required for parametric analysis, some authors prefer to use a non-parametric analysis. Even though the actual scaled values may not be on interval scale, at least they can be ranked in order. Therefore, a non-parametric analysis using ranked data may be more appropriate (O' Mahony, 1986). Statistical tests of the non-parametric techniques are usually based by comparing the sum of ranks, where the measure of the central tendency used is the median and its inter-quartile range shows the spread of data. A Kruskal Wallis test which is the non-parametric equivalent to a one way ANOVA was used in this research to determine significant differences between the acceptability ratings of the samples. The data was analyzed by using SPSS version 11 for Windows software package. Correlation of the evaluation of blackening area to the colour intensity was used to indicate the significance of the relationship between acceptability of area of blackening and colour intensity. The correlation between colour intensity from spectrophotometer measurement and sensory acceptability on melanosis level was also determined.

RESULTS AND DISCUSSION

Instrumental measurement of colour

The average L* value was determined by using Minolta spectrophotometer. L* is the lightness of the component, ranging from 0=black to 100= white. RGB intensity from digital image analysis can be converted to L* value by using the formula (Yam and Papadakis, 2004) :

$$L^* = \frac{\text{Intensity}}{255} \times 100$$

The converted RGB L* value ranges from 0=white to 100=black which is in the opposite direction of spectrophotometer L*. The reason for this is because the original RGB intensity has a value of 0 = white and 255 = dark. Therefore, the correlation between converted RGB L* and spectrophotometer L* will give a negative result as shown on Figure 3. The overall acceptability score showed a strong positive correlation with L* value from spectrophotometer measurement with r value of 0.71 and $P < 0.01$ (Figure 2). From this result, it is indicated that the instrumental data were related to the sensory perception. The result obtained from sensory and instrumental evaluation showed that it is possible to predict sensory acceptability from instrumental data.

Melanosis acceptability

The sensory evaluation results obtained for the control sample, with no indication of melanosis in western rock lobster, showed no significant difference between the 4 images of the same control sample. There is no significance

difference ($P > 0.05$) between melanosis acceptability in all control samples with respected to blackening area, colour intensity and overall acceptability. Therefore, it is implied that the consumer panelists have high consistency in their evaluation and that they always rate the control samples with a high score.

There is a significance difference between acceptability of areas and colour intensities of melanosis in the samples ($P < 0.05$). The black area and colour intensity showed a very strong negative correlation with acceptability score with r value of 0.92 and 0.79, respectively and P value <0.01 (Figure 1). From this result, it indicated that the larger the black area and the higher the colour intensity the less the acceptability. The significant differences were also detected in overall acceptability levels of melanosis. Both the area of blackening and colour intensity showed a strong negative correlation with overall acceptability, with r values of 0.89 and 0.78 respectively and P value <0.01 (Figure 2). The first 3 samples, which received the highest score, were the same samples as those acceptable for the area and colour intensity (Table 2 and 3). The overall acceptability of melanosis level has a very high correlation to intensity acceptability. The result indicates that between large area with low intensity and small area with high intensity, the latter is more acceptable.

CONCLUSION

Melanosis levels in western rock lobster

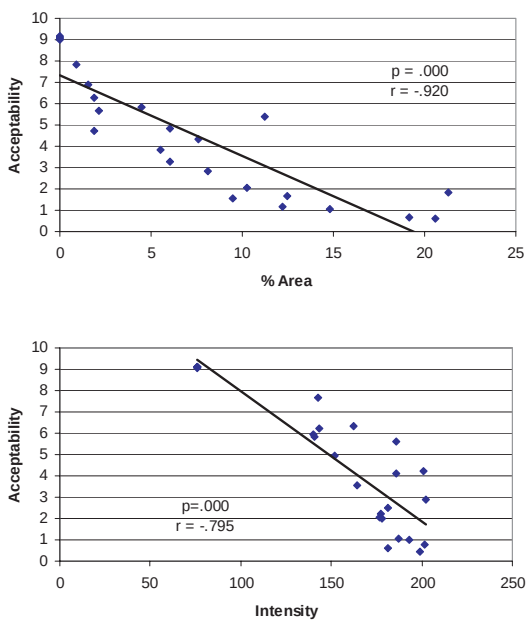

Figure 1 The relationship between area of blackening, colour intensity and acceptability.

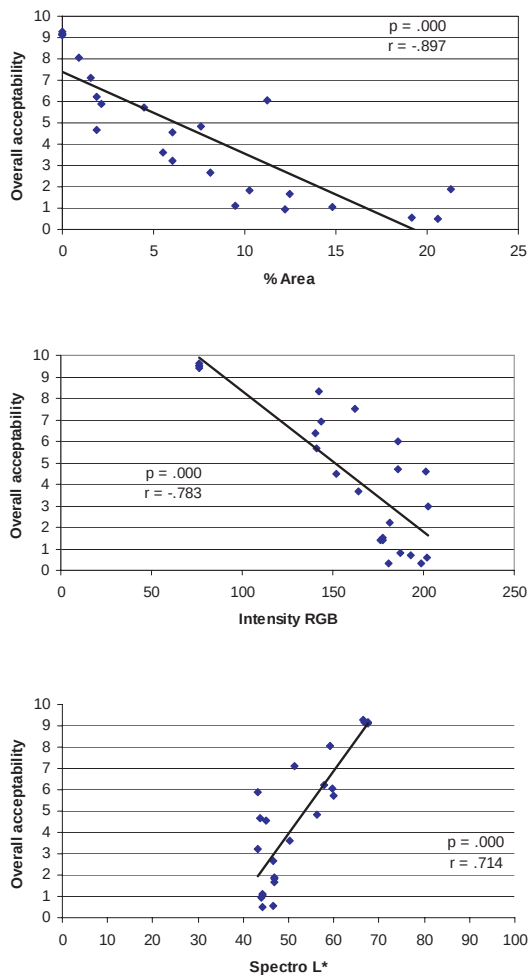

Figure 2 The relationship between area of blackening, colour intensity, spectro L* value and overall acceptability.

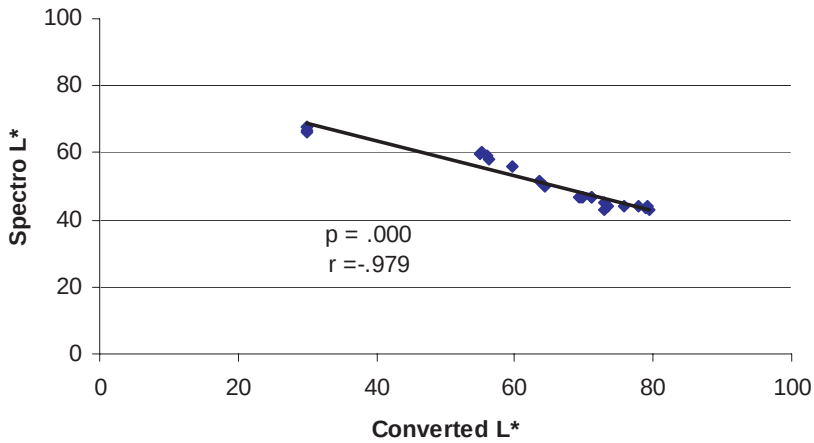

Figure 3 The relationship between converted RGB L* and spectro L*.

Table 2 Ranking of panelist preference in area of melanosis.

Photo code	%Area	Acceptability score		Kruskral wallis mean rank	Rank
		Mean	Median		
428	0	9.17	9.4	1486.82	1
147	0	9.12	9.5	1483.30	2
540	0	9.04	9.2	1467.90	3
839	0	9.00	9.2	1459.46	4
570	0.88	7.86	8.0	1297.80	5
139	1.56	6.88	7.4	1175.17	6
175	1.91	6.30	6.4	1100.20	7
826	4.50	5.84	5.9	1041.67	8
812	2.13	5.64	5.4	1021.99	9
710	11.22	5.38	5.5	980.03	10
385	6.04	4.84	4.5	909.07	11
623	1.91	4.74	4.7	900.41	12
291	7.57	4.36	4.1	839.20	13
213	5.52	3.85	3.8	769.47	14
497	6.01	3.26	3.0	683.42	15
327	8.09	2.84	2.5	614.35	16
863	10.24	2.03	1.6	482.34	17
928	21.32	1.84	1.4	425.84	18
374	12.49	1.67	1.4	415.53	19
501	9.47	1.54	1.2	376.17	20
621	12.18	1.16	0.8	295.70	21
972	14.80	1.04	0.9	285.66	22
457	19.17	0.68	0.4	192.47	23
409	20.57	0.63	0.3	180.02	24

Table 3 Ranking of panelist preference in colour intensity of melanosis.

Photo code	Intensity	Acceptability score		Kruskral wallis mean rank	Rank
		Mean	Median		
428	76.04	9.12	9.5	1487.41	1
839	76.04	9.12	9.4	1486.61	2
540	76.04	9.10	9.4	1484.68	3
147	76.04	9.05	9.4	1478.27	4
570	142.53	7.67	8.0	1290.91	5
139	162.23	6.36	6.6	1131.38	6
175	143.28	6.20	6.0	1108.05	7
710	140.27	5.94	5.8	1079.56	8
826	141	5.81	5.7	1065.62	9
812	186.11	5.60	5.5	1038.69	10
291	151.97	4.92	4.8	946.54	11
623	201.12	4.22	4.4	845.76	12
385	185.67	4.13	4.0	828.85	13
213	164.33	3.55	3.7	737.66	14
497	202.4	2.90	2.8	641.71	15
327	181.51	2.50	2.4	572.19	16
928	177.59	2.25	2.3	520.58	17
863	176.39	2.04	1.7	498.15	18
374	177.88	1.99	1.5	485.96	19
972	187.41	1.04	0.9	297.75	20
501	193.13	0.98	0.6	276.00	21
621	201.73	0.79	0.5	236.39	22
457	180.99	0.59	0.4	192.10	23
409	198.84	0.44	0.3	153.20	24

were accepted only when it occurred in a small area and low intensity. However, there was an interaction between area and colour intensity, the higher intensity with a small area was more accepted than the lower intensity with the larger area of blackening. On the other hand the consumer panelists accepted the level of melanosis which occurred in black colour with a small area more than pale colour with a big area. Both spectrophotometer and digital image analysis methods were also effective in measuring colour. The results from these two methods may be used to predict consumer acceptability in melanosis levels in western rock lobster in future study where a limited number of people are available and frequent and repetitive evaluations cannot be sustained. Base on this study, it indicated that the instrumental data were related to the sensory perception.

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Table 4 Ranking of panellist preference in overall acceptability of melanosis.

Photo code	%area	Intensity	Acceptability score		Kruskral wallis mean rank	Rank
			Mean	Median		
428	0	76.04	9.26	9.6	1486.29	1
839	0	76.04	9.18	9.5	1471.35	2
147	0	76.04	9.17	9.5	1470.99	3
540	0	76.04	9.11	9.4	1460.55	4
570	0.88	142.53	8.04	8.3	1306.16	5
139	1.56	162.23	7.10	7.5	1182.99	6
175	1.91	143.28	6.25	6.9	1112.36	7
710	11.22	140.27	6.08	6.4	1060.82	8
812	2.13	186.11	5.90	6.0	1037.51	9
826	4.50	141	5.71	5.7	1019.10	10
291	7.57	151.97	4.85	4.5	905.60	11
623	1.91	201.12	4.67	4.6	885.83	12
385	6.04	185.67	4.55	4.7	867.95	13
213	5.52	164.33	3.63	3.7	741.34	14
497	6.01	202.4	3.20	3.0	684.71	15
327	8.09	181.51	2.65	2.2	599.89	16
928	21.32	177.59	1.90	1.5	461.46	17
863	10.24	176.39	1.83	1.4	460.16	18
374	12.49	177.88	1.66	1.4	428.78	19
501	9.47	193.13	1.12	0.7	310.20	20
972	14.80	187.41	1.05	0.8	306.99	21
621	12.19	201.73	0.92	0.6	270.79	22
457	19.17	180.99	0.55	0.3	183.04	23
409	20.57	198.84	0.49	0.3	169.14	24

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LITERATURE CITED

ABARE 2004. **Australian Fisheries Statistics 2003**. Australian Bureau of Aricultural and Resource Economics, Canberra.

Beaten, W. D. 1946. Organoleptic tests pertaining to apples and pears. **Food Research** 11: 84.

Chen, J. S., R. S. Rolle, M. R. Marshall and C. I. Wei. 1991. Comparison of phenoloxidase activity from Florida spiny lobster and Western Australian lobster. **Food Science** 56(1): 154-157.

Chubb, C. F. and E. H. Barker. 2002. **Fisheries Research Report** No. 135, Fisheries Research Division, Department of Fisheries, Perth, WA.

Department of Fisheries, 2001. **Application to environment Australia on the western rock lobster fishery.** Perth, WA

Haard, N. F. and B. K. Simpson. 2000. **Seafood enzymes.** Marcel Dekker, Inc., New York.

Jang, M. S., A. Sanada, H. Ushio, M. Tanaka and T. Oshima. 2003. Inhibitory efffect of enokitake extract on melanosis of shrimp. **Fishery Science** 69(2): 379-385.

Johnson, P. and L. H. Evans. 1991. Investigation of discoloration of western rock lobster cooked product. **Aquaculture Research and Development**. Curtin University of Technology, Perth.

Kim, J., M. R. Marshall and C. Wei. 2000. Polyphenoloxidase, pp. 271-315. *In* N. F. Haard and B. K. Simpson (eds.). **Seafood enzymes:** utilization and influence on post harvest seafood quality, Marcel Dekker Inc, New York,

O'Mahony, M. 1982. Some assumptions and difficulties with common statistics for sensory analysis. **Food Technology** 36(11): 75-82.

O'Mahony, M. 1986. **Sensory evaluation of food**: Statistical methods and procedures, Marcel Deckker, New York.

Scion Corporation 2004. *Scion VisiCapture*, Available: [http://www.scioncorp.com/downloads/user_manuals/VisiCaptureWin.pdf] (May 16, 2004).

Sidel, J. L. and H. Stone. 1976. Experimental design and analysis of sensory tests. **Food Technology** 30(11): 32-38.

Stevens, S. S. and G. H. Galanter. 1957. Ratio scales and category scales for a dozen perceptual continua. **Experimental Psychology** 54: 377.

Williams, H. G. 2002. Striking balance between melanosis and weight recovery in western rock lobster. **The Lobster News** 3(11): 3-4.

Yam, K. L. and S. E. Papadakis. 2004. A simple digital imaging method for measuring and analyzing colour of food surfaces. **Food Engineering** 61(11): 137-142.

Yan, X., K. D. A. Talor and S. W. Hanson. 1990. Phenolase in Norway lobster (*Nephrops norvegicus*):Activation and purification. **Food Chemistry** 36(1): 19-30.