Seaweed Processing Study

Executive Summary

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Objectives

The Chemical Analysis Laboratories Ltd (CAL) was commissioned to undertake a study on Alaria esculenta, whereby the protocol required methods utilised by Japanese seaweed processors for preparation of post-harvest product for further use and consumption (1). The protocol was designed by Ms Watson at BIM, in order that CAL could process laboratory batches of Alaria, after which tests were carried out to measure the total viable bacterial counts (TVC) and Group 1 nutritional parameters to include Fat, Protein and Carbohydrate (CHO). The objectives were to ascertain the levels of TVC present in each batch after processing and also to study the effects of processing on the Fat, Protein and CHO content, following processing by different methods.

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Experimental Design

The protocol employed methods to precisely mirror the Japanese seaweed processing procedures on a laboratory scale. The following 18 processing methods (M1 – M18) were employed for every 500g batch prepared for further testing. It can be seen from the methods hereunder, that M1, 2, 12-14, only required a single 500g batch to be prepared, whereas M3-11, 15-18 required 10 x 500g batches, as they were dried at different temperatures. It should be noted that the batch dried at 40°C to 12% Moisture (M17 below) was employed as the Control sample for comparative purposes. It was also shown that the seaweed samples that were not dried had a moisture content of 66 – 85% with a mean value of 71%. To standardise the results, the data for Nos. M1, M2 and M12-M14 were reported at 12% Moisture and on a Dry Matter Basis (DMB). Where salting was required, the amount of salt used in each case was 150g.

The seawater used for washing was collected from Sandycove Bay at high tide. Analysis for total bacterial counts (TVC) showed that there was none detected (<10cfu/ml).

Where required, the 500g batch of seaweed was blanched for 1 minute, washed in seawater bath at ambient temperature for 2 minutes, pressed lightly to remove excess seawater, salted with 150g table salt for 24 hours and pressed with 25kg for 24 hours. The methods are summarised as follows:-

M1 - Blanch, Wash, Light Press, Salt, Press. **M2** - Wash, Light Press, Press, Salt. **M3** – Blanch, Wash, Light Press, Salt, Press, Desalt, Chop, Dry at 40°C. **M4** – Blanch, Wash, Light Press, Salt, Press, Desalt, Chop, Dry at 70°C. **M5** – Blanch, Wash, Light Press, Salt, Press, Desalt, Chop, Dry at 90°C. **M6** – Blanch, Wash, Press Lightly, Press, Chop and Dry at 40°C. **M7** – Blanch, Wash, Press Lightly, Press, Chop and Dry at 70°C. **M8** – Blanch, Wash, Press Lightly, Press, Chop and Dry at 90°C. **M9** - Wash, Press Lightly, Press, Chop and Dry at 40°C. **M10** - Wash, Press Lightly, Press, Chop and Dry at 70°C. **M11** - Wash, Press Lightly, Press, Chop and Dry at 90°C. **M12** - Blanch, Wash, Light Press, Salt, Press, Freeze. **M13** - Blanch, Wash, Light Press, Press, Freeze. **M14** - Wash, Light Press, Press, Salt, Freeze. **M15** – Blanch, Wash, Light Press, Dry at 40°C. **M16** – Blanch, Wash, Light Press, Dry at 90°C. **M17** – Dry at 40°C. **M18** – Dry at 90°C.

Analytical Methodology

Aerobic colony count: 30°C Pour plate using PCA, 48-hour incubation. **Determination of total fat and moisture:** CEM SMART Trac II™ Rapid Fat and Moisture/Solids Analyser. **Determination of ash:** Microwave Furnace. **Determination of nitrogen (protein):** LECO Nitrogen Determinator, (protein conversion factor = 6.25). **Total carbohydrate (by difference):** % Carbohydrate = 100 - (%Moisture + % Fat + % Protein + % Ash). **Energy calculations:** Calculations according to McCance and Widdowson. The Composition of Foods.

Results

Tables 1 - 2 show the results of each processing method at 12% Moisture and also on a DMB. It should be noted that Method 1 – 18 are referred to as M1 – M18.

To summarise the results obtained in this study, the following tables show all the data for each processing method at 12% Moisture (Table 1) and on DMB (Table 2).

Table 1. Summary TVC and Nutritional Parameters of Alaria by M1-M18. Results at 12% Moisture.

	M1	M2	M3	M4	M5	M6	M7	M8	M9
Fat %	1.6	0.5	0.3	0.6	0.7	0.9	0.9	1	0.6
Ash %	58.7	61.4	63.8	51.9	47.9	23.2	23.3	27.6	50.6
Protein %	8	7.3	8.1	10.3	10.5	21	20.8	18.3	10.6
E (kcal)	124.2	107.6	98.8	144.1	163.3	263.7	263.9	246.8	150.9
E (kJ)	528	462.9	419.1	614.9	696.2	1121.4	1119.1	1047.5	641.8
CHO %	19.7	19.1	16	25.3	28.9	43	43	41.3	26
TVC cfu/ml	730	<10	3,600	90	210	>300,000	<10	<10	80

	M10	M11	M12	M13	M14	M15	M16	M17	M18
Fat %	0.6	0.8	0.6	0.6	1.1	0.9	0.6	0.6	0.7
Ash %	50.4	40	50.7	23.4	57.6	28	33.5	29.6	28.4
Protein %	11.5	12.7	12.3	24.6	9.9	18.2	17.5	15.7	18.5
E (kcal)	154.2	196.2	152.5	102.9	124.9	244.1	237.4	236.9	241.2
E (kJ)	652.4	830.7	642.3	434.3	533.7	1037	1007.8	1004.7	1025.7
CHO %	25.4	34.4	24.3	40	19.3	41	36.4	42	40.4
TVC cfu/ml	50	130	5,100	120	67,000	7,800	<10	230,000	110

Table 2. Summary Nutritional Parameters of Alaria by M1-M18. Results on DMB.

	M1	M2	M3	M4	M5	M6	M7	M8	M9
Fat %	1.8	0.6	0.3	0.6	0.8	1	1.1	1.1	0.7
Ash %	66.8	69.7	72.5	59	54.4	26.4	26.4	31.3	57.5
Protein %	9.1	8.3	9.2	11.8	11.9	23.9	23.6	20.8	12
E (kcal)	141.2	122.3	112.3	163.8	185.5	299.7	299.8	280.4	171.5
E (kJ)	600	526	476.3	698.8	790.7	1274.4	1271.5	1190.2	729.2
CHO %	22.4	21.7	18.2	28.8	32.9	48.9	48.8	46.9	29.5

	M10	M11	M12	M13	M14	M15	M16	M17	M18
Fat %	0.7	0.9	0.7	0.6	1.3	1	0.7	0.7	0.7
Ash %	57.3	45.5	57.7	26.6	65.5	31.8	38.1	33.6	32.3
Protein %	13.1	14.4	14	27.9	11.3	20.7	19.9	17.9	21
E (kcal)	175.2	223	173.3	116.9	141.9	277.4	269.7	269.1	274.3
E (kJ)	741.2	944	729.9	493.5	606.5	1179	1145	1141.4	1166.1
CHO %	28.9	39.1	27.7	45.5	21.9	46.6	41.4	47.7	45.9

Discussion

M1 showed normal fat and protein levels, but low CHO compared to reported reference values (2 - 3). It should be noted that the reference values cited were on a on a dry matter basis. Although a blanching step was employed the TVC of 730cfu/ml was low. A slightly raised Fat level was shown compared to the Control (M17), but Protein and CHO were significantly lower that the Control levels.

M2 showed low fat, protein levels and CHO compared to reported reference values. Although a blanching step was not employed, the TVC of <10cfu/ml was unexpected and would not be considered a hazard to human health. A similar Fat level was shown compared to the Control, but Protein and CHO were significantly lower that the Control levels.

M3 showed lowest fat, low protein levels and CHO compared to reported reference values. Although a blanching step was employed the TVC of 3,600cfu/ml may have been related to the drying step at 40°C. which would have allowed bacterial growth. However, this value was low. A low Fat level was shown compared to the Control, and Protein and CHO were significantly lower that the Control levels.

M4 showed low fat and CHO levels compared to reported reference values. Although a blanching step was employed the reduced TVC compared to M3 of 90cfu/ml may have been related to the drying step at 70°C. which would have inhibited bacterial growth. However, this value was low and would not be considered a hazard to human health. A similar Fat level was shown compared to the Control, but Protein and CHO were significantly lower that the Control levels.

M5 showed low fat and slightly higher CHO levels compared to reported reference values. Although a blanching step was employed the reduced TVC compared to M3 of 210cfu/ml may have been related to the drying step at 90°C. which would have inhibited bacterial growth. A similar Fat level was shown compared to the Control, with Protein and CHO were slightly higher that the batch dried at 70°C.

M6 showed fat within the guide level and protein above the reference levels. Higher CHO levels compared to previous results were also noted, being also above the Control level. Although a blanching step was employed the TVC of >300,000cfu/ml may have been related to the drying step at 40°C. which would have allowed bacterial growth. However, this value was very high and may be considered a hazard to human health. A similar Fat level was shown compared to the Control, with Protein and CHO higher than previous batches and above the Control levels.

M7 showed similar results to M6, with Fat within the guide level and protein above the reference levels. Higher CHO levels compared to previous results were also noted, being also above the Control level and close to the Reference level. Although a blanching step was employed the TVC <10cfu/ml may have been related to the drying step at 70°C. which would have inhibited bacterial growth. A similar Fat level was shown compared to the Control, with Protein and CHO higher than previous batches and above the Control levels.

M8 showed similar results to M6, with Fat within the guide level and Protein above the Reference levels. Higher CHO levels compared to previous results were also noted, being also above the Control level on a DMB basis and close to the Reference level. Although a blanching step was employed the TVC <10cfu/ml may have been related to the drying step at 90°C. which would have inhibited bacterial growth. A similar Fat level was shown compared to the Control, with Protein and CHO higher than previous batches and above the Control levels.

M9 showed fat below the guide level and Protein within the reference levels. Lower Protein and CHO levels compared to previous results were also noted, with the CHO being also below the Reference levels. Although no blanching step was employed, the TVC 80cfu/ml was low considering the drying step at 40°C. which should have allowed bacterial growth. Similar Fat, Protein and CHO were shown, lower than previous batches and below the Control levels in both batches.

M10 showed Fat below the guide level and Protein within the reference levels. Lower Protein and CHO levels compared to previous results were also noted, with CHO being also below the Reference levels. Although a blanching step was not employed, the TVC of 50cfu/ml was found and may have been related to the drying step at 70°C. which would have inhibited bacterial growth. Similar Fat, Protein and CHO was shown, lower than previous batches and below the Control levels in both batches.

M11 showed Fat below the guide level and Protein within the reference levels. Lower Protein and CHO levels compared to previous results were also noted, with the CHO being higher than M10, but below the Reference levels. Although a blanching step was not employed the TVC of 130cfu/ml was low and may have been related to the drying step at 90°C. which would have inhibited bacterial growth. Similar Fat, Protein and CHO was shown to M10 and below the Control levels in both batches.

M12 showed Fat below the Reference levels and Protein within the Reference levels. Similar Protein but lower CHO levels compared to M11 were also noted, but below the Reference levels. Although a blanching step was employed, the TVC of 5,100cfu/ml may have been related to the drying step not being employed. Similar Fat, Protein and CHO to M10 were shown, with CHO below the Control level in both batches.

M13 showed Fat below the Reference levels and Protein higher than the Reference levels. Protein levels were within the Reference levels with high CHO levels compared to M12. A blanching step was employed and the TVC of 120cfu/ml was low. Similar Fat, higher Protein and CHO were shown, compared to M12.

M14 showed Fat within the Reference levels and Protein just within the Reference levels, with low CHO levels compared to M12. No blanching step was employed the TVC of 67,000cfu/ml was high, which may have allowed bacterial growth. Similar Fat, lower Protein and CHO were shown compared to M13.

M15 showed Fat within the Reference levels and Protein just above the Reference levels, with similar CHO levels compared to M12. A blanching step and a drying step at 40°C. were employed and the

TVC of 7,800cfu/ml was high, which may have allowed bacterial growth. Similar Fat and higher Protein and CHO were shown compared to Control levels.

M16 showed Fat lower than the Reference levels and Protein at the higher end of the Reference levels, with CHO below the Reference levels. A blanching step and a drying step at 90°C. was employed and the TVC of <10cfu/ml was demonstrated, which would have inhibited bacterial growth. Similar Fat, slightly higher Protein and CHO just below the Control levels were shown.

M17 showed Fat lower than the Reference levels and Protein at the higher end of the Reference levels, with CHO below the Reference levels for the 12% Moisture only. A drying step at 40°C. was employed and the TVC of 230,000cfu/ml was high which may have allowed bacterial growth. A similar Fat, slightly higher Protein and CHO were shown, above the Control level.

M18 showed Fat lower than the Reference levels and Protein above the Reference levels, with CHO just below the Reference levels. A drying step at 90°C. was employed and the TVC of 110cfu/ml was demonstrated, which would have inhibited bacterial growth. A similar Fat, slightly higher Protein and CHO just below the Control level were shown.

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References

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