# ESTIMATIONS OF EXTINCTION RATIOS AND VITAMIN A POTENCY OF 12 REDUCTION PLANT OILS

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In recent months, the Seattle laboratory has received numerous requests for information concerning the vitamin A potencies of the oils produced by the local fish reduction plants. Most, if not all of these oils, are of low potency and any estimates of vitamin A content based upon non-biological methods may be in error.

In order to appraise the difficulties involved in the accurate determination of the vitamin A content of the oils, a number of them were obtained for study. Descriptions of the oils chosen are given in Table 1 (see p. 17).

Oser, et al,[1/] have shown that unless the extinction ratio $\frac{E\ 300}{E\ 328}$ is 0.72 or less, vitamin A values as determined by the ultraviolet absorption method are likely to be unreliable, even if the values are determined on the unsaponifiable portion of the oil. The extinction ratios $\frac{E\ 300}{E\ 328}$ of the 12 reduction plant oils examined (Table 2, p. 16) were all greater than 0.72. Saponification resulted in lower ratios, but did not reduce any of them to the 0.72 level. The unsaponifiable fractions of Sample No. 10 (English sole) and Sample No. 12 (ratfish) had very abnormal ratios.

It is obvious from these data that no great reliance can be placed on the vitamin A potency estimated by the ultraviolet absorption method even when the unsaponifiable portion of the oil is used. Nevertheless, a rough estimation of the potency of the reduction plant oils studied may be of interest. The data presented in Table 3 (see p. 17) indicate that the potency determined by the ultraviolet absorption and the antimony trichloride methods are in poor agreement, except for the oil from rockfish.

The data in Table 3, especially for Samples No. 11 and No. 12 which were known not to be mixtures, indicate that grayfish and ratfish carcasses are poor sources of vitamin A oils. Evidently, when these carcasses are mixed with rockfishes, or sources of a higher vitamin A potency, they serve only to lower the potency of the resulting oil. Thus, it may be advisable to separate the species yielding high potency oils from those yielding low potency oils. This problem will receive further attention by the staff of the laboratory.

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1/Oser, B. L.; Melnick, D.; Pader, M.; Roth, R.; and Oser, M. Ind. Eng. Chem., Anal. Ed. 17, 559-62 (1945).

Table 2 - The Extinction Ratio of the Whole Oil and its Unsaponifiable Fraction

| Sample No. | Source of Oil | Source of Vitamin A | Extinction Ratio $D_\lambda/D_{328}$ for Wave Lengths in mmu. ($\lambda$) | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 300 | 302.5 | 305 | 307.5 | 310 | 312.5 | 315 | 317.5 | 320 | 322.5 | 325 | 330 | 335 | 340 | 345 | 350 |
| 1 | Rockfish offal | Whole Oil | 0.934 | 0.951* | 0.968 | 0.989* | 1.010 | 1.069* | 1.125 | 1.142* | 1.115 | 1.071* | 1.035 | 0.978 | 0.893 | 0.795 | 0.684 | 0.575 |
| | | Unsap. | 0.790 | 0.828 | 0.866 | 0.923 | 0.958 | 0.980 | 0.992 | 0.998 | 1.007 | 1.020 | 1.022 | 0.972 | 0.878 | 0.777 | 0.656 | 0.530 |
| 2 | Rockfish & sole offal | Whole Oil | 0.910 | 0.928* | 0.945 | 0.965* | 0.985 | 1.020* | 1.054 | 1.066* | 1.059 | 1.040* | 1.022 | 0.980 | 0.900 | 0.813 | 0.726 | 0.627 |
| | | Unsap. | 0.842 | 0.876 | 0.916 | 0.950 | 0.985 | 0.998 | 1.010 | 1.016 | 1.022 | 1.033 | 1.025 | 0.974 | 0.895 | 0.785 | 0.670 | 0.556 |
| 3 | Ratfish carcass | Whole Oil | 1.589 | 1.572* | 1.555 | 1.502* | 1.448 | 1.547* | 1.668 | 1.663 | 1.508 | 1.294* | 1.117 | 0.954 | 0.836 | 0.727 | 0.650 | - |
| | | Unsap. | 1.044 | 1.068 | 1.085 | 1.090 | 1.100 | 1.108 | 1.102 | 1.085 | 1.060 | 1.040 | 1.022 | 0.976 | 0.869 | 0.765 | 0.678 | 0.579 |
| 4 | Grayfish & ratfish carcasses | Whole Oil | 1.185 | 1.182* | 1.180 | 1.172* | 1.163 | 1.243* | 1.349 | 1.363* | 1.287 | 1.171* | 1.070 | 0.965 | 0.870 | 0.767 | 0.680 | 0.590 |
| | | Unsap. | 0.890 | 0.920 | 0.946 | 0.980 | 1.010 | 1.028 | 1.038 | 1.036 | 1.030 | 1.030 | 1.021 | 0.977 | 0.880 | 0.777 | 0.675 | 0.561 |
| 5 | Ratfish carcass | Whole Oil | 1.785 | 1.770 | 1.680 | 1.567* | 1.520 | 1.600* | 1.730 | 1.730* | 1.585 | 1.348* | 1.140 | 0.936 | 0.820 | 0.721 | 0.650 | 0.596 |
| | | Unsap. | 1.005 | 1.020 | 1.017 | 1.022 | 1.043 | 1.065 | 1.084 | 1.075 | 1.035 | 1.005 | 0.997 | 0.986 | 0.875 | 0.750 | 0.707 | 0.644 |
| 6 | Rockfish offal | Whole Oil | 0.958 | 0.978* | 0.991 | 0.997* | 1.020 | 1.066* | 1.110 | 1.127* | 1.110 | 1.072* | 1.035 | 0.980 | 0.900 | 0.805 | 0.704 | 0.600 |
| | | Unsap. | 0.788 | 0.822 | 0.862 | 0.904 | 0.938 | 0.965 | 0.980 | 0.989 | 1.004 | 1.020 | 1.019 | 0.975 | 0.878 | 0.772 | 0.658 | 0.535 |
| 7 | Uniden-tified | Whole Oil | 1.045 | 1.065 | 1.070 | 1.066* | 1.070 | 1.074* | 1.090 | 1.090* | 1.075 | 1.058* | 1.035 | 0.974 | 0.896 | 0.814 | 0.733 | 0.650 |
| | | Unsap. | 0.954 | 0.976 | 1.000 | 1.030 | 1.055 | 1.065 | 1.065 | 1.050 | 1.045 | 1.036 | 1.026 | 0.968 | 0.880 | 0.767 | 0.657 | 0.540 |
| 8 | Col. River Smelt offal | Whole Oil | 1.028 | 1.038 | 1.030 | 1.016 | 1.016 | 1.035 | 1.062 | 1.083 | 1.083 | 1.068 | 1.040 | 0.987 | 0.900 | 0.800 | 0.708 | 0.612 |
| | | Unsap. | 0.932 | 0.944 | 0.954 | 0.968 | 0.987 | 0.990 | 1.000 | 0.990 | 1.010 | 1.015 | 1.015 | 0.973 | 0.898 | 0.805 | 0.702 | 0.600 |
| 9 | Rockfish offal | Whole Oil | 0.979 | 1.010 | 1.025 | 1.032 | 1.038 | 1.056 | 1.090 | 1.115 | 1.112 | 1.087 | 1.045 | 0.967 | 0.870 | 0.761 | 0.645 | 0.542 |
| | | Unsap. | 0.817 | 0.850 | 0.886 | 0.928 | 0.962 | 0.983 | 0.995 | 1.003 | 1.014 | 1.025 | 1.023 | 0.972 | 0.876 | 0.770 | 0.652 | 0.527 |
| 10 | English Sole offal | Whole Oil | 1.630 | 1.660 | 1.654 | 1.574 | 1.474 | 1.405 | 1.400 | 1.425 | 1.430 | 1.340 | 1.190 | 0.908 | 0.742 | 0.618 | 0.523 | 0.444 |
| | | Unsap. | 1.356 | 1.377 | 1.372 | 1.368 | 1.346 | 1.313 | 1.280 | 1.230 | 1.165 | 1.110 | 1.056 | 0.963 | 0.870 | 0.782 | 0.706 | 0.624 |
| 11 | Grayfish carcass | Whole Oil | 1.342 | 1.351 | 1.324 | 1.278 | 1.247 | 1.255 | 1.278 | 1.278 | 1.231 | 1.156 | 1.074 | 0.958 | 0.850 | 0.745 | 0.636 | 0.530 |
| | | Unsap. | 1.022 | 1.044 | 1.055 | 1.062 | 1.073 | 1.073 | 1.070 | 1.062 | 1.052 | 1.045 | 1.037 | 0.974 | 0.876 | 0.762 | 0.652 | 0.537 |
| 12 | Ratfish carcass | Whole Oil | 1.700 | 1.698 | 1.640 | 1.560 | 1.490 | 1.487 | 1.514 | 1.500 | 1.413 | 1.280 | 1.135 | 0.934 | 0.797 | 0.687 | 0.595 | 0.510 |
| | | Unsap. | 1.387 | 1.377 | 1.347 | 1.304 | 1.309 | 1.330 | 1.336 | 1.280 | 1.185 | 1.108 | 1.040 | 0.974 | 0.878 | 0.755 | 0.677 | 0.592 |

*Values obtained by interpolation

Table 1 - Description of Oil Samples

| Sample No.[1] | PROBABLE SOURCE OF OIL[2] Common and Scientific Names | Type of Waste | OIL Color | Free Fatty Acids | Index of Refraction at 20°C. | Unsaponifiable Matter |
|---|---|---|---|---|---|---|
| | | | | Percent | | Percent |
| 1 | Rockfish (Sebastodes pinniger) | Offal | Orange | 1.12 | 1.4775 | 5.4 |
| 2 | | 50% rockfish & 50% sole offal | Red | 5.32 | 1.4782 | 8.2 |
| 3 | Ratfish (Hydrolagus colliei) | Carcass | Amber | 1.73 | 1.4725 | 27.4 |
| 4 | | 50% grayfish 50% ratfish | " | 0.78 | 1.4745 | 21.8 |
| 5 | | Carcass | Brown | 0.52 | 1.4710 | 30.5 |
| 6 | Rockfish | Offal | Orange | 1.80 | 1.4772 | 12.5 |
| 7 | | Unidentified | Red | 3.48 | 1.4752 | - |
| 8 | Columbia River Smelt (Thaleichthys pacifious) | Offal | Amber | - | - | 15.3 |
| 9 | Rockfish | Offal | Amber | - | - | 3.4 |
| 10 | English Sole (Parophrys vetulus) | Offal | Amber | - | - | 2.7 |
| 11[3] | Grayfish (Squalus suckleyi) | Carcass | Amber | - | - | 12.6 |
| 12[4] | Ratfish | Carcass | Amber | - | - | 32.0 |

1/Samples 8, 9, and 10 were produced by wet rendering. The remaining oils were produced by dry rendering.

2/The principal constituents as estimated by the production plant manager. Usually varying amounts of other species such as skates and other scrap fish were also present.

3/Grayfish only, not a mixture.

4/Ratfish only, not a mixture.

NOTE: "Offal" is the waste portion remaining from filleting operations on rockfish and sole and from dressing operations on Columbia River smelt. "Carcass" is the round fish in the case of ratfish and skates and the round fish with the liver removed in the case of ratfish.

Table 3 - Comparison of Vitamin A Potency of Oils as Determined by the Ultraviolet Absorption and by the Antimony Trichloride Methods

| Sample No. | Source of Oil | ESTIMATED VITAMIN A POTENCY: Ultraviolet Absorption Method at 328 mmu. Whole Oil | Ultraviolet Absorption Method at 328 mmu. Unsaponifiable Portion | Antimony Trichloride Method at 620 mmu. Whole Oil[1] | Deviation of potency estimated by ultraviolet method on the unsaponifiable portion from the antimony trichloride method on the whole oil |
|---|---|---|---|---|---|
| | | USP units per gram | USP units per gram | USP units per gram | Relative percent |
| 1 | Rockfish offal | 2140 | 1881 | 1819 | -3.4 |
| 2 | Rockfish and Sole offal | 2350 | 1664 | 1717 | +3.1 |
| 3 | Ratfish carcass | 1010 | 772 | 614 | -25.7 |
| 4 | Grayfish and Ratfish | 1080 | 921 | 787 | -17.0 |
| 5 | Ratfish carcass | 770 | 481 | 310 | -55.2 |
| 6 | Rockfish offal | 2340 | 1917 | 1848 | -3.7 |
| 7 | Unidentified | 1890 | 1162 | 1006 | -15.5 |
| 8 | Columbia River Smelt offal | 490 | 479 | 372 | -28.8 |
| 9 | Rockfish offal | 1310 | 1163 | 1000 | -16.3 |
| 10 | English Sole offal | 360 | 241 | - | - |
| 11 | Grayfish carcass | 700 | 606 | 410 | -47.8 |
| 12 | Ratfish carcass | 500 | 368 | 204 | -80.4 |

1/Results were not obtained for the antimony trichloride method on the unsaponifiable portion