Technical Papers

The Effect of Drying Temperature on the Folic Acid Content of Herring Meal[1]

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Biely *et al.* (*1*) showed that when fishmeal alone replaced the combination of soybean oil meal, fishmeal, and meat meal ordinarily used in the Connecticut high energy broiler ration, the growth rate of the chicks fed the ration was lowered. It was suggested that the elimination of soybean oil meal from the ration lowered the folic acid content of the ration below the optimum requirement of the chick. Lillie and Briggs (*2*), in a study of the folic acid content of different feedstuffs by the chick assay method, found that menhaden meal showed no folic acid activity. Cheldelin, Woods, and Williams (*3*) reported that cooking destroyed or rendered unavailable as much as 74% of the folic acid content of halibut and salmon flesh.

In the following experiment a study was made of the effect of processing temperature on the folic acid content of herring meals. Two sets of meals were tested. The first set was made from herring caught in November 1951, and the second from herring caught in January 1952. Each set comprised a low-temperature meal and a normal meal made from the same lot of herring press cake. The low-temperature meals were made by drying the press cake in a current of air maintained at 100°–110° F. The normal meals were dried by the commercial flame-drying method.

The folic acid content of the herring meals was determined microbiologically,[3] using *Streptococcus faecalis* as test organism. The herring meals were prepared for analysis by digestion of oil-free samples with hog kidney conjugase as recommended by Bird *et al.* (*4*).

The results of the assay are given in Table 1. It will be seen that there was a marked difference in the folic acid content of the herring meals prepared from the same raw material, depending on the temperature at which the meals were dried. The two meals that were dried at 100°–110° F contained 4.1 and 4.7 γ folic acid/g. The commercial herring meals, although processed from the same lots of herring press cake as the corresponding low-temperature meals, contained only 0.29 and 0.27 γ folic acid/g.

In addition to the microbiological assays, a chick biological experiment was carried out with the various herring meals. Each of the herring meals was added as the sole protein supplement to the chick ration shown in Table 1. The experimental rations were fed with and without supplementary folic acid. Each ration was fed *ad lib* to duplicate lots of 20 day-old White Leghorn cockerels.

TABLE 1

Folic Acid Activity of Low-Temperature and Commercially Processed Herring Meal

Description of herring meal added to basal ration*	Folic acid content of herring meal (γ/g)		Av wt (g) of chicks fed basal rations	Av wt (g) of chicks fed basal ration supplemented with folic acid (0.35 mg/lb)
Low temperature (Nov. 1951)	4.1	Lot A	213	212
		Lot B	221	226
		Av	217	219
Commercial (Nov. 1951)	0.29	Lot A	165	219
		Lot B	161	222
		Av	163	220
Low temperature (Jan. 1952)	4.7	Lot A	214	203
		Lot B	205	218
		Av	210	210
Commercial (Jan. 1952)	0.27	Lot A	144	223
		Lot B	166	214
		Av	155	218

* Composition of basal ration:

Ground yellow corn	78.16 lb.
Iodized salt	0.5 "
Feeding oil (2250 A, 300 D)	0.25 "
Limestone	1.25 "
Choline chloride (25%)	0.25 "
Manganese sulphate	10.0 g
Nicotinic acid	0.8 "
Calcium pantothenate	0.5 "
Riboflavin	0.16 "

The herring meal in question was added to the above basal ration to raise the protein level to 21%. Adjustment was made for the slight differences in the moisture content of the meals.

From the average weights of the chicks on the different experimental rations as shown in Table 1, it will be seen that, with the basal ration employed, both the meals dried at low temperatures promoted a faster rate of growth than did the corresponding commercially dried meals. The addition of 0.35 mg folic acid/lb of diet was without effect on the growth rate of chicks fed the diets containing the low-temperature dried meals. When, on the other hand, this amount of folic acid was added to the rations containing the commercially dried herring meals, the growth rate of the chicks fed these rations was stimulated to equal that of the chicks on the diets containing the meals dried at low temperatures.

It is concluded from the data obtained in the microbiological assays and the chick biological test that the

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[2] Contribution No. 72.

[3] Difco folic assay medium was used.

high temperatures employed in the flame-drying process in the commercial manufacture of herring meals are responsible for the low folic acid content of these meals.

References

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Reactions of the Porpoise to Ultrasonic Frequencies[1]

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Whales and porpoises make many varieties of sounds under water (*1–6*). In the case of the bottlenose dolphin, *Tursiops truncatus* (Montagu), these can range from a low growl and groanlike sound, in the general pitch range of the bark of a seal or sea lion, to a shrill whistle which may go to several thousand cycles/sec (*4, 5*). Little is known of the way in which the porpoises themselves respond to such sounds, although they have been observed to react to artificial noises produced under water. Howell (*7*) and Fraser (*2*) report that the use of a supersonic depth finder by a vessel near a school of porpoises will immediately drive them away.

The acoustic receptor of the porpoise, moreover, is a highly developed organ especially adapted to receive sounds in a medium as dense as water (*8*), yet the olfactory or chemical sense, which is present in most fishes, is absent altogether in these cetaceans (*5, 8*). This is no less than astonishing in view of the fact that porpoises obtain all their food under water. These animals must consequently locate food by some sense or senses other than olfaction, quite likely by vision and by hearing.

Evidence from neuroanatomy supports further the view that audition is a dominant, if not the dominant, sense in the porpoise. The temporal lobes, including the cortical area for acoustic reception, are tremendously enlarged (*8, 9*). In fact, in the case of *T. truncatus,* the cerebral hemispheres are in some cases actually wider than they are long. Such a development parallels the enlargement of the frontal lobes in man, or the unusual size of the olfactory bulbs in the dog. The anatomical data point, therefore, to a kind of superacoustical area in the cerebral cortex, which in turn suggests a functional capacity, so far as hearing is concerned, which may far exceed that of other animals.

Preliminary observations on the auditory sensitivity of the porpoise were recently made at the Marine Studios at Marineland, Fla., where captive animals are available for scientific study. The subjects included 12 individuals, 10 of which were *T. truncatus,* and 2 long-snouted dolphins, *Stenella plagiodon* (Cope). These animals were kept together in a large circular tank 12 ft deep and 75 ft in diameter.[2] The sound-producing gear consisted of an oscillator with a frequency range of 20–200,000 cps, which activated a 20-w amplifier whose response characteristic was essentially linear to 100,000 cycles. Projection of these frequencies into the water was accomplished by a USRL transducer, type 1K, which was lent by the U. S. Navy on ONR contract.[3] That the equipment was capable of faithfully transmitting vibrations in water up to 200,000 cps was empirically determined by a special hydrophone and underwater sound pickup apparatus, recording through an oscilloscope. When used with porpoises, the apparatus was adjusted so as to produce a minimum underwater sound pressure of 4.03 dynes/cm^2 at a distance of 4 m from the transducer.

Since the observations were to be made in terms of the reactions or responses to auditory vibrations alone, and since porpoises are notoriously wary of strange objects in the water (*5*), it was necessary to allow a preliminary period of adaptation or adjustment to the visual appearance of the transducer before any of the actual sound tests were begun. To this end an exact wooden replica of the transducer was constructed to be used as a kind of stage "stand-in" for the real article. This model was kept intermittently in the tank at a fixed place and depth (*ca.* 5′) for a period of 2 weeks before the genuine transducer was substituted for it. In this way the porpoises learned to adjust to the sight of the new object and to accept it as a regular part of the environment.

The sound stimuli given in the tests were presented in short units or bursts of 2–3 sec. The bursts were given independently, and the porpoise reactions before and after each stimulus were compared. The time interval between stimuli was irregularly varied from 30 sec to several minutes during any single period of observation. Two to 4 observers were continuously on hand at the windows or portholes in the sides of the tank beneath the water level whenever tests were conducted. No stimulus was ever credited with producing a positive response unless all observers agreed that such a response had occurred. Since the projector or transducer focused sounds in a concentrated cone of 75°, the sound stimuli for testing were found to be most effective when the animals were swimming within this cone. The relative positions of observers, transducer, and porpoises are diagrammed in Fig. 1.

The porpoises were in continuous motion both during periods of daylight observation and during night

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[3] Invaluable technical and consulting assistance on the projection and propagation of underwater sound frequencies was obtained from the U. S. Navy Mines Countermeasures Station at Panama City, Fla., and from the ONR Sound Reference Laboratory at Orlando, Fla.