EFFECTS OF DIET NUTRIENT COMPOSITION ON RISK OF ABNORMAL BLOOD VALUES IN BOTTLENOSE DOLPHINS (*TURSIOPS TRUNCATUS*), BELUGA WHALES (*DELPHINAPTERUS LEUCAS*), AND KILLER WHALES (*ORCINUS ORCA*)

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Abstract

The lack of data about piscivorous marine mammals' nutrient requirements or how well different types of fish meet those needs has implications for both the health and welfare of zoo animals as well as for assessing the health and sustainability of wild populations. This study utilized long-term (6-13 years) data about the individual diets and blood values of 158 Atlantic bottlenose dolphins, 33 killer whales, and 28 beluga whales housed at SeaWorld parks to understand how diet impacts animal health. Data were extracted from our medical records system and limited to animals with at least 365 days of feeding data and at least 10 blood samples. Each blood parameter was compared with published reference ranges for each species, and values outside the 95% CI were flagged. Clusters of flags were used to classify the blood sample as being indicative of 15 "syndromes", such as renal insufficiency, hepatic insufficiency, or anemia. Diets were calculated based on recorded fish intake each day using yearly average nutrient composition of each fish type including macronutrients and minerals. In the first analysis, we calculated the odds ratios of having *any* lifetime blood sample test positive for a syndrome based on a lifetime average diet, while in the second, we calculated the odds ratios of any specific blood sample testing positive for a syndrome based on the previous 90 days of diet, adjusting for age and sex.

In bottlenose dolphins, we found that diets higher in iron tended to have a lower lifetime risk of non-regenerative anemia (OR = 0.67, $P = 0.07$), and increased dietary iron in the preceding 90 days reduced the odds ratio of developing non-regenerative anemia even further (OR = 0.22, $p < 0.001$). In the 90-day analysis, anemia (OR = 9.7, $P < 0.001$) and hyperbilirubinemia (OR = 17.2, $P < 0.001$) in bottlenose dolphins were positively correlated with increasing dietary fat:protein caloric ratio. A high fat:protein caloric ratio tended ($0.05 \leq P < 0.1$) to increase the risk of electrolyte imbalances, azotemia, prerenal insufficiency and inflammation as well.

In beluga and killer whales, we found no associations between lifetime average diet and lifetime risk of a blood sample testing positive for a "syndrome." However, in beluga whales a high fat:protein caloric ratio in the 90 days prior to blood collection decreased the risk of the blood sample testing positive for hyperbilirubinemia, anemia, prerenal insufficiency, regenerative anemia, azotemia, low cholesterol, hepatic insufficiency, and elevated GGT (OR range: 0.07 to 0.6, $P < 0.05$). In killer whales, a high protein:fat caloric ratio reduced the odds of a blood sample indicative of hyperbilirubinemia, elevated GGT, and hepatic insufficiency (OR range: 0.02 to 0.2, $P < 0.001$), but increased the odds of prerenal insufficiency and azotemia (OR range: 2.2 to 5.4, $P < 0.02$).

It appears that diet affects different cetaceans differently, and bottlenose dolphins may benefit from lower fat diets, while beluga may benefit from higher fat diets.

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