Impact of Maternal and Post-Weaning Nutrition on Puppy Trainability

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Introduction: Every breeder has the desire to produce a litter of healthy puppies that grows and develops to exemplify the characteristics of their breed. Unfortunately, this task is far easier to describe than to accomplish. Numerous factors, both reproductive and non-reproductive, influence the outcome of a breeding and ultimately the health and nature of the puppies. Reproductive factors include genetics (breed and genetic worth of parental selections), maternal age, health and maternal ability of the bitch, the size of the litter, and the bitch's nutritional status. Non-reproductive factors include the environment in which the litter is born, the level and type of socialization that the puppies receive, the home environment, the ability of the owner to teach (train) expected behaviors, and nutritional support. Although nutrition remains important throughout the puppy's life, it is especially critical during the early developmental windows of puppy growth (pre-, neo-, and post-natal). This manuscript will focus on the impact of maternal and post-weaning nutrition on the puppy's learning ability with particular emphasis on essential fatty acids.

Maternal Nutrition: Numerous factors have been shown to impact the reproductive process in the canine. Maternal breed, health, age, reproductive history, and nutrition can all impact the outcome of a breeding and influence the health and well-being of the offspring.[1] Historically, studies in canine nutrition have focused primarily on growth (puppy diets) and adult maintenance using nutrient classification (protein level, fat level) comparisons with little attention given to specific nutrients or more specialized lifestyles and life stages.

Nutritional management of the bitch during pregnancy and lactation is not a stagnant system, nor is it "one size fits all". In fact, the nutritional needs of a bitch will be dependent upon her breed, the stage of pregnancy or lactation, and her litter size. While each bitch must be managed on an individual basis, there are general guidelines that can increase the likelihood of success for all bitches.

Many breeders fail to appreciate the nutritional demands placed on the bitch during pregnancy and lactation. Much as an umbrella protects someone during a rainstorm, optimal nutrition will help protect the bitch and her progeny from the various metabolic and environmental stresses that will occur during pregnancy and lactation. During the reproductive process, a bitch's diet must support 3 areas: 1) her body maintenance, 2) the growth of her reproductive tissues, and 3) the growth and development of her offspring. Compiled, the total nutritional requirement during pregnancy and lactation can increase several fold (3-5) above the bitch's normal maintenance requirements.

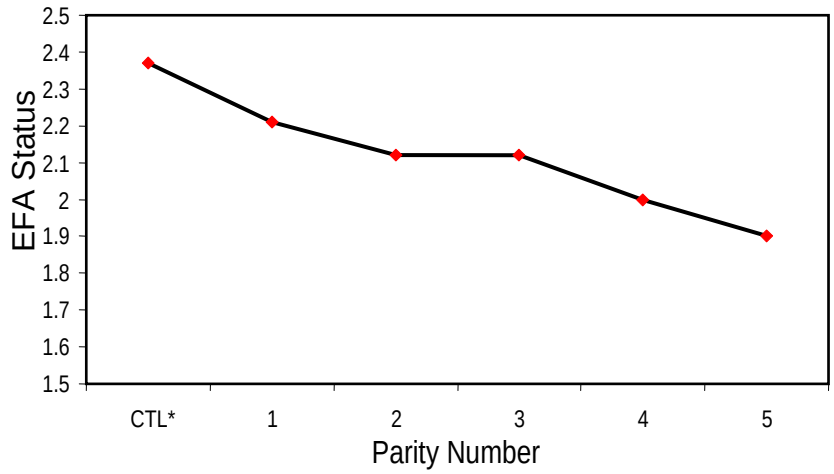
A simple way to understand the relationship between a bitch, her puppies, and her diet is to think of the bitch as a reservoir, her diet as the tributaries, and her puppies as the down-stream water flow. The down-stream flow (nutrients for the puppies) can come from either the tributaries (maternal diet) directly or

supplemented by reducing the level of the reservoir (bitch's body tissues). So how does a breeder guarantee that the proper plane of nutrition is provided to the bitch? The truth is there is no guarantee. However, better breeders will strive to provide optimal nutrition by understanding the current knowledge of the subject.

Effect of Reproduction of on Maternal Essential Fatty Acid Status: A report by Kelley (2000) suggests that maintaining bitches on a diet containing the appropriate level of both n-6 and n-3 fatty acids increases litter size and decreases still-births.[1] Additional efforts demonstrate that reproductive activity (parity number and litter size) reduces maternal essential fatty acids (EFA) stores in a linear fashion (Figure 1), particularly for the omega-3 fatty acid docosahexaenoic acid (DHA; 22:6n-3).[2] Collectively, these findings suggest that maternal nutrient status is sensitive to diet and that dietary shortages could be a contributing factor for reduced maternal reproductive performance with increasing parity number.

Later efforts established that reductions in maternal EFA status could be attenuated via dietary intervention.[3] A study utilizing 60 purpose bred Beagle bitches of similar genetics compared the effect of 3 diets differing in fat profiles on the EFA status of both the bitch and her pups and maternal reproductive performance over 4 sequential parities. This study produced 3 critical findings: (1) while maternal EFA status were influenced by the stage of reproduction, any reduction in maternal EFA status could be minimized by supplying the appropriate levels of both n-6 and n-3 fatty acids, (2) maternal EFA status, including DHA, could be maintained across multiple parities, and (3) puppy DHA status was dependent upon the maternal pre-breeding DHA status and maternal dietary DHA supply.

Figure 1. Effect of parity number on maternal EFA status in the canine.



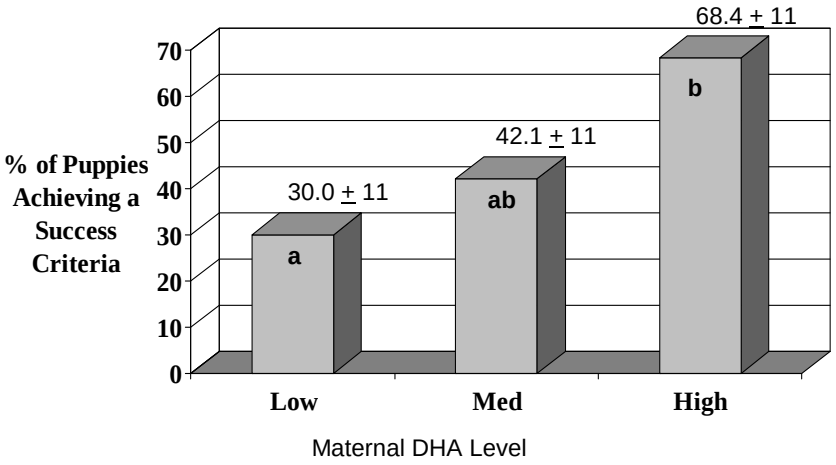
*CTL denotes nulliparous group (Parity 0)

Effect of Maternal and Post-Weaning Dietary DHA in the Canine:
Numerous studies in several species have demonstrated the benefits of DHA regarding the development and function of neurological tissues (see Lauritzen at al., 2001 for review).[4] However until a recent study by The Iams Company, little attention had been given to DHA and trainability in the canine. These recent efforts examined the effect of supplying various DHA levels in both the maternal (throughout pregnancy and lactation) and puppy (post-weaning) diets. Thus the impact of the treatment was considered to span the entire development of a puppy through 16 weeks of age. To assess the effect of dietary DHA on puppy trainability, 28 litters were produced across 5 replications to undergo testing in a standard T-Maze between weeks 10 and 15 of age. All bitches were sourced from a single Beagle colony and had similar nutritional profiles and reproductive histories. Selected bitches (28) were assigned across 3 dietary treatment groups at breeding and maintained throughout gestation and lactation on their assigned diet. Bitches were fed *ad libitum* and diet was the exclusive source of nutrition. Fifty-eight puppies from these litters (20 Low DHA, 19 Medium DHA and 19 High DHA) were selected from these litters at weaning for trainability assessment through 16 weeks of age. All puppies were weaned onto and fed their respective maternal diet throughout the duration of the study. All puppies were fed based on energy needs to achieve a normal growth curve. Assessment of red blood cell (RBC) membranes demonstrated that treatments were effective in influencing the DHA status of both the bitch and puppies (nursing and post-weaning. Puppies received 1 week of training in the T-Maze at 9 weeks of age and were then tested twice daily (5 days/week) for 5 weeks. A Success Criterion in the maze was defined as a puppy achieving 8/10 trials correct for 2 consecutive sessions. A significant ($P < 0.05$) effect of dietary DHA level was observed with the greatest percentage of puppies (68%) achieving at least 1 success criterion when fed the High DHA diet compared to the Low DHA group, which produced the fewest successes (30%). While success rate increased in a dose-dependant manner, puppies from the Medium DHA group (42%) did not differ from the High or Low DHA group (Figure 2). These data demonstrate the importance of dietary lipid sources (fatty acids) on neurological function (trainability) and nutrient status in the canine during critical developmental periods.

Conclusion: Genetics and environment are key contributors to the development of the puppy and ultimately determine the characteristics that will be expressed as an adult. Environment can be continually modified (for better or worse) throughout growth and development, however, an animal's genetic potential is, to a degree, fixed at the time of conception. Traditionally, nutrition has been characterized as the supply of necessary building blocks for organ and system growth. Clearly this remains vitally important; however, it is becoming increasingly evident that nutrition can also significantly impact the achievement of genetic potential in the puppy in ways not previously appreciated. Such is the case with increased puppy trainability with appropriate dietary concentrations of DHA. The benefits of improved trainability can have long-lasting effects by strengthening the owner-companion animal bond and thus increasing the

likelihood of a puppy's successful integration of the puppy into various environments, work or households. While better nutrition cannot overcome inferior genetics and/or training programs, it certainly should not be a puppy's limiting factor. This clearly points to the importance of continuing to expand nutritional horizons beyond the current dogma and identify opportunities to fulfill the puppy's genetic potential through optimal nutritional support.

Figure 2. Effect of Maternal and Post-Weaning Diet on Puppy Trainability



Differ subscripts denote significant difference at P < 0.05

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