

Diet and Wellbeing: A Dynamic Interplay

Soufien Rhimi¹, Juan Hernandez², Aicha Kriaa¹, E Maguin¹ and Moez Rhimi^{1*}

¹UMR 1319 Micalis, INRAE, Microbiota Interaction with Human and Animal Team (MIHA), AgroParisTech, Université Paris-Saclay, Jouy-en-Josas, France

²ONIRIS, Ecole Nationale Vétérinaire, Agroalimentaire et de l'Alimentation, Nantes, France

*Corresponding Author: Moez Rhimi, UMR 1319 Micalis, INRAE, Microbiota Interaction with Human and Animal Team (MIHA), AgroParisTech, Université Paris-Saclay, Jouy-en-Josas, France.

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The importance of the gut microbiota in human health and wellbeing has emerged over the last few decades. Each individual's microbiome is unique and is considered as a hidden metabolic organ that modulates the host health. In humans, several reports have demonstrated that the composition of such ecological niche is challenged by the diet. Complex relationships between diet, the microbiome and host metabolism have been recently highlighted and similar ideas have been proposed for dogs. The domestic dog (*Canis lupus familiaris*) shares a long history of co-existence with humans. It is considered to be the first domesticated animal between 20,000 and 40,000 years ago [1]. Its wild counterpart, the wolf (*Canis lupus*), represents the early ancestor of the modern dog. In their natural habitat, wolves consume a diet predominantly composed of prey animals and can be considered as true carnivores, with vegetal matter being a minor to a negligible component of their overall diet. Published data shows that the selected protein-fat-carbohydrate profile of wolf's diet is 54-45-1% by energy [2]. Conversely, the selected protein-fat-carbohydrate profile of modern dog's fed with a commercial diet is 30-63-7% by energy. Carbohydrate source is essentially cooked starch of cereal grains. It is generally well digested by dogs, with ileal apparent digestibility reaching values of above 99% in dry extruded diets [3]. Recent evidence shows that three genes (AMY2B, MGAM and SGLT1) involved in starch digestion and glucose uptake were the target of selection during dog domestication. Axelsson, *et al.* have proposed that genetic variants within these genes may have been selected to aid adaptation from a mainly carnivorous diet to a more starch-rich diet during dog domestication [4].

Recently, Bones and Raw Food (BARF) has been gaining popularity among dog owners in a more general search for naturalness and wellbeing. Feeding such diets has even become an increasing tendency in canine nutrition. These diets try to imitate the feeding behavior of the wolf. Consequently, BARF diets contain raw meat, different offal and raw meaty bones, representing the wolf's prey. This approach is quite controversial. The defenders advocate a better adequacy with the natural needs of the dogs and some health benefits such as cleaner teeth, more muscular build and leaner, fewer metabolic diseases, all of which leading to improved wellbeing. Critics invoke the health risk due to nutritional imbalances or transmission of parasites or pathogenic bacteria [5]. Even if the dog has been shown to have an increased digestive and absorptive capacity to cope with starch-containing foods compared to wolves, the impact of a consistent high amount of absorbed glucose on the dog's health and longevity remains to be investigated [6].

In this context, taxonomical composition and functionality comparison of the intestinal microbiota between wild wolves, dogs fed with a commercial diet (omnivorous) and dogs fed with a BARF diet (carnivorous) may give some clues. Comparison of the gut microbiota of dogs fed with BARF or commercial food to that of wolves shows a statistically significant progressive increase in the relative abundance of carbohydrate-degrading taxa such as *Prevotella*, *Faecalibacterium* and *Sutterella*, moving from a raw-meat based diet to a commercial food diet. Conversely, *Parabacteroides* and *Ruminococcaceae* exhibited an opposite trend, displaying a significant reduction in relative

abundance in the commercial food group as compared to wolves and dogs belonging to the BARF group whose diet is based on raw-meat [7,8]. Also, evaluation of the bacterial biodiversity is significantly different showing a higher level of complexity of the commercial food group gut microbiota compared to the BARF and the wolf groups [7]. Shotgun metagenomic data showed that the microbiome datasets of dogs fed with a commercial food possessed proportionately more reads classified as Glycosyl Hydrolases (i.e. enzymes that hydrolyze complex carbohydrates into mono- or oligomeric glycan constituents). These differences may be explained by the increased intake of carbohydrates and fibers of vegetable origin by the commercial food group when compared to the BARF group, indicating that the gut microbial glyco-biome of dogs is influenced by diet. In parallel, analysis of predicted bacterial metabolic pathways revealed that genes involved both in amino acid degradation pathways and fatty acid and lipid degradation are more abundant in the BARF group, suggesting that an increased animal fat and protein intake favours colonization of the canine gut by microorganisms with an enriched repertoire of amino acid and lipid degradation pathways [7].

These observations show the plasticity of the intestinal microbiota when faced to changes in diet. They also show that certain bacteria can be favored or on the contrary reduced when diet changes. However, certain bacteria, in addition to their role in digestion, exhibit protective abilities that could be preserved. The most striking example is that of *Faecalibacterium*. It has been shown in human that *Faecalibacterium prausnitzii* possesses anti-inflammatory features and positively influences the gut physiology [9]. In this context, the reduction of *Faecalibacterium spp.* in the BARF group indicates that a meat-based diet may be less protective against inflammation of the canine gut. Even if these data's do not have the power of a randomized clinical trial, they provide evidence that supports the omnivorous diet of the dog. The intricate inter-relationships between diet, the microbiota and their impact on the host are only now beginning to be deciphered. A better understanding of such interplay would help in designing new nutritional approaches that may improve dog's health and address certain diseases. Such uncharted area could also offer novel opportunities to harness gut bacterial members in optimizing health benefits conferred by nutrition. When the microbiota comes to the rescue of animal welfare!

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