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# Labelled analytical constituents of commercial dog foods according to the main point of sale. Are there any clues as to the origin of phosphorus?

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## Introduction:

In our subconscious, a gradation has taken place between pet food depending on where it is sold. However, are these foods objectively different and could these differences have health consequences? Here we study the analytical constituents present on dog food labels in order to provide an objective view of the market. Finally, we propose an indicator to estimate the presence of soluble salts of phosphorus.

## Data:

### Foodstuffs studied

- Dry adult maintenance dog food

### Sources of data

- Preferably the manufacturer, if not online or physical store

### Price data

- The lowest price found for the largest commercial package

### Classification

- According to their main point of sale and if they are grain-free or not : veterinary, mass retailers, online/pet store and grain-free.

## Calculations:

### Main Working Assumption

- Calcium comes only from bone materials

### Energy

- NRC 2006<sup>1</sup>

### Soluble phosphorus

- Lineva et al.<sup>2</sup>
- $P_{\text{bone}} = \text{Ca}/2$
- $P_{\text{n-bone}} = P - P_{\text{bone}}$

### Proteins from bone materials

- Bone<sup>3</sup>: Prot/P ratio=6
- $\text{Prot}_{\text{bone}} = 6 * P_{\text{bone}}$
- $\text{Prot}_{\text{n-bone}} = \text{Prot} - \text{Prot}_{\text{bone}}$

**Results/Discussion:** A total of 409 dry commercial dog foods (320 with labelled phosphorus) were evaluated. The main results are presented in table 1. In this report, **grain free** products are **sold exclusively in online or pet shops**. All foods have **phosphorus levels higher than the minimum recommendation of FEDIAF** (1.16g/Mcal)<sup>4</sup>. The highest levels of calculated soluble phosphorus are reported in mass retail and online pet store product. In addition, the level of **non-bone phosphorus** in these products is **not correlated** with their level of **none-bone proteins** ( $\text{Prot}_{\text{n-bone}}/P_{\text{n-bone}}$ ), which can be a source of organic phosphorus (fig 1A). In veterinary and grain free products, the  $\text{Prot}_{\text{n-bone}}/P_{\text{n-bone}}$  ratio is closest to the non-bone animal by-products (80-116<sup>5</sup>). Thus, it can be assumed that the **phosphorus** content of the added **inorganic salt** would be higher in **entry-level products** where the ratio is well below the limits of 80. This highly soluble phosphorus could be harmful to the kidney health<sup>2</sup>. To estimate the presence of this inorganic phosphorus salt the crude protein to phosphorus (Prot/P) ratio can be used (fig 1B). When this ratio is less than **25**, it appears that a **significant amount of phosphorus** has been added to the diet, above 35 it is less likely and section 25-35 is uncertain. To explore the **discrepancies** between the **two ratios**, we studied the percentage of **protein of bone origin** as a function of the Prot/P ratio for all foods with a  $\text{Prot}_{\text{n-bone}}/P_{\text{n-bone}}$  ratio greater than 80 (Fig 1C). Thus a Prot/P ratio of less than 25 in the absence of added phosphorus could be a sign of a **high proportion of bone protein in the food** (>20%).

It should be noted that the phosphorus levels provided on the label might be incorrect or underestimated. In addition, our working assumption: "Calcium comes only from bone material", while true in some cases, is not generalizable to all commercial dog foods. Therefore, the Prot/P ratio should only be used through a global analysis of the food.

**Conclusion:** This study highlights the differences between products depending on where they are sold, especially with regard to phosphorus. While more research is needed to understand the implication of added inorganic phosphorus on dog kidney health, its level needs to be communicated to the consumer.

**References:** 1. National Research Council. Nutrient Requirements of Dogs and Cats (2006). 2. Lineva et al. J Anim Physiol An N 103, 317–323 (2018). 3. Shirley et al. Poultry Science 80, 626–632 (2001). 4. FEDIAF. Nutritional Guidelines (2019). 5. ANSES. CIQUAL food database (2016).

**Table 1:** Analytical constituents from different dog foods (median, the first and the third quartile). Different letters in the same column indicate a statistically significant difference (Kuskall Wallis).

Brand's key sellers (n <sub>phos</sub> /n)	Protein (g/Mcal)	NFE (g/Mcal)	Fat (g/Mcal)	P (g/Mcal)	P <sub>n-bone</sub> (g/Mcal) Calculated <sup>2</sup>	Protein <sub>n-bone</sub> vs P <sub>n-bone</sub> ratio	Price (€/Mcal)
Mass retail (44/69)	68 <sup>A</sup> [62-71]	117 <sup>A</sup> [103-127]	35 <sup>A</sup> [32-40]	2.7 <sup>A</sup> [2.6-3.0]	0.94 <sup>A</sup> [0.8-1.13]	56 <sup>A</sup> [51-69]	0.79 <sup>A</sup> [0.59-0.95]
Online/Pet store (143/168)	66 <sup>A</sup> [61-71]	119 <sup>A</sup> [107-135]	35 <sup>A</sup> [30-39]	2.5 <sup>B</sup> [2.3-2.8]	0.80 <sup>B</sup> [0.66-0.97]	70 <sup>B</sup> [85-87]	1.0 <sup>B</sup> [0.78-1.17]
Grain free (99/138)	79 <sup>B</sup> [67-95]	93 <sup>B</sup> [65-110]	41 <sup>B</sup> [38-46]	2.7 <sup>A</sup> [2.4-3.1]	0.84 <sup>AB</sup> [0.67-1.1]	84 <sup>C</sup> [64-102]	1.35 <sup>C</sup> [1.2-1.54]
Veterinary (34/34)	72 <sup>B</sup> [65-84]	107 <sup>C</sup> [91-122]	41 <sup>B</sup> [33-44]	2.1 <sup>C</sup> [1.8-2.3]	0.73 <sup>C</sup> [0.51-0.79]	91 <sup>D</sup> [82-125]	1.19 <sup>D</sup> [0.96-1.43]

