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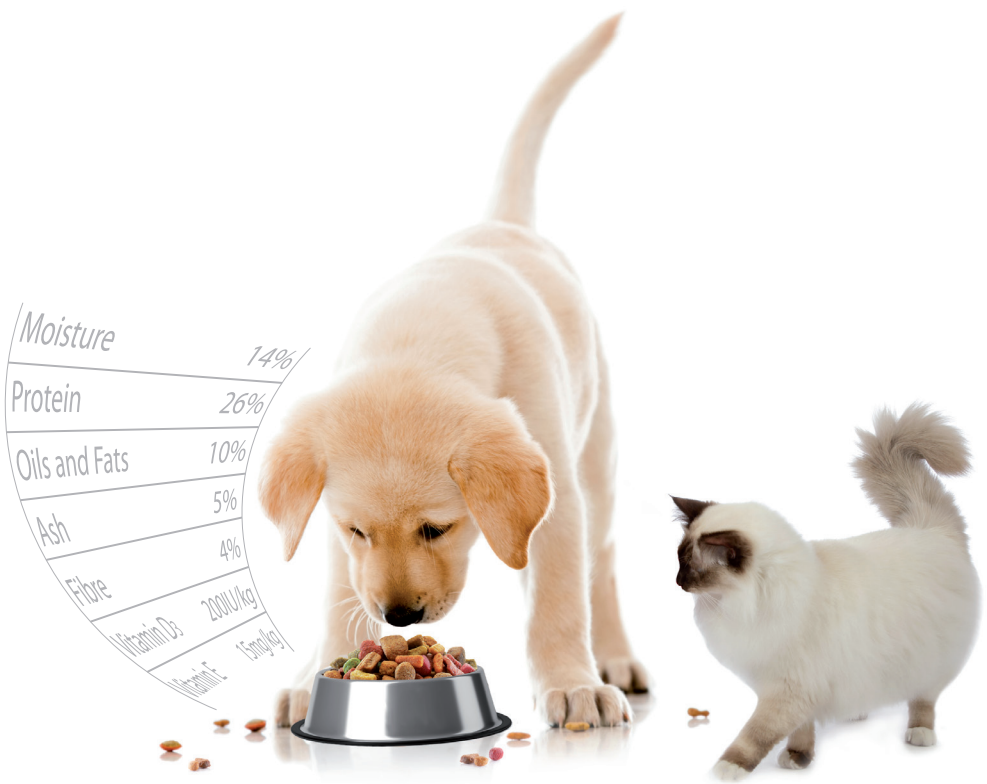
IMPACT OF KIBBLE FORMULATION ON PALATABILITY



DIANA
Performance from nature
PET FOOD

SCIENTIFIC RELEASE //

IMPACT OF KIBBLE FORMULATION ON PALATABILITY

By Magali FOURNIER, *R&D Project Manager*

According to animal scientists, food scientists and chemists, palatability is defined as the appeal of food for the animal and the ease with which it is eaten. Palatability is thus a key factor in the success of a product launch. Therefore, it is crucial for the pet food market players to carefully manage the palatability performance when formulating their products.

KIBBLE MAIN ATTRIBUTES

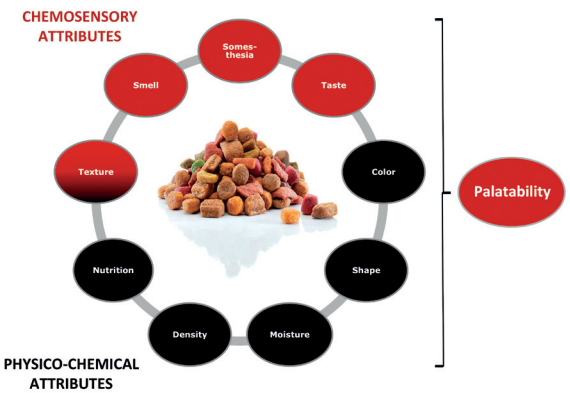


Figure 1: Representation of kibbles main attributes

PETFOOD PALATABILITY DRIVERS

The overall palatability of a food results from the combination of its sensorial, physical and chemical attributes such as smell, taste, somesthesia but also nutritional value, moisture and shape... Dog and cat food is obtained by blending various ingredients in specific proportions in order to achieve optimal nutritional balance and good palatability. There is a high diversity of kibble formulas observed in the market, and for each of them, the nature and incorporation level of each ingredient as well as the whole manufacturing process influences the attributes and thus the palatability of the final product. The coating system, constituted of palatability enhancers and fat, the kibble formulation itself and the combination and interactions of those components are the main elements that give to food its unique attributes and palatability.

Due to physiological and behavior differences, each product attributes does not have the same importance to cats or dogs. We do know for instance that smell is the most highly developed dog sense and that it plays a major role in the research of food and food selection. Palatability enhancers and the fat used for coating are crucial for the products' acceptance due to the volatile compounds they release and the water they bring onto the kibble that directly impact product smell.

On the other hand, previous studies conducted by SPF showed that kibble taste, somesthesia and texture are essential palatability drivers for cats. Formulation and process management will then be central for palatability performance through their strong impact on key attributes such as moisture and texture.

The review below, gathers the results of several researches on the impact of kibble formulation on palatability conducted by SPF during the past few years. Based on the feeding behavior difference between cats and dogs and the identification of their specific palatability drivers, the study focuses on the impact of starch, protein and water content on palatability.

CORE KIBBLE : THE FRAME

> NUTRITIONAL BALANCE AND PALATABILITY

Energetic needs of the cat population do not vary a lot, compared to dogs; indeed, adult cats have very similar weights with low breed effect and physiological variation (except for kittens and during lactation).
A complete geometric analysis of macronutrient selection (Hewson-Hughes et al., 2011 – Waltham Institute) reveals that cats regulate the macronutrient composition of their diets towards a target composition: 52% of protein, 36% of fat and 12% of carbohydrate. It was also demonstrated that carbohydrate intake should be no higher than 300 kJ (70 kcal) per day due to metabolization difficulties (bad starch assimilation) and, therefore limiting the nitrogen intake.

We studied the nutritional impact on palatability of 4 European market kibbles (K1 to K4), K1 to K3 being specific low carbohydrates kibbles, with a composition close to the target quoted above and K4 being normal super premium cat diets.
Figures 2 and 3 detail the composition of each kibble and the geometrical positioning of each one.

	Labelling					Calory Intake					
	protein %	fat %	ash %	fibres %	starch %	Hyp water	NFE	Metab. Energy (kcal/100g)	protein contribution %	lipid contribution %	NFE contribution %
K1	47,5	18,8	5,6	3,6	15,5	6	24,5	412	40	39	21
K2	46	12	6,4	4,6	17,4	6	31	372	43	27	29
K3	50	17	8	1,5	12,5	6	23,5	402	44	36	20
K4	36	16	7	1	35,6	6	40	402	31	34	35

Figure 2: nutritional composition of the kibbles studied

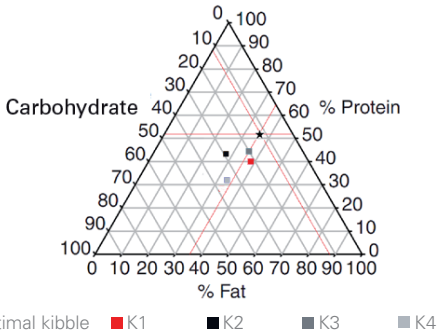


Figure 3: geometrical positioning of the optimal kibble and the kibbles studied

All the kibbles were tested by a cat expert panel in versus test, with a paired experimental design.

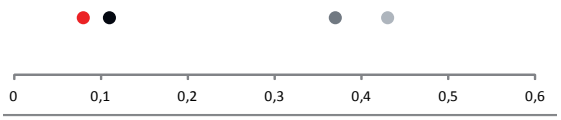


Figure 4: Bradley score

Figure 4 shows that in the study cats do not necessarily prefer the food with the best nutritional balance.

The macronutrient composition of the diet is probably not the only driver for palatability. Therefore, a balance between healthy levels of macronutrients and palatability would have to be found.

> PROTEINS : A KEY FACTOR

PROTEIN RATE

Proteins are necessary for all aspects of growth and development and are very important for structural growth and for building the immune system, especially for cats which are strict carnivorous.

In a first experiment, we studied the effect of protein levels in cat kibbles. On a base of a 20 ingredients super premium kibble formula, we increased the level of poultry meal and adjusted the corn flour amount in order to reach protein levels of 25 to 40%. All the kibbles were produced under the same manufacturing process and with equivalent shape, density and water content. The kibbles where then coated with 6% of poultry fat and 3% of a premium liquid palatant.

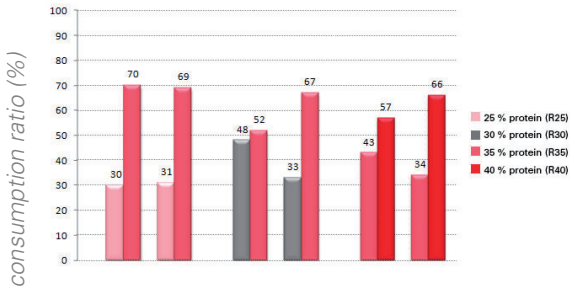


Figure 5: Palatability comparison of kibbles with different content of proteins

Palatability results showed on Figure 5 confirms that the higher is the protein level, the more palatable it is to cats.
In parallel we also evaluated the impact of the protein rate on the texture of the studied kibbles. Figure 6 shows that the kibble rigidity increases when increasing the protein level.

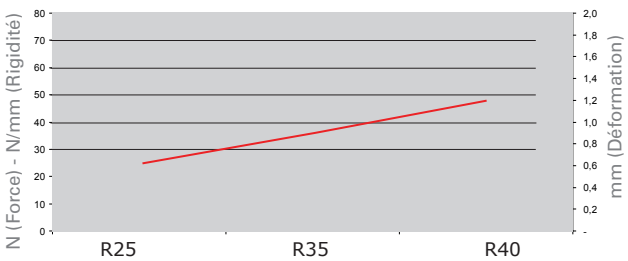


Figure 6: Representation of the maximal strength of the kibble (force/deformation) according to the amount of protein

PROTEIN SOURCE

Protein rate is not the only driver of palatability. Another experiment assessed the impact of the protein nature on cat palatability. Firstly 10% of the animal protein (poultry) was substituted by vegetable (derivative of pea) or marine (white fish hydrolysate) protein, keeping a constant protein level of 37.5%. The kibbles were coated with 6% of poultry fat, 3% of a super premium liquid palatant and 2% of super premium dry palatant.

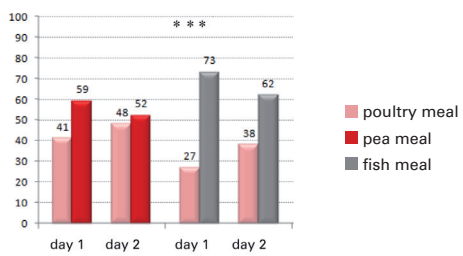


Figure 7: Palatability comparison of kibbles having different protein source

As detailed on Figure 7, the protein source can also have an impact on cat preferences, and we can see in this case, that animal protein does not seem significantly more palatable than a vegetable one .

PROTEIN HYDROLYSIS LEVEL

In the same experiment, 5% of the poultry meal was substituted by the same marine hydrolysate (white fish protein) or by another one with a lower degree of hydrolysis in order to evaluate the protein differences according to the process used.

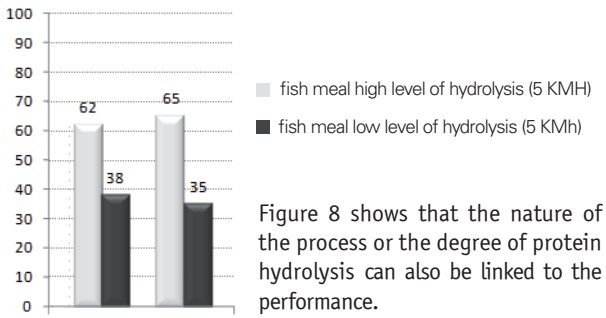


Figure 8 shows that the nature of the process or the degree of protein hydrolysis can also be linked to the performance.

Figure 8: Palatability comparison of kibbles with fish meals having different degrees of hydrolysis

In another study, we evaluated the effect of introducing high quality hydrolyzed proteins, in inclusion, in cat and dog kibbles. 10% of poultry meal was substituted by a poultry liver hydrolysate. The kibbles where coated with 6% of poultry fat and :

- 2% of super premium liquid palatant + 2% of premium dry palatant for cat kibbles
- 3% of super premium liquid palatant for dog kibbles

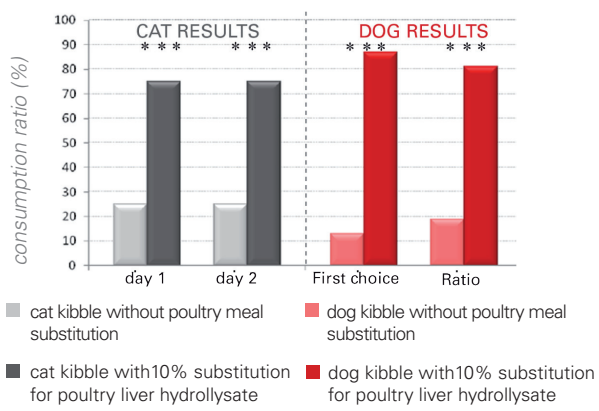


Figure 9: Palatability comparison of kibbles having proteins of different qualities

Figure 9 clearly confirms that the quality of the protein source is very important; it significantly affects both cat and dog food palatability.

The impact of the protein source, rate and quality on palatability is noticeable but is also complex; it is closely linked to the nutritional balance and texture.

> STARCH CONTRIBUTION

Different kind of starches can be found in kibble formula, generally depending on the kibble range: we would mostly find wheat and corn in standard kibbles, and corn or rice in premium kibbles. In super premium range, there is almost no more wheat but much more corn, and rice incorporation is often used.

In another experiment, 4 starches were tested (wheat, corn, potato and rice) on 2 cat kibbles containing either :

or 31% proteins, 27.5% starch, 13.4% fat
35% proteins, 24% starch, 13.3% fat

All the kibbles were produced with the same type of extrusion, drying and starch cooking, and with equivalent shape, density and water content. Gluten was also added in some formulas in order to reach the same level of protein. The kibbles were then coated with 6% of poultry fat and with a combination of a super premium liquid palatant (3%) plus a super premium dry palatant (1%).

For each level of protein (31% or 35%), the control kibble (wheat starch) was tested by an expert cat panel against the 3 prototypes with wheat substitution.

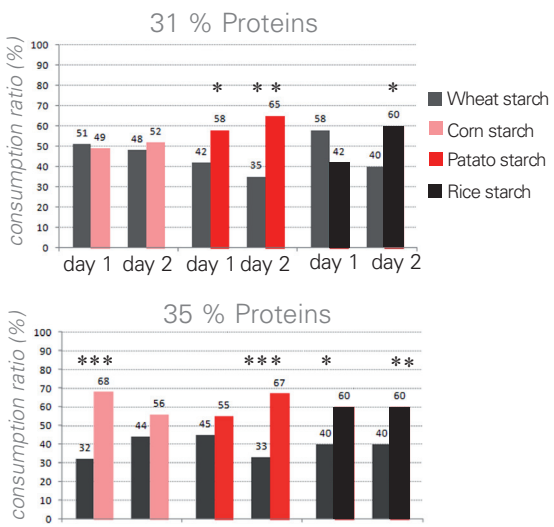


Figure 10: Palatability comparison of kibbles having different starch sources

Figure 10 points out that the nature of the starch influences the overall palatability of the kibble.

Whatever the level of protein, potato starch, and to a lesser extent rice starch confer to the product a better palatability. However, we noticed that this impact was bigger when the protein level was higher, letting us think that the quality of the starch has more importance when the incorporation rate decreases .

> WATER, A KEY «INGREDIENT»

Around 150 cat kibbles were produced on the same formula, but with different drying levels , conferring to the kibbles a water content varying between 4 and 10%.
After 6% poultry fat coating, a palatable solution was coated with either liquid palatability enhancer, either dry palatability enhancer or either with a combination of both.

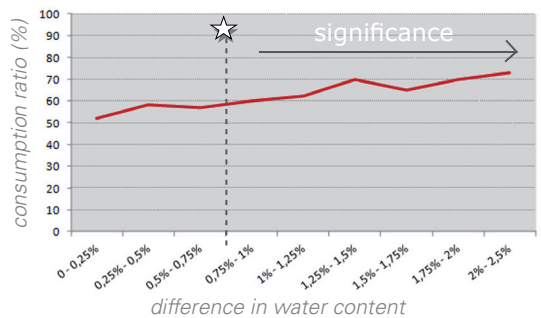


Figure 11: Evolution of the consumption ratio of the dryest food

Figure 11 represents the evolution of the consumption ratios' according to moisture differences for the 150 products tested. We can see that cats detect a significant difference when the variation of water content between the 2 kibbles exceeds 0.75%. Their preference goes for the dryer products.

We also analyzed the textural characteristics of these kibbles, and as highlighted in the Figure 12 below, we can see that the rigidity of the kibble is inversely proportional to water content level.

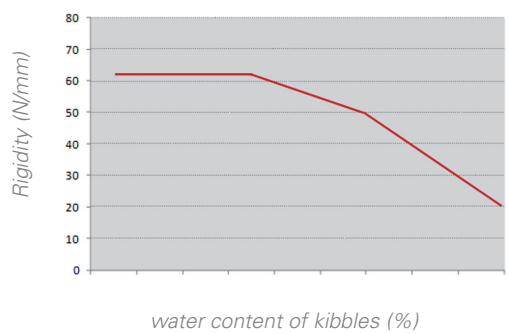


Figure 12: Impact of water content on kibble rigidity

Once again, cats preference for kibbles with lower humidity is closely linked to the structure and the texture of the kibble, the dryer kibble being the more rigid.

Another study was conducted to determine dog sensitivity on kibble water content. We coated kibbles (same kibble base) with a variable amount of water, 6% of poultry fat and 2% of a premium dog liquid palatant. We raised the water content from 0 (H0) to 2.1% (H2.1) by 0.3% steps. Physico-chemical analysis (humidity, water activity), texture analysis (penetrometry), palatability (versus test, first choice and consumption ratio) and human sensory (triangular test) were run .

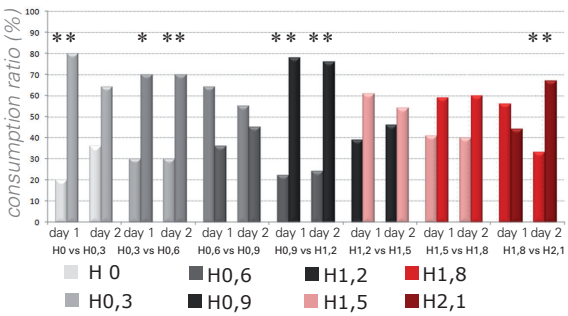


Figure 13: Palatability comparison of kibbles having different humidity

As seen previously on the cat kibbles, the rigidity of the kibble decreases when the water content increases. Nevertheless, for dogs, the link to palatability is the opposite, the most humid product being the preferred one.

We also ran a human sensorial analysis test on kibbles in order to see if olfactive differences could also be perceived by humans. A panel of 20 trained judges participated to 3 triangular tests evaluating kibbles having 1, 1.4 or 2% of humidity differences. They were able to detect differences of 1.4 or 2%.
The variation of kibble water content has an impact on the release of volatile compounds, and could interfere, just as rigidity, on the palatability. A more detailed GCO analysis could confirm this data.

The effect of water content is opposite when we consider cats or dogs. Cats prefer dryer kibbles whereas dogs prefer ones which are moister.
Water is always present in the formula, the drying process will be decisive in order to reach the target moisture content. Coating has to be taken in account especially if a liquid palatant is added, because water content greatly influences pet palatability.

AND WHAT ABOUT FAT COATING?

As explained previously, the main palatability drivers are linked to palatability enhancers and the core kibble characterization. However, the fat coating, due to the high level of volatile compounds it confers to the kibble, has a big impact, especially in dog palatability.

The main fat types used in pet food come from poultry, pork and beef. In order to investigate which parameters were having a role in dogs' preference, we studied and analyzed 11 fat types of 3 origins (poultry: PL1 to PL3, pork: PK1 to PK6, beef: B1 to B2, Mix beef and pork: M1).
For each fat, the following factors were monitored :
- Fat manufacturing process (time-temperature...)
- Raw material composition (viscera, bone, adipose tissue, rind...)
- Fatty acids composition (saturated, unsaturated, omega 3, omega 6)
- Volatiles composition
- Oxidation

Then all the fat types were used as a coating at a 6% level with 1.5% of premium liquid dog palatant and tested against a control coated with 6% of poultry fat and 1,5% of the same premium liquid dog.

There is a significant effect of the fat origin on the palatability. We can clearly see in figure 14 that beef tallow and the mix between beef and pork are most palatable solutions. Pork fat seems to be more palatable than poultry fat as well.

We can also notice differences of dog appreciation between fats of the same origin (poultry or beef), confirming that there is an impact of fat manufacturing process and composition (volatiles, fatty acids...) on palatability.

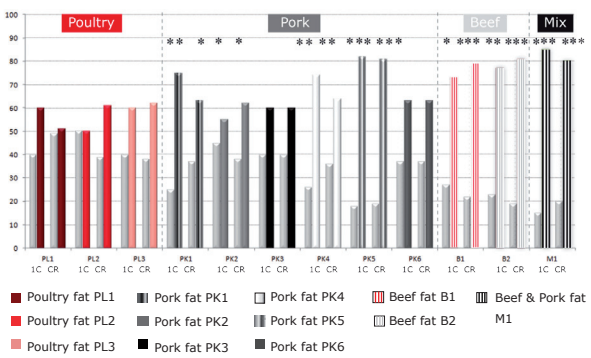


Figure 14: Palatability comparison of kibbles coated with different fat sources

An experimental designed was set up to determine the best palatability answer when increasing the fat (poultry fat from 3 to 8%) or the palatant (super premium dog liquid palatant from 1 to 4%) level.

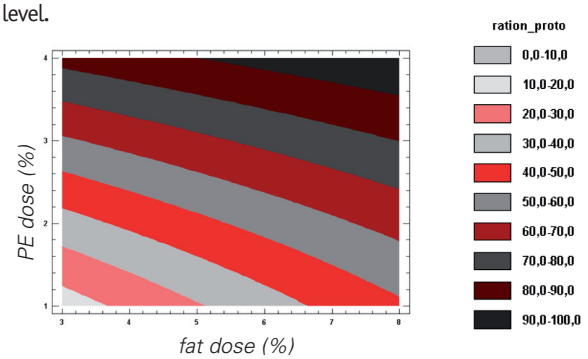


Figure 15: Estimated response surface of the experimental design

Figure 15 reveals that the amount of liquid palatability enhancer is the only variable which impacts very significantly the palatability. Fat dosage and fat*palatant dosage interaction do not have significance in this design.

CONCLUSION : PALATABILITY AND FORMULATION, A COMPLEX INTERACTION

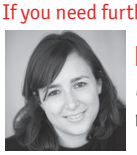
These results help us better understand the role of kibble formulation on palatability. Elements of the formulas such as the quality and dose of starch, proteins and fat clearly impact pet food palatability.

However, a kibble is a very complex system where each ingredient interacts on all the product attributes such as texture, smell, taste and moisture.

Will a dog kibble be more palatable because of its moisture or because the volatile compounds are more easily perceived? Will a cat kibble be more palatable because its high protein level is closer to cats primary carnivore diet, because it tastes better/smells better, or because of the rigidity the protein gives to the kibble?

There are still some questions remaining on the interactions of all these palatability drivers. Many formulation aspects, but also process parameters, can be further investigated in order to get the perfect kibble, a healthy one and palatable one.

If you need further information, do not hesitate to contact the author.



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