Aroma in Pet Food Palatability

Flavor perception in humans is characterized as multimodal responses of our senses, which include olfaction, taste, and somatosenses, such as sense of touch.[1]

Olfaction is the result of interaction of volatile components with olfactory receptors in the nasal cavity that generate sense of smell, also known as aroma. Historically, flavor has been viewed as predominantly aroma. Although this perspective oversimplifies the broad nature of flavor perception, it is still crucial to understand the impacts of aroma on flavor perception and food choices.

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Aroma and Preference

In dogs, olfaction is believed to play a key role in sensory experience and food preferences.[2] Although very little work has been published on canine flavor perception, the role of olfaction in food choices has been investigated. In early studies, trained dogs were made anosmic, or unable to smell, by intranasal infusion of zinc sulfate. Compared to intact dogs which showed significant preferences of one meat over another (e.g. beef over lamb, pork over lamb), anosmic dogs had significantly less preferences and failed to choose one meat over another for most of the comparisons.[3] This study demonstrates the importance of aroma in determining preference. Methods involving anosmia are harsh and controversial, and have rarely been used since the 1980s.

> If pets find the food aroma enticing, they are very likely to eat more of that food.

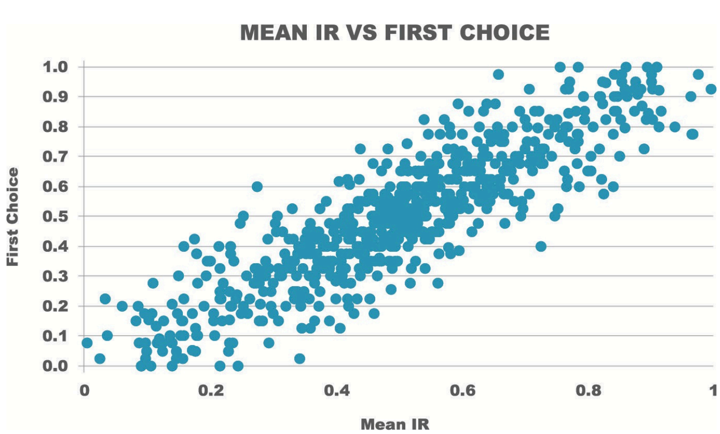
Unlike humans, pets do not talk. They cannot “describe” why they like food A but not food B, or vice versa. Therefore, pet owners look for pets’ behavioral signals of accepting or rejecting the foods. In the pet food industry, palatability is measured by comparing the relative food intake by animals to determine preference of one food over another. The most common method for evaluating palatability is a two-bowl test, in which animals are expected to choose between foods A and B placed in their respective bowls.

To monitor how pets respond to food aroma specifically, the “first-choice”, or the food first approach and consumed by the animal, is observed. Compared to an intake ratio (Ration A or Ration B consumed/Ration A consumed + Ration B consumed), first choice is NOT impacted by the sensory responses that are only stimulated by food consumption, including gustatory inputs (e.g. taste) and combined physico-chemical mechanisms (e.g. texture).

First choice is a direct assessment of how[4] much an animal is attracted by one aroma over another by smelling both rations of foods. As first choice measurements are typically averaged as proportion of total choices, statistical analysis can be used to assess the correlations between first choice and intake ratio.

The figure below demonstrates a strong correlation of first choice and mean intake ratio from over 300 palatability trials (both canine and feline) conducted by Kemin through third-party kennel facilities. This indicates that if pets find the food aroma enticing, they are very likely to eat more of that food. In other words, **a winning palatant should be designed to improve the aroma profile of pet foods, as a start.**

Figure 1. First choice vs. mean intake ratio (data from 300+ palatability trials)[5]



Aroma Development

What gives food its aroma? There are several primary routes of aroma formation in foods, such as non-enzymatic browning, fermentation, and oxidation. Pet food manufacturers are commonly working with flavors developed from thermal processing.

The Maillard reaction, as a type a non-enzymatic browning, plays a major role in developing characteristic aromas of many food products under high temperatures, including roasted meat, toasted marshmallow, baked bread, and chocolate. **Domesticated pets, particularly dogs, have engaged their olfactory senses to seek these types of aromas since they joined humans around campfires.** Nowadays, the influence of the Maillard reaction is ubiquitous in pet food matrix flavor development. It is also the key mechanism to develop the savory, meaty, robust aroma profiles of palatants.

Although the Maillard reaction is complex, dissecting the key compounds that drive palatability is important to developing effective palatability enhancers. Understanding the chemistry of Maillard technology is vital, as is the ability to translate this knowledge into new formulations. The Kemin Palatant R&D team investigates palatability at the molecular level and develops proprietary Maillard techniques to obtain desirable reaction flavor profiles that are more appealing to cats and dogs.

The Maillard Reaction

How does the Maillard Reaction work? The Maillard reaction is a cascade of reactions initiated by a carbonyl group from a reducing sugar and a free amino group from either amino acids, peptides, or proteins.

All monosaccharides (e.g. glucose, fructose, ribose, xylose) are reducing sugars, along with some disaccharides and polysaccharides. Amino acids play key roles influencing the character of the aromas developed from the Maillard reaction. By changing the type of amino acids in a reaction flavor system, one can obtain a variety of distinctive aroma profiles from roasted chicken to dark chocolate.

Factors such as temperature, pH, and water activity are also important to monitor when controlling the Maillard reaction.

Aroma Analysis in Pet Food

Most aroma compounds are volatile organic molecules, so their distribution in food matrices are highly dependent on the nature of the compound and the matrix composition (for example, protein, fat, and carbohydrates), which further complicates the extraction and isolation of aromas. One must understand clearly the goal of analysis to develop suitable extraction methods. For example, if your goal is to detect a certain off-odor from a food product with a set quantification limit, your extraction would differ from one trying to compare the comprehensive aroma profiles of two benchmark diets.

A solvent extraction/distillation method (e.g. solvent assisted flavor evaporation) might yield more aroma compounds with broad range of volatility, however, can be very ineffi ient and unrealistic (keep in mind aroma can also change during those sample preparations!) On the other hand, a rapid, solventless, sorptive extraction method (e.g. solid phase microextraction) can directly reflect the aroma composition of the volatile fractions of pet foods and significantly increase analysis output, however, may still risk compromising specificity and sensitivity of the analysis. In brief, the methodology should be selected to solve real problems more wisely.

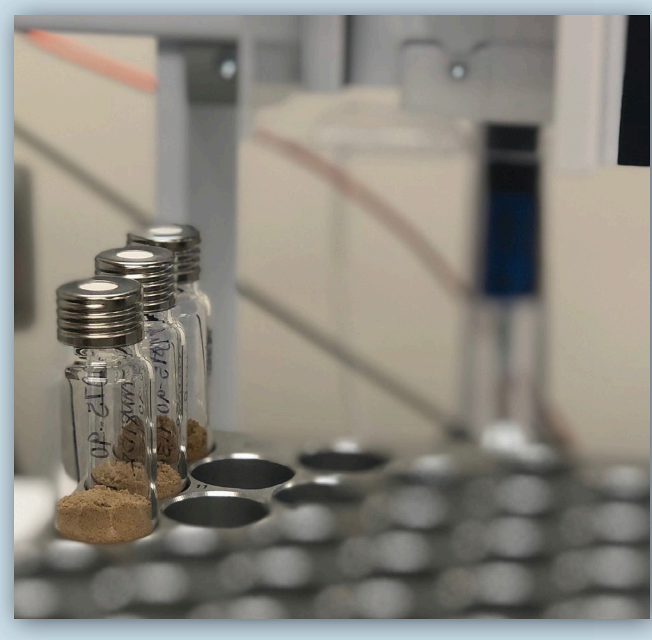
Instrumental analysis of the isolated aroma components in pet food matrices can be more challenging due to equipment limitations, such as sensitivity and resolution. **Pets' noses are much more sensitive than most of the modern analytical instruments and can detect some aroma compounds at levels lower than the detection limit of any instruments!**

The aroma portion of palatants or pet foods typically consist of hundreds of volatile compounds, with many potent odorants present in extremely low concentrations. Even the modern chromatographic methods such as gas chromatography (GC) coupled with non-specific detectors (e.g. FID), or fast GC-based electronic nose technology are challenged by the limited separation resolution and lack of identification specificity when applied to the analysis of complex flavor matrices like palatants or pet food.

Kemin Aroma Analysis

To address these challenges and improve flavor analysis in-house, Kemin utilizes a state-of-the- art GC/Q-TOF (Quadrupole Time-of-Flight) mass spectrometer (MS) that provides enhanced capability of detection, deconvolution, and identification of key aroma compounds in trace amounts from complex palatant and pet food matrices.

Q-TOF mass spectrometers are distinguished by their high resolution, mass accuracy, and sensitivity, which facilitate flavor discovery in palatants and pet foods, allowing us to apply the technology platform to the molecular level. By advancing techniques to measure flavor profiles of palatants, we also address key factors to ensure our product consistency and performance.



Unlock the Potential of Aroma Discovery in Palatant Product Innovation

Aroma compounds are the most valuable components in palatant products. Although they are typically present in very small quantities compared to the macronutrients and micronutrients, aroma compounds are vital to the palatability of pet foods.

Because at the end of the day, we are still talking about palatability, which is the ultimate task of all pet food manufacturers. If a pet refuses to eat its food, it doesn't matter if the nutrition is balanced, the price is right, or the packaging and marketing claims are attractive enough. It needs to smell good first. A reliable palatant supplier should have the in-depth knowledge of ingredients, processing, and application at the level of aroma chemistry.

To unlock the tremendous potential of aroma discovery to provide options for today's palatability challenges, our innovation team develops methodology to effectively translate the MS-directed aroma discovery to new product development platform, which is integrated into multiple phases of product innovation to guide formulation, prototype scale-up, product stability, and production application.

One example is a modified aroma recombination model that establishes proof-of-principle of the significant efficacy of a palatability enhancer developed for dry dog diets:

Table 1. Palatability results for aroma recombination model of a palatability enhancer

Variable A	Intake Ratio	First Choice
Control + Palatability Enhancer T	0.740***	77.5%
Control + Compound 1 Control +	0.682***	72.5%
Compound 2	0.673**	67.5%
Control + Compound 3	0.633*	57.5%

(NS: $p > 0.05$; *:$0.01 < p < 0.05$; **:$0.001 < p < 0.01$; ***: $p < 0.001$)

Several aroma compounds are identifi ed in palatability enhancer T and compounds 1, 2, 3 (derived from T) are spiked into the control at the same quantify present in T. From the aroma recombination model, we can discover the importance of individual aroma compounds in formulation and discover their optimal combinations and concentrations for various applications.

By understanding palatability as aroma chemists, we are continuously seeking more sustainable, versatile and effective ways to deliver high-performance palatability enhancers for pet food manufacturers.

If a pet refuses to eat its food, it doesn't matter if the price is right, or the packaging and marketing claims are attractive enough.

IMPORTANCE OF AROMA IN PET FOOD PALATABILITY

Key Takeaways

- Aroma, the predominant component of flavor, is key to pet food preference
- The Maillard reaction is the key mechanism to develop the savory, meaty and robust aroma profiles of palatants
- Given the complexity of aroma composition in palatants, understanding the key compounds that drive palatability is important in developing effective palatability enhancers
- Kemin's state-of-the-art analytical platform facilitates flavor discovery in palatants and pet food and addresses key factors to ensure product consistency and performance
- As aroma experts, we are continuously seeking for more sustainable, versatile, and effective ways to deliver high-performance palatability enhancers

References
1. Reineccius GA. Flavor Chemistry and Technology. 2nd ed. Taylor & Francis; 2005.
2. Hall NJ, Péron F, Cambou S, Callejon L, Wynne CDL. Food and Food-Odor Preferences in Dogs: A Pilot Study. Chem Senses. 2017;42:361-370.
3. Houpt KA, Hintz HF, Shepherd P. The Role of Olfaction in Canine Food Preferences. Chem Senses. 1978;3(3):281-290. doi:10.1093/chemse/3.3.281
4. Aldrich GC, Koppel K. Pet Food Palatability Evaluation: A Review of Standard Assay Techniques and Interpretation of Results with a Primary Focus on Limitations. Animals. 2015;5:43-55.
5. Kemin Internal Document: SD-19-00012
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