Obtaining the maximum benefits from flavours

Introduction

We will try to summarise the potential benefits that flavours provide to the feed manufacturing industry, either integrated or commercial, for self-consumption or produced on behalf of third parties.

Basically we will:

1) Provide an overview on the benefits that flavours give depending on the particular needs every feed manufacturer has; and
2) Draft a checklist of requirements that flavour manufacturers must include in its R+D processes, so that the final products perform in the changing environment of the modern animal nutrition.

Why using flavours today?

The answer to this question is rather simple: because everyone wants profits. But let's introduce a small twist to this: if our target is to maximise the potential benefits, we should previously ask ourselves how benefits are generated.

Irrespective of the particular field of activity, benefits today can only be obtained if the product or service supplier addresses the needs and also the expectations of its customers.

If we analyse the general needs of the feed manufacturers related to its primary activity, we will find two main ones: productive needs and marketing needs.

This classification adapts initially to dividing the feed companies between integrated concerns and those making their living selling feed, although some overlapping may exist in between.

It is true that a commercial feed manufacturer (so defined because it develops most of its activity selling feed in the free market) is also interested in the performance its feeds cause in animals. Nevertheless, it is also true that its specific needs may be radically different from those of the integrated companies, as we will see further on.

Integrated companies work this way to maximise profits, taking advantage from economy of scale and the homogeneity of operative patterns. It is thus natural that their primary needs are those of productivity. From our point of view, this target is feed intake.

The need of addressing the intake parameters has two main aspects, which can be linked to different animal species and growing stages:

- Enhancing feed intake, and
- Maintaining the actual intake parameters.

Enhancing feed intake

Feed intake stimulation can be defined as the sum of the techniques used to increasing feed intake above the limits considered normal. The target is to improve the growing rate and, indirectly, the financial efficiency of the operation.

This is the basic strategy applied to the young pig, where a high growth rate is very interesting. In these circumstances, feed intake stimulus turns out to increase daily growth rate and possibly FCR (Figure 1).

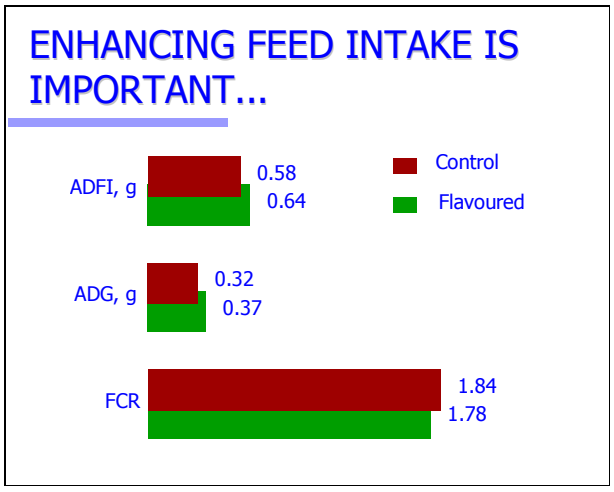

Figure 1. Feed intake enhancement in piglets

Stimulating intake in the early stages of the piglet's life causes normally the extra benefit of an increase of growth rate, which can mean up to

2 extra kilos of body weight 4 weeks after weaning (Figure 2).

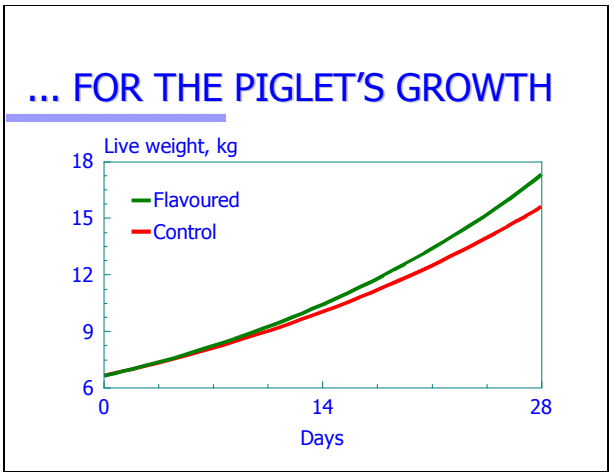

Figure 2. Increased growth curve in piglets due to higher feed intake

This phenomenon has been recently studied in Europe. Dr. C. Makkink demonstrated that a higher intake level in piglets led to the stimulation of the pancreatic secretion and therefore to increased levels of proteolytic enzymes being released. Also Dr. Makkink recorded that a high correlation existed between feed intake and the exocrine pancreatic secretion (Figure 3).

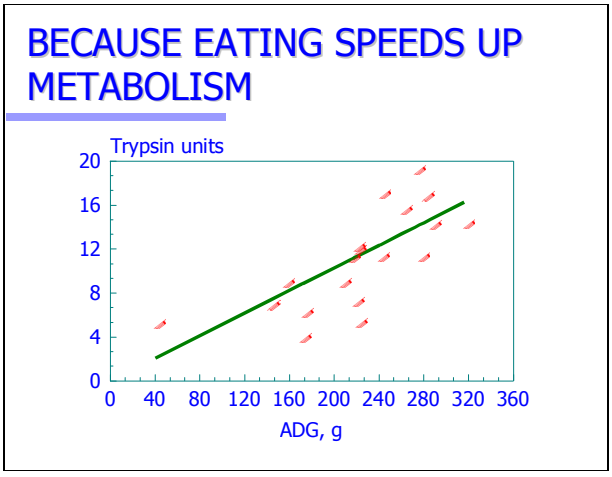

Figure 3. Correlation between feed intake and pancreatic secretion in piglets

An experimental method to test the flavour stimulus upon prestarter feed intake would be formulating a high palatability feed, and checking via animal experimentation whether the flavour is able to improve feed intake. Table 1 shows the composition of an experimental creep feed designed for this purpose.

Table 1. What do piglets like? Pre-starter preference testing. Feed composition

Wheat	22.20	Flaked corn	16.65
Soya Bean Meal	20.15	Full fat soy	8.42
Skim milk	17.80	Dried whey	8.00
Fat	2.50	Limestone	0.89
DCP	1.98	Salt	0.50
Choline HCl	0.01	Premix	0.90

The simultaneous supply of flavoured and unflavoured feed would allow us to draft the feed preference towards different flavour profiles by lactating piglets.

It is clear that this experimental design does not match the normal practices of the industry, as rarely two feed are simultaneously supplied in the pen. Nevertheless, this experiment allows us obtaining a knowledge base of the consumption response and alarm reactions in very young animals (Table 2).

Table 2. What do piglets like? Intake and preference index

Day	Intake, %			PI
	Total	Flavour	Control	
7-28	100	55.9	44.1	1.27
21-28	100	60.2	39.7	1.51

It is possible to observe the evolution of piglets' feed preference. Also it is interesting to see that this preference shows strong ratios while weaning time approaches. This design sets a sow with its litter as the experimental unit having two feeders in each pen, one feeder for the control and the other for the flavoured feed.

After weaning, each pen with piglets and two feeders per pen is the experimental unit. Feed preferences are obtained in a similar way: two feeds are simultaneously supplied and consumption of every feed is calculated. The control feed must not introduce any variation

factor and its palatability must be consistent with that of other commercial feeds, as set in Table 3.

Table 3. What do piglets like? Starter preference testing. Feed composition

Wheat	22.20	Flaked corn	16.65
Soya Bean Meal	20.15	Full fat soy	8.42
Skim milk	17.80	Dried whey	8.00
Fat	2.50	Limestone	0.89
DCP	1.98	Salt	0.50
Choline HCl	0.01	Premix	0.91

Looking at the results from one of these experiments (Table 4), one can see that the consumption of the flavoured feed is higher than that of the control, and that preference is particularly high from the two first post-weaning weeks when a higher growth rate has been established.

Table 4. What do piglets like? Intake and preference index

Day	ADFI, g			PI
	Total	Flavour	Control	
0-14	494	267	227	1.17
14-30	731	496	235	2.11
0-30	644	386	259	1.49

This experimental design can be modified to check flavour influence on feed intake variations caused by the change of some feed ingredients. This is a normal case in flexible feed formulation. Table 5 contains the composition of a calf starter feed manufactured to show the flavour capacity to increase feed intake in this species.

Table 5. What do calves like? Experimental calf starter. Feed composition

Wheat	40.73	Corn	22.90
Full fat soy	9.08	Rapeseed	20.00
Fat	3.00	Limestone	2.28
DCP	0.16	Salt	0.50
Bicarb	0.75	Premix	0.50

For this trial, a single feed was supplied to each group of animals, either control or experimental. The flavoured feed showed an increased feed intake of about 3% (Figure 4).

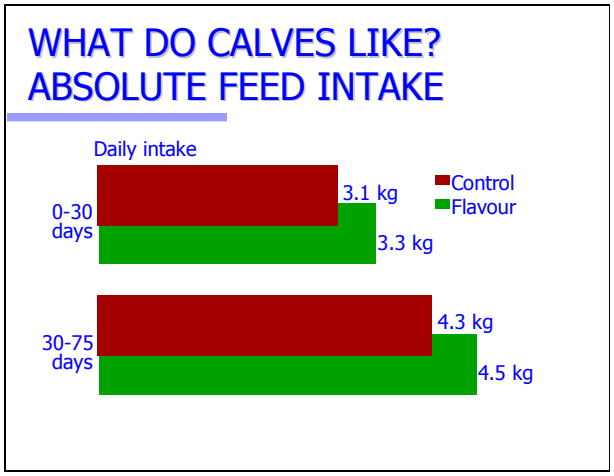

Figure 4. Increased feed intake in young beef cattle by the use of a feed flavour

Using appropriate flavours, we will obtain the intake increase we look for, achieving healthier, faster growth from the animals and providing customer satisfaction.

Maintaining intake

Maintaining feed intake while reducing cost at the minimum is the key for the success of flexible feed formulation. Very low cost feed ingredients are worthless if animals refuse to eat the feed being produced with those.

Some cases requiring the use of corrective treatment by flavours could be:

1) Reduction of costs in formulation:
   a) Energy component: sugar, processed cereals.
   b) Replacement cereals and protein sources: sorghum, rape, sunflower, peas, etc.
   c) Soya instead of fish meal in aquaculture.
2) Novel ingredients:
   a) Mixtures of fats with specific profiles.
3) Prescription diets:
   a) Sulfamides, quinoleines.

Every situation has its specific solution. There is

no silver bullet that can solve all palatability problems at once, irrespective of its origins. So professional advice must be sought when difficult conditions are encountered.

There exist many situations requiring specific flavour studies. Some examples are shown here.

a) Substituting sorghum for corn as energy component.

b) Substituting sunflower meal or peas for soybean meal or peas, as protein source.

c) Substituting soybean meal for fishmeal in fish feed.

d) Profile-specific blends that are usually manufactured from fats and oils unfit for human consumption.

e) Mineral premixes: direct consumption blocks or powdered salts, lick blocks with monensin.

f) The rendering of slaughterhouses' are refuse to be used as raw materials in the manufacture of complete feed: feather meal, poultry meal, spent hen meal, poultry litter, digests.

g) Agricultural by-products: spent marigold meal, citrus pulp meal.

h) Other sources of ingredients: Low-cost brewer's yeast, dried blood, high erucic rapeseed meal, etc.

Apart from feed formulation we encounter some other situations in animal nutrition that will lead to stress:

1) Environment:
   a) Heat, cold.
2) Management:
   a) Weaning, regrouping, transportation.

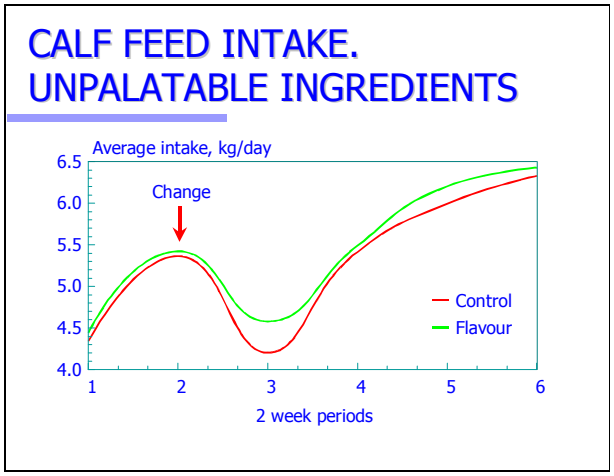

Figure 5. Intake changes in calves when an unpalatable ingredient is introduced in feed formulation

Following the previous example of rapeseed in calves, high glucosinolate/erucic acid Chinese rapeseed was substituted for canola. Right after the change there was a drop in feed intake. The feed intake decrease was lower in the flavoured group, and after the readjustment process feed intake maintained higher levels when compared to the control (Figure 5).

The commercial feed manufacturer has indeed to promote feed intake and to offer a competitive nutritional quality to its potential customers.

Nevertheless considerations other that just nutrition are in order here.

There are some factors to be considered in order to achieve successful results, getting new customers, keeping the existing ones and fulfilling the customer's expectations. In mature, highly competitive markets we find that this will lead to better sales performance.

These factors are:

1) Feed acceptance/ Barrier overcoming:
   a) Hedonism: "If I like it my animals will".
2) Territory mark:
   a) Branding.
   b) Product differentiation:
   c) Area delimitation.
3) Feed distribution:

a) Freshness.

4) Shelf competition:

a) Petfoods.

Hedonism is the acceptance of a new product by the customer (not the consumer). It is characterised by being:

a) Subjective.

b) Based on personal preferences.

c) Related to cultural aspects and not necessarily to the productive parameters expected from the animals.

d) Strong affective component, especially if it is aimed at young animals and pets.

Overcoming this factor is sometimes a hard task, especially when our customer is thinking: "If I like it so will my animals". This is why we might have to mask the smell of fishmeal in a piglet prestarter in some parts of the world, while enhancing it in others.

Another need in a commercial feed manufacturer might be the delimitation of a geographical distribution area with a characteristic flavour. In the mineral premix industry in Europe this is a common marketing strategy. We find customers asking for a "flavour similar to that of company X" or a "clearly different flavour of that of company Y" depending on their respective competitive positions on that specific market.

Also, commercial feed manufacturers use flavours as a branding trait. In doing so, its customers will recognise the feed manufacturer, including the confidence factor into the commercial relations.

Keeping a fresh, just-manufactured profile might be necessary when using distribution channels with long supply lines. The sensory levels of the flavour used must be strong and persistent enough to avoid refusals and non-conformities due to lack of freshness and stale off-flavours.

The feed's sensory profile is also crucial in Pet foods, where competition is closer to that of human consumer products than that of the livestock feed segment.

Flavour differentiation

When considering using flavours, the Nutritionist has to have confidence. He needs the knowledge on how and why a particular product works in his own conditions and provides him with benefits.

This capacity to provide profits is related to the mastering of both internal and external flavour factors.

Among the internal factors there are:

- Creation: combination of n defined raw materials and manufacturing methods.
- Physico-chemical parameters for each and every raw material.
- Support technology: powders/liquids.
- Packaging: specific materials used for flavours.

The external factors are those of the substrate to which the flavour is added. They include:

- Type of feed: piglets, pigs, calves, beef cattle, petfoods, etc.
- Manufacturing process: pellet, mash, extruded, expanded.
- Packaging: paper bag, plastic bag, and bulk.
- Storage time and storage conditions.

To satisfy the feed industry needs and expectations regarding flavours, the flavour manufacturers will have to have a deep knowledge of both the feed manufacturing technology and flavours.

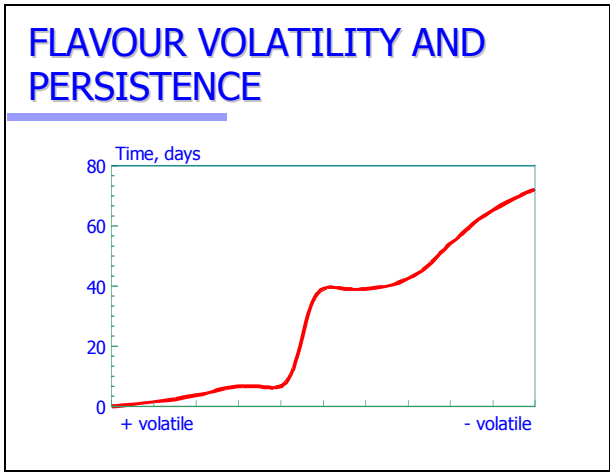

Figure 6. Persistence of flavours in mash feed depending on its volatility

One of the most important factors will be mastering flavour persistence once they are mixed with the feed. Fig. 6 shows the persistence factor in flavours with different volatility. The higher its volatility the lesser its persistence.

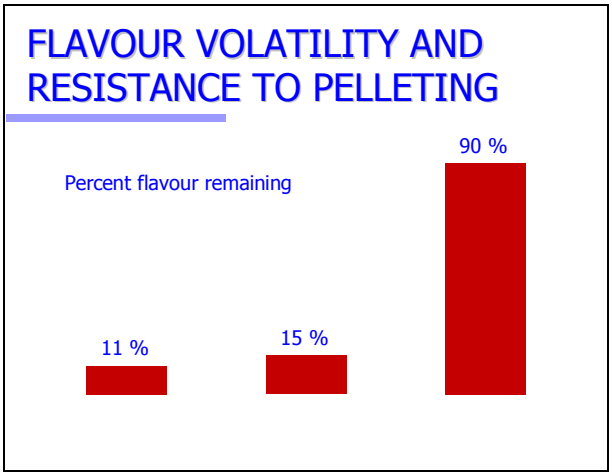

Figure 7. Resistance of flavours to pelleting depending on volatility

Flavour persistence needs to be taken into account during the feed manufacturing process. It is important to know how much flavour is lost related to the meal during pelleting. Fig 7 shows the retention values, or the flavour amount left in the pellet after

processing.

This knowledge can be achieved using Dynamic Headspace Gas Chromatography (DHGC). This technique allows observing the evolution of the individual flavour applied to the feed depending of its manufacturing process and/or the storage time after manufacturing.

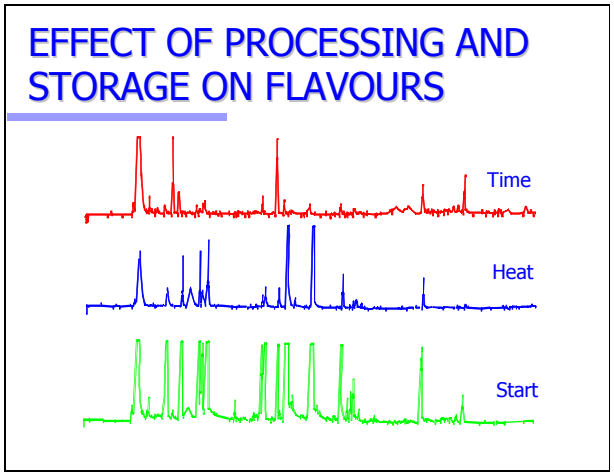

Figure 8. Dynamic Headspace Gas Chromatography of feed showing the effect of processing on flavours

Fig 8 shows a trial result: we can see the different effect of time (storage) and temperature (pelleting) on a certain flavour. This is why it is so important to master the flavour manufacturing techniques to assure the best performance of the palatability enhancers once applied to a certain feed.

It is also important to be able to identify and differentiate the performance when a solid flavour is changed into a liquid. Studies show lower performance along time when the same amount of flavour is applied externally when compared to that mixed with the mash before pelleting. Commercial feed manufacturers shall consider carefully before changing from powder to liquid flavours.

Communicating advantages

A reliable flavour supplier will fulfil its customers' needs and expectations if he is able to recommend the product that will best adapt to the particular conditions of each and every user.

And the classical flavour structure is no longer valid today. All flavours meet the head-body-bottom division (Figure 9).

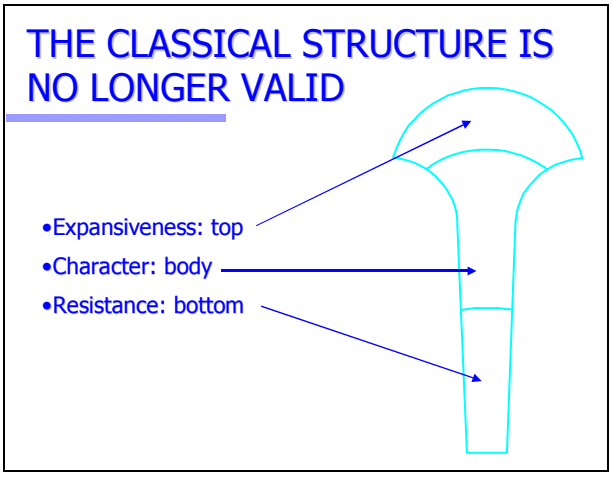

Figure 9. The classical flavour structure division

Therefore we need other type of data that provides the Nutritionist with a solid understanding on the advantages a particular flavour gives to him. One of such models, developed by LUCTA, S.A., divides flavours into five groups, following a structure-volatility relationship. With this, one can easily attach certain characteristics to each structure and thus identify and anticipate how a certain flavour will perform (Figure 10).

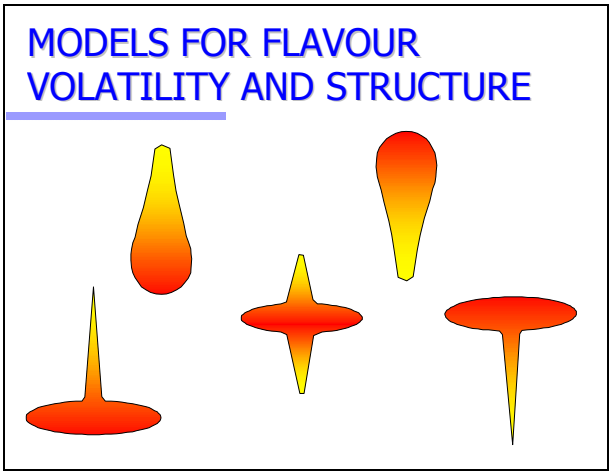

Figure 10. Structural models for flavours

Also, persistence is critical for the Nutritionist. An adequate communication package will provide easy-to-understand codes for projecting pelleting and storage resistance for every flavour offered (Figure 10).

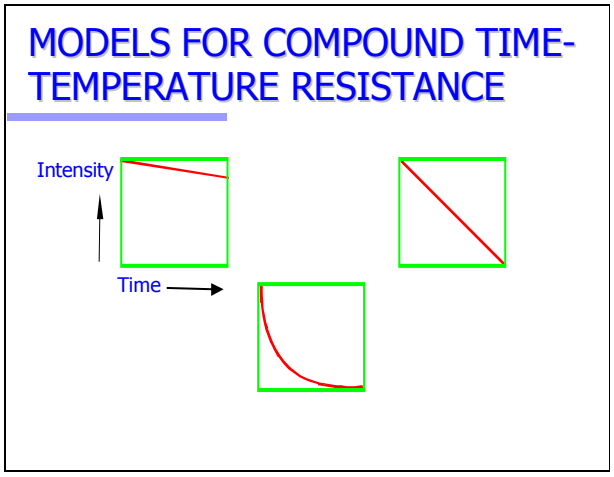

Figure 11. Time and temperature resistance models for flavours

Different species and age respond differently to different flavour profiles (Table 6).

Table 6. Preference indices to flavours in piglets

	Prestarter	Starter
Cheesy	1.50-1.60	1.55
Milk/vanilla	1.40-1.51	1.40-1.49
Red fruits	1.20-1.25	1.20-1.38
Green fruits	1.2	1.11
Aniseed		1.25

Thus given the multiplicity of choices, the Nutritionist has to ask for a set of data allowing him to choose surely from the multiple options from the Market. A basic set of information would include:

- Aromatic Structure Profiling.
- Sensory Performance.
- Substrate Compatibility.
- Time-Temperature Resistance Profiling.
- Animal Preference Data.
- Product Tailoring to Needs.

Armed with this information, the Nutritionist will be able to choose the best options for his particular needs by comparing and correlating the price offered to the performance expected. This Flavour Information System will also prove the technological level of the flavour manufacturer and its ability to transmit it to its customers.