Keynote Address

There is more to taste than meets the tongue

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Ducks are supposed to have very few taste buds. At least that's what I thought until very recently when a paper came out indicating that ducks actually have a lot of taste buds. People were just looking for them in the wrong place; they are not on their tongue.

The subject of this symposium, natural versus artificial, is in the same category. I wonder if we are looking for the correct answer in the wrong place.

The basic question is "do we need flavors at all?" I think this is the question that regulatory agencies are asking. The issue of natural vs. artificial is a front. The second question is "do we really need this endless variety of flavors?" It would be much easier if we only had five or six. We could test them at every level and every combination.

I will cover some old ground answering these two fundamental questions.

When do we first encounter taste? Taste buds can be identified in the seven week fetus. In Australia forty years ago a researcher introduced a little saccharin into the fetal fluid and found that it stimulated the fetus. At Monell we have done a lot of work with newborns. Newborn babies will respond to sugar. Not only will they respond to sugar but they will respond to it at half the amount of concentration as an adult. A baby at one to three days of age will differentiate between sugars. Newborn babies don't respond to salt. And there is no mistaking a baby's reaction to bitterness. But they will not respond to bitter at the concentrations we do. The concentration must be quite high. In any event all I wanted to point out is that we are born with the apparatus to taste.

Les Blau, Program Chairman, with M. Kare

At adolescence people begin to change their diet dramatically. Most adolescents stop eating peanut butter, at least the way they did earlier. They prefer a much higher concentration of sucrose, maybe because they have a need for energy. (Monell is working on adolescents now. We want to find out why they won't eat the school lunch we provide them.)

In the mature age group, tastes like many other things, hit a plateau. The chief executive of one of our members went to Ecuador, and tested a group of twelve people, allegedly between 96 and 127 years of age, with one of his perfumes. He tells me that twelve out of twelve identified it as a perfume. Eleven out of twelve identified it as floral.

Now when you get to be 80 or 85 you know you lose 80% of your taste buds. In studies we've done with people that age we've found that their preference is essentially the same as that of the 40 year old. Now I am not referring to their detection threshold, which is another thing.

About 2% of the population at any time are suffering from clinical problems in taste and smell. And it's true these problems get bigger in older people. But there are other things that modify taste, for instance, older people suffering from hearing difficulties. Most foods have a characteristic sinusoidal frequency. When you eat carrots, when you eat celery, you hear sounds. If you go deaf you don't get the sounds. This will modify your reaction to these foods.

But with all the other problems you may have as you age, if it is any comfort to you, with a little bit of luck you are going to keep your taste and smell all the days of your life.

One thing that happens in a regulatory agency is one kid in a hundred thousand gets a stomach ache from something, and you can't sell that material.

To get back to the question the regulatory agency asks, it is not "how is your business going?" but "what is your function, why should you add flavor to anything?"

I am not going to consider the hedonic or the pleasurable aspects of flavor. I am just going to look at the physiological functions of flavors. One of the first things that happens if you add one of your flavors to a food, is that when you put it in your mouth it stimulates salivation. Saliva is important, not in terms of digestion, but it does lubricate and help the food go down. The taste of food determines how long you chew it, and determines your pattern of swallowing. A strong taste stimulant, a piece of herring, a piece of chocolate, induces gastric contractions. It

steps up intestinal motility. So taste added to food affects the activity all along the digestive tract.

You know that just as soon as you get a strong taste stimulant, you get a lot of anticipatory effect along the digestive tract. When you go into the bathroom in the morning and drink a glass of water, the first thing you are going to want to do is urinate. You drink hot water, and almost immediately you will begin to sweat. There is a lot of information drawn off oral stimulation.

As soon as you stimulate your mouth, your rate of oxygen consumption goes up, that is, your respiratory quotient (RQ) goes up. As soon as you take a drink of Coca Cola you get a release of insulin, and a couple minutes later you get another release of insulin, and twenty minutes later up goes your hyperglycemia.

What happens if you drink Tab? Coke and Tab may taste very similar to you but you do not get a release of insulin from Tab. Artificial sweeteners don't fool the body. You don't get those blips. If you inject the same amount of sugar intervenously you don't get those initial releases.

So taste that flavor you are adding. Does it initiate those metabolic hormones?

We do a lot of work with dogs with holes in their stomachs. With a taste stimulant that is positive and favorable you get as much as a thirty-fold increase in release of pancreatic enzymes.

If we use a series of stimuli, and limit the amount of enzymes in the digestive tract, we can decrease the reversal stimuli proficiency 50%. Those are the first real hard data that taste does something and serves as a tangible value. If we apply a taste stimuli right into the stomach we don't get these releases. Taste has an enormous effect on many of the activities of the metabolic systems.

The flavors you are selling are affecting the RQ, are affecting the activity along the digestive tract, affecting the release of digestive hormones, affecting the volume and the character of the enzymes in the digestive tract. They are very important.

Just one example. We work with children without mouth parts. And normally they are fed through a tube down their stomach and most of them die anyway. It doesn't make any difference. If we feed them spoonful by spoonful stimulating them orally, the prognosis goes up dramatically. We find that cancer patients die from starvation. They won't eat. If you can get nutrients into them, their prognosis increases dramatically.

The point I want to make is that the flavors you are selling, the taste stimulants are terribly important, physiologically.

Now to my second questions, "Do you need all those flavors? Why not just six?" Well the first thing we have to accept is that there is an

enormous diversity in our sense of taste. I went to Washington about 2 weeks ago with a guy I've been working with for a long time, and I thought I knew him. Greg and I had lunch together and the guy put seven packets of sugar in his coffee. And, you know, he probably didn't get any more taste out of that cup of coffee that I did.

You have to accept that it doesn't matter how good a flavor is, it's not going to appeal to everybody. You have to have a variety of flavors because there are some people in every population that don't respond. This applies to saccharin, some people taste it and some don't. Some people taste phenyl ethyl carbomate and some don't. Some taste creatinine in meat and some don't. There's an enormous number who don't. Some people don't respond to perfumes for a variety of reasons.

Your sense of taste is influenced by a lot of things. The circulating level of hormones can modify what you perceive. In any event, we do need a lot of flavors.

Now I would like to come back again to this question of natural versus artificial. Monell is mainly concerned with how taste and smell work and of course their function as well. With the olfactory epithelium that we all have, we can identify about six thousand different odors. We have people who work on receptors, we have people working the pathway to the brain and we have people who work in the brain. Let me very quickly tell you about some of the work we do.

We have a biophysicist who takes out live taste cells. On the outside of the taste cell is a membrane. How did that membrane identify that chocolate or pears or strawberries or whatever it is, and send the message back?

Another person works with banana slugs. He works in the brain, takes up the nerves going back into the brain. Banana slugs have a pretty simple brain, 10,000 cells.

We have a man who works with glass fish. The reason he uses glass fish is that he can put the electrode right into the taste cells and see where it's going.

We receive money from the Department of Interior to study sea lampreys. We work with sea lampreys because of their great sensitivity; a sea lamprey's whole face is one big taste bud. It has got to identify a whitefish, and hook onto it. One sea lamprey destroys about eighteen to thirty pounds of whitefish a year in the Great Lakes. We collected urine from the female sea lamprey, separated it and found what in it attracts the lamprey itself.

One of our people works on the mechanism of taste buds. How do they work? We use catfish a lot because they have three or four hundred thousand taste buds. They are all over the outside of the body so they can scan the whole area. We take these apart.

One molecule of monellin, the protein sweetener, brings out a beautiful pleasant sweet taste. It's equal to a hundred thousand molecules of sucrose. How does one molecule of this protein sweetener send a message back? Why is one pound of monellin equal to a ton and a half of sugar? Can we get potentiators to make glucose sweeter? Can we use one twentieth of some material you are using, and do just as well?

A young Japanese man at Monell says potentiators and modifiers permit the taste cells to come into bloom so they will respond as they never have responded before.

One thing, we are going to understand within the next five to ten years, and if we don't, I have been wasting my time there, is how taste and odor work at the receptor level.

At the Monell Center we work on cancer, on cystic fibrosis, we work on diabetes and on alcoholism. We test all cancer patients when they come in and we test them again after the treatment. When a person's head is irradiated, half of his or her ability to taste will be lost in one day. In breast cancer there is a characteristic change in detection threshold for the sour taste. There are also characteristic changes in taste threshold for patients with lung cancer.

There are other very crucial health functions for taste. In the typical school lunch program, from 35% to as high as 80% of the food served in a program can end up in the garbage can. There is no reason why taste can't be used as a vehicle for good nutrition. Right now when you think of taste and flavor, you think of junk food. These are linked in the public's mind, what tastes good just isn't good for you. There is just no reason at all for this.

I am not at all pessimistic about new developments in taste and odor. I think this is a brand new frontier and one of the more exciting areas of potential growth and service. The opportunities in this field are just unbelievable. The new technology is developing and we are on the point of new opportunities for exploitation.

I am sure that when all the fish were swimming around and one jumped out on the land, everyone else thought he was crazy. But the one that jumped out survived and that's why we are all here.

I think we are at that stage now in taste and smell. I hope that you and we can take up the challenge.