EDITORIAL: “The Koch’s” view on the sense of taste in endocrinology

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Published online: 30 August 2016
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In September 2015, Trust in America’s Health reports that “obesity remains one of the biggest threats to the health of our children and our country. Around 17 percent of children and more than 30 percent of adults are currently considered obese—putting them at heightened risk for a wide range of health problems. If we fail to change the course of the nation’s obesity epidemic, the current generation of young people may be the first in American history to live shorter, less healthy lives than their parents. According to the most recent data, rates of obesity now exceed 35 percent in three states (Arkansas, West Virginia and Mississippi), 22 states have rates above 30 percent, 45 states are above 25 percent, and

every state is above 20 percent. Arkansas has the highest adult obesity rate at 35.9 percent, while Colorado has the lowest at 21.3 percent. The data show that 23 of 25 states with the highest rates of obesity are in the South and Midwest [1]”. In one of my previous reviews on the topic endocrine hypertension, I have provided insights into the various hormone imbalances that occur in people who are overweight or obese and have mentioned the potential problem of major addictions including hedonic eating and the addiction to consuming food items with a high content of fat, carbohydrates, and salt [2]. During the preparation of this endocrine hypertension review, I had the idea that perhaps taste perception is altered in many people nowadays, perhaps by manipulation of the taste system. This triggered my curiosity and I searched the literature with the key words taste, perception, endocrine, addiction, brain, hormones, sweeteners, salt, sweet, sour, bitter, umami, and fat. Among the published literature sources, I came across the names of the guest editors Drs. Duffy and Rother. Dr. Duffy and colleagues had investigated salt sensation and liking in an attempt to explain variability in sodium intake through oral sensory phenotype, and Dr. Rother had extensively published on artificial sweeteners.

After phoning Drs. Duffy and Rother and proposing my idea of a special guest issue on the topic taste in endocrinology, they suggested that I should attend the annual meeting of the Association for Chemoreception Sciences. I followed their advice and enjoyed this convention immensely, especially meeting and interacting with a very diverse group of scientists including neuroscientists.

As with many things in life nowadays, perception has become more important than real facts and some people may call this phenomenon simply “superior marketing” or propaganda. Perceived taste is affected by “diet” drinks which contain less sugar but non-nutritive sweeteners like aspartame [3]. The increasing use of artificial sweeteners over the last several

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decades apparently did not stop the obesity epidemic [4]. Growing up in post world war Germany and having received an education in the humanities studying classic literature in Latin and Greek, while exercising Prussian virtues including austerity, toughness, discipline, diligence, fortitude, delayed gratification, courage, frankness, straightness, incorruptibility, sense of justice, and following the motto *mehr sein als scheinen* (more substance than semblance) has likely helped me to preserve *mens sana in corpore sano* (a healthy mind in a healthy body) and withstand numerous temptations and traps one has to face these days regarding addictions and addictive behaviors, including compulsive eating, drinking, shopping, gambling, etc. Dopamine plays an important role in such behaviors (reviewed in [2, 5]). Enkephalins, peptides related to endorphins, can contribute to generating intense consumption of palatable food [6].

I had the fortune to have gourmet cooks during my childhood and adolescence, my grandmother and my mom “Mama Koch.” Both used homegrown natural and unprocessed fresh ingredients for preparing the best meals, often with very simple recipes. Watching them cook and bake taught me how one can assess food quality, as both frequently tasted (with me “pre-tasting”) and sampled their food items during the cooking/baking process, rapidly discovering when something was not headed into the right direction. The best outcome and the highest quality of the prepared meal or baked food item (cake, pie, etc.) heavily depended on the quality of the ingredients and one could not “fake” that. Those days (before the 1990s), when processed food items and food chains and food chain restaurants were a rarity, one (at least in my family) would instantly discover the “taste” problem, perhaps suggesting that my family was growing up with good/functional taste buds. Family-owned mom and pop stores including bakeries, butcheries, grocery stores, as well as family-owned restaurants were the norm then rather than the exception. There was real freshly baked bread and pastries, fresh milk (sometimes delivered by the milkman), fresh ice cream, etc. compared to nowadays with our lives being exposed to mass production of processed foods, often enriched by additives and taste enhancers as well as antibiotics and/or being genetically modified. The question arises whether all these modifications in corroboration have had an impact on the animal and human intestinal microbiome and changes in metabolism [7–9].

Growing up, me and my family often went to farmers to buy fresh milk directly from the cow. Of course, even when refrigerated, the milk became sour after a few days, and the way we learned that was not just the change from sweet to sour taste but also by us occasionally looking for the bathroom which, however, in no way had been much harmful and surely not explaining the angst/anxiety people have nowadays when seeing a milk expiration date (weeks after the milk had been purchased) with the milk itself still tasting sweet. Bovine kefir, a fermented milk drink, has sour taste and has unique peptides which are released from caseins

during its production with bioactive properties, including angiotensin-converting enzyme inhibitory, antimicrobial, immunomodulating, antioxidant, and antithrombotic effects [10]. Why are we mass producing less qualitative foods, making them last longer via adding antibiotics, salt, and sugar and are now facing the challenges of increasingly obese and often less efficiently working populations and of antibiotic resistant super bugs? I guess one could argue that this strategy (big is better) has worked over the last several decades to slowly move the (humanistic) values of societies into a superficial comfort seeking “throw away and replace” mentality and to accelerate the spread of various markets and business models. For instance, buffet food eating with increasing clothing size would translate into a constantly changing wardrobe, larger furniture, (bigger) cars (unfortunately not necessarily larger seats in airplanes), more comorbidities associated with obesity, and therefore, more utilization of various pharmaceutical and surgical procedures, etc.

Knowing that many food items are mislabeled, for instance, one in three seafood samples, as published by Oceana, I wonder if people are even aware of what they are buying or what they are getting served in restaurants [11]. For those readers who have not seen the movie *Soylent Green* starring Charlton Heston in 1973, I suggest to watch it and think about how much of that movie would really be “fiction” in 2016 and thereafter. The movie depicts a dystopian future with the majority of the population surviving on processed foods while suffering from pollution, overpopulation, depleted resources, poverty, and year-round humidity caused by global climate change.

In the USA, diet-related chronic diseases are leading causes of disability and premature death [12]. Transitioning from being overweight as a child or adolescent to a normal weight adult rarely occurs, and there are many factors that influence the eating habits of young people with individual, social, and cultural factors being very important [12]. As reviewed by Dr. Mennella and her team, more than 15 % of children’s total caloric intake comes from added sugars and by age 3 years, most children consume at least one sugar-sweetened beverage daily [13]. Habitual consumption of sugar-sweetened beverages is linked to a greater incidence of type 2 diabetes [14]. In 1985, Drewnowski and colleagues evaluated taste responses of normal weight, obese, and formerly obese individuals for sucrose- and fat-containing stimuli using a mathematical modeling technique. Obese people preferred high-fat stimuli and formerly obese subjects had enhanced responsiveness to both sugar and fat [15]. Neural processing of sweet taste might be reduced by CO₂ (carbonation) and combining CO₂ and sucrose may lead to increased consumption of sucrose [16]. Oral administration of food and taste matters when comparing subjects consuming a buffet meal vs. a nasogastric infusion of chocolate milk [17]. Interestingly, higher chocolate intake appears to be linked to a lower risk of future cardiovascular events [18]. Not all chocolate is created equal, and we all

Fig. 1 *Left*, Nutella from Germany; *right*, Nutella from North America

know the difference between chocolate from Switzerland, Germany, North America, South America, and other parts of the world. I have conducted a short taste experiment among my local scientific colleagues by providing two spoons of the hazelnut chocolate bread spread Nutella (one produced in Canada and distributed throughout North America, the other produced near Frankfurt, Germany) with the question which Nutella spoon the study subjects would perceive as more pleasant. The liking of these Peruvian American endocrinologists was in favor of the Nutella produced in Canada, whereas my own liking was the Nutella I had grown up with in Germany. As shown in Figs. 1 and 2, the German Nutella is darker and contains more cacao/cocoa than the Canadian Nutella. Figure 3 provides an analysis of Nutella ingredients, showing a higher content of carbohydrates and fat in the North American brand. Nutella had been developed in 1940 by the confectionist/pastry cook Pietro Ferrero in Piedmont, Italy. (Hazel)nuts are a very important ingredient which makes up approximately 13 % of the cream. The recipe and ingredient content of Nutella varies in different countries.

Per 100 g, the German Nutella contains the following: 31.8 g of total fat, 11 g of saturated fat, 56.9 g of carbohydrates, 6.6 g of protein, 102 mg of salt or 40 mg of sodium, and 547 kcal.

Per 100 g, the North American Nutella contains the following: 32.4 g of total fat, 10.8 g of saturated fat, 62.2 g of carbohydrates, 5.4 g of protein, 40 mg of sodium, and 540 kcal.

The combination of fat and carbohydrates, for instance, snack food like potato chips, French fries and ketchup, etc. can trigger hedonic hyperphagia, ongoing food intake independent from hunger, leading to ongoing weight gain [19]. Calorie-rich nutrients can directly influence brain reward

Fig. 2 *Left*, Nutella from Germany; *right*, Nutella from North America

Fig. 3 Analysis of Nutella ingredients

circuits independently of palatability or taste receptor signaling [20, 21]. A high-fat diet can activate peroxisome proliferator-activated receptor delta signaling in intestinal stem cells and progenitor cells which after loss of the tumor suppressor Apc can lead to tumor formation [22]. A diet high in sucrose (and fructose) can lead to increased 12-lipoxygenase signaling, promoting tumorigenesis in mammary glands [23]. Corn syrup and fructose is present in many food items and I personally wonder why people prefer to use syrup with their pancakes instead of good quality honey, jam, or Nutella—well, the answer lies in the taste buds, the individual brain, and how one grew up, I guess [24]. The frequency of taste disorders in endocrine conditions has been understudied. Examining 761 healthy subjects from age 5 to 89 years, hypogeusia was present in 5 % [25].

In my opinion, the future of combating obesity will have to focus on children age 5 years and younger, many of whom will have “diseased” overweight or obese parents, to make them learn the different qualities of taste without becoming hedonic/addicted. Our current environment with proteome research certainly can help analyze food composition, assure food authenticity, assess safety of genetically modified food, etc. with the overall goal of improving food quality [26]. Instead of mass production of low quality and often unhealthy

food, we should “go back to the future” of high-quality nutrition prepared with love and should not fall for the motto “big is better.” The foundation and largest challenge is returning to authenticity, discipline, and delayed (truly earned) gratification.

Compliance with ethical standards

Conflict of interest The author CAK declares that there is no conflict related to this work.

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