Perspective

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Ideal Dietary Approach and Preference for High-Fat Food in Animals

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Abstract

The phenomenon of animals preferring high-fat foods has been accepted as natural behaviour. Animals are equipped with fat not only for energy storage, but also for regulation of body temperature and as a source of many hormones. It is reasonable that animals eat and store fat based on physiological demands. On the other hand, eating an excessive amount of fat causes many metabolic diseases such as type II diabetes, atherosclerosis, and cardiovascular disease.

Keywords: High fat food; Palatability; Safety; Efficacy

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Introduction

Reflecting the current health situation in industrialized nations, fat studies are focused on why we over eat high-fat foods and how we can cope with accumulating body fat. Ironically, many tasty and palatable foods such as snack foods, ice cream, donuts, and so on, contain large amounts of fat [1]. The high palatability of fatty foods has been reported in many articles. Animals, including humans, show a hedonic preference for fat that increases with fat concentration. When it comes to dietary fat, we cannot regulate proper calorie intake, and so we consume more calories than we physiologically need. In a long-term drinking test for corn oil in mice, the mice continued to prefer corn oil and ingested excess calories beyond their physiological needs.

Possible Factors Involved in the High Palatability of Fat

Taste Receptors for Fatty Acids on the Tongue

Fatty foods are tasty and preferable. When mice were offered both fried potatoes and boiled potatoes at the same time, they significantly preferred fried potatoes. Mice also preferred a corn oil solution to vehicle during a 10 min two-bottle choice test paradigm [2]. How did mice recognize fat in the oral cavity in such a short period? In the past, researchers believed that the preference for dietary fat came mostly from its texture and flavour. However, the sensation of fat spreads throughout the oral cavity when we eat high-fat foods such as butter or fresh cream. Does fat have a recognizable taste? At the moment we do not have an appropriate word to describe the fatty taste, and we are still not sure that the fatty sensation in the oral cavity is one of taste. The authors of recent studies suggest that there may be fatty acid (FA) receptors on the tongue that play an important role in the recognition of Fas [3].

Polyunsaturated long-chain fatty acids (PUFAs), which are preferred by mice, are strong ligands for GPR120 [4], suggesting that GPR120 on the tongue is also a possible fat recognition receptor. Recently, GPR40 was also found on the tongue in circumvallate, foliate, and a small number of fungiform papillae; therefore, it too, might be involved with the FA recognition on the tongue [5]. Glossopharyngeal whole nerve recordings in GPR40 knockout (KO) mice showed a diminished response to oleic acid, linoleic acid, linolenic acid, and docosahexaenoic acid. Although GPR40 KO mice showed an attenuated preference for intake of corn oil, the mice's electrophysiological as well as behavioral responses to FA solutions were normal, suggesting that other FA receptors besides GPR40 are important in the recognition of FAs. Considering these facts, there seem to be various kinds of FAs recognition receptors on the tongue that might have distinct roles.

How Do Rodents Recognize Fat in the Oral Cavity?

Dietary oil consists of >90% triacylglycerols, and a small percentage of mono- or diacylglycerols and FAs. This fact raises the question of whether we recognize triacylglycerol, monoacylglycerol, diacylglycerol, or FAs when we perceive the taste of fat. So far no receptor for triacylglycerols has been identified, whereas several FA receptors, such as CD36, fatty acid transporters (FATPs), GPR40, and GPR120 have been found expressed in various organs. As described above, CD36, GPR40, and GPR120 are expressed in the circumvallate papilla. In behavioral studies, rats prefered 1% oleic acid, linoleic acid, and linolenic acid to 0.3% xanthan gum. A similar preference for FAs is also observed in mice, suggesting that rodents can recognize FAs on the tongue [6]. Interestingly, rats also display a preference for pure triacylglycerol. When offered a choice between a triolein solution and a vehicle, rats showed a significant preference for the triolein solution. How do rodents recognize triolein on the tongue? Kawai answered this simple question by showing that when rats were offered a triolein solution with the lipase inhibitor orlistat, their preference for triolein was abolished. Therefore, lingual lipase released from Ebner's glands cleaves triacylglycerols on the tongue to release free FAs. The small percentage of free FAs found in dietary oil or those released from triacylglycerols are recognized on the tongue, possibly through an FA receptor such as CD36 or GPR120, which might be important to evoke the fat sensation in the oral cavity of rodents. However, it seems difficult to extrapolate the results from the animal experiments to a model for humans, since humans have a lower level of lingual lipase than rodents. Humans have an orosensory mechanism to detect FAs and perceive them as attractive ingredients [7]. Free FAs released voluntarily from triacylglycerols in foods might be important for humans as a signal of fat.

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