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REVIEW

Potential effects of umami ingredients on human health: Pros and cons

Yin Zhang[a], Longyi Zhang[a], Chandrasekar Venkitasamy[b,c], Zhongli Pan[b,c], Huan Ke[a], Siya Guo[a], Di Wu[a], Wanxia Wu[a], and Liming Zhao[a,d]

[a]Key Laboratory of Meat Processing of Sichuan, Chengdu University, Chengdu, China; [b]Department of Biological and Agricultural Engineering, University of California, Davis, Davis, California, USA; [c]Healthy Processed Foods Research Unit, Western Regional Research Center, USDA-ARS, Albany, California, USA; [d]State Key Laboratory of Bioreactor Engineering, R&D Center of Separation and Extraction Technology in Fermentation Industry, East China University of Science and Technology, Shanghai, China

ABSTRACT

Umami taste is the most recent confirmed basic taste in addition to sour, sweet, bitter, and salty. It has been controversial because of its effects on human nutritional benefit. Based on the available literatures, this review categorized 13 positive and negative effects of umami taste on human health. On the positive side, umami taste can improve food flavor and consumption, improve nutrition intake of the elderly and patients, protect against duodenal cancer, reduce ingestion of sodium chloride, decrease consumption of fat, and improve oral functions. On the other hand, umami taste can also induce hepatotoxicity, cause asthma, induce migraine headaches, damage the nervous system, and promote obesity. Due to its novelty, there are many functions and effects of umami taste waiting to be discovered. With further investigation, more information regarding the effects of umami taste on human health will be discerned.

KEYWORDS
Umami taste; positive effects; negative effects; health

Introduction

Umami was accepted as one of the basic tastes after the umami receptors mGluR 4, T1R1 + T1R3, GPRC6A, mGluR1, CaSR, GPR92 were found in 2000, 2002, 2004, 2005, 2010, and 2013, respectively (Zhang et al. 2017, 2019). Monosodium glutamate (MSG), the first umami agent, was separated from kelp in 1908 (Yamaguchi and Ninomiya 2000). Recently, monosodium L (D) –pyroglutamate (Zhang and Peterson 2018), peptides, Maillard reaction products, and other chemicals have been confirmed to show or enhance the umami taste (Zhang et al. 2017). After nearly 40 years of investigations on the characteristics of umami, researchers found that the taste could not only make food delicious, but also potentially improve human health and induce disease.

With the improvement of people's quality of life, health promotion has become one of the main considerations in food consumption (Winkel et al. 2008). Prepared food is a direct source of energy and nutrients. The lack of palatability of prepared foods will result in less ingestion of nutrients for consumers, potentially leading to poor nutritional management and excess consumption of salt, sugar, and fat (Mouritsen 2016). Recent investigations found that the cross-cultural, physical conditions of consumers barely influenced the acceptance and liking of umami taste (Elman, Geraldo, and Karcher 2010; Sorokowska et al. 2017). This suggests that, besides flavoring, there are wide prospects for the use of umami in the human health industry. To further conclude positive and negative concerns of umami taste on human health, recent investigations of umami ingredients on human health are reviewed.

Category of umami ingredients

There are two kinds of umami ingredients to enhance umami taste in foods, namely umami agents and umami enhancers. The umami agents provide umami taste directly by interacting with umami receptors, whereas the umami enhancers only increases umami taste through synergistic functions with the umami agents. Both L-glutamic acid and its sodium salt or MSG show umami taste by binding to umami receptors (Zhang et al. 2017). Therefore, they are umami agents. Since MSG was first reported in 1908, the umami taste and umami enhancing products gained great attention in the world.

Guanosine monophosphate (GMP), inosine monophosphate (IMP), and other ribonucleotides cannot produce umami taste directly as they are all umami enhancers (Zhang et al. 2013). Recent research indicated that (1) organic acids, such as succinic acid, pyroglutamic acid, succinoyl amides of amino acids, gallic acid, and theanine; (2) peptides, such as pyroglutamyl peptides (Amado and Schlichtherle-Cerny 2003), dipeptides, tripeptides, octapeptides, pentapeptides, hexapeptides, tetrapeptides, heptapeptides, and undecapeptides (Zhang et al. 2017); and (3) other ingredients, such as theogallin, N-glycosides, N-acetylglycine, glycopeptides (Iwasaki et al. 2004), alapyridaine (Soldo, Blank, and Hofmann 2003), morelid, etc. (Zhang et al.

CONTACT Yin Zhang zhangyin@cdu.edu.cn Key Laboratory of Meat Processing of Sichuan, Chengdu University, Chengdu, 610106, China.

Table 1. Effects of umami taste on human health.

Effect category	Description	References
Positive effects	Improve food flavor and consumption	Miyaki et al. (2016);Yuasa et al. (2017); Qi et al. (2018); Nwe et al. (2017);Jinap and Hajeb (2010); Noel, Finlayson, and Dando (2018); Yeomans et al. (2008); Lindemann (2001); Lejeune, Smeets, and Westerterp-Plantenga (2007); Masic and Yeomans (2017)
	Improve nutritional intake in patients and the elderly	Shoji, Satoh-Ku, and Sasano (2016); Sasano et al. (2014); Kubota, Toda, and Nagai-Moriyama (2018); Zai et al. (2009); Toyama et al. (2008); Tomoe et al. (2009); Dermiki et al. (2015)
	Protects duodenum	Reeds et al. (2000); Akiba et al. (2009); Burrin et al. (2009); Amagase et al. (2015)
	Reduces ingestion of sodium chloride	He et al. (2018); Yamaguchi and Ninomiya (2000); Maheshwari et al. (2017); Jasmine et al. (2016); Ball et al. (2002); Kawano et al. (2015); Onuma, Maruyama, and Sakai (2018)
	Decreases consumption of fat	Bellisle (2008); Jinap and Hajeb (2010); Imada et al. (2014); Takashi et al. (2016)
	Improves oral functions	Yamamoto et al. (2009); Satoh-Kuriwada et al. (2018); Schiffman and Miletic (1999); Noel, Finlayson, and Dando (2018)
	Improves stomach function	Kochetkov et al. (1992); Yamamoto et al. (2009); Marik and Kaplan (2003); Zai et al. (2009); Nakayama and Teramoto (2016)
	Treats of hypogeusia	Sasano et al. (2010)
	Enhances positive emotions	Miyaki et al. (2016)
	Reduces risk of metabolic problems	Chamoun et al. (2018)
	Improves healthy eating and food choice in humans	Magerowski et al. (2018).
	Has anticarcinogenic effects in female mice	Jurasek et al. (2017),
	Reduces aggressive actions of rats	Nishigaki et al. (2018).
Negative effects	Induces hepatotoxicity	Nakanishi et al. (2008); Tawfik and Albadr (2012); El-Nashar (2010); Abbas and Hefnawy (2016); Quines et al. (2017)
	Causes asthma	Allen, Delohery, and Baker (1987); Moneret-Vautrin (1987); Jinap and Hajeb (2010); Yoneda et al. (2011)
	Induces migraine headaches	Radnitz (1990); Shimada et al. (2013); Shimada et al. (2016)
	Causes nervous system damages	Lau and Tymianski (2010); López-Pérez, Ureña-Guerrero, and Morales-Villagrán (2010); Rosa et al. (2018); Hussein et al. (2017); Mohan, Gangurde, and Kadam (2017)
	Induces obesity	Iwase et al. (2000); Nakanishi et al. (2008); He et al. (2008); Shannon et al. (2017); Kondoh and Torii (2008)
	Reduces birth weight of rat offspring	Hermanussen et al. (2006)
	Decreases skeletal muscle growth of male rats	Igwebuike, Nwankwo, and Ochiogu (2010)
	Induces atherosclerosis in normal adult male rats	Singh et al. (2011)
	Negatively affects the pancreas of adult wistar rats	Boonnate et al. (2015)
	Suppresses reproductive function in female rats	Mondal et al. (2018)
	Reduces the pain threshold of mice	Zanfirescu et al. (2018)
	Induces diabetes and impaired memory in rats	Saikrishna et al. (2018)
	Acts as a mutagenic agent	Amamarasekara, Logeswaran, and Kothalawala (2016)

2017), were all reported to have umami taste or show umami enhancing properties. With the continuous discovery of new flavor analysis techniques and the deepening of research on the interaction between umami substances and umami receptors, more umami agents and umami enhancers will be discovered.

Principles of effect of umami taste on health

The umami receptors are confirmed to exist in the tongue cavity, gastric mucosa, gastric wall, intestinal wall, and hepatoportal region (Niijima 2000). As umami agents, such as L-glutamate or MSG, make contact with umami receptors, the taste will not only stimulate the oral cavity, but also confer sensory information to the vagal afferent fibers in the gastric mucosa or other organs (Kondoh et al. 2009).

The stimulation produced by the umami agents with receptors urges the nervous system in the brain or other organs to react accordingly. Glutamate also functions as an intestinal oxidative material and important neurotransmitter (Kondoh et al. 2009). These functions of umami ingredients on the nervous system and intestines might produce positive or negative effects on human health as they are consumed.

Effects of umami taste on human health

Umami taste can improve the palatability of foods, and its flavor is accepted worldwide (Elman, Geraldo, and Karcher 2010; Sorokowska et al. 2017). As a result, it has been widely adopted in the food industry. However, a 1968 report based on clinical evidence indicated that MSG could induce physical discomfort in humans (Kazmi et al. 2017). This report set off more investigations on functions of umami taste on human health.

Up until now, researchers have found both positive and negative functions of umami on human health. The positive functions include, the improvement of food flavor and consumption, improvement in the nutritional intake in the elderly and patients, protection against duodenal cancer, reduced ingestion of sodium chloride, decreased consumption of fat, improvement of oral functions, etc. The negative functions include, the induction of hepatotoxicity, asthma, migraine headaches, nervous system damages, obesity, etc. The two effects of umami on human health are detailed in Table 1.

Positive functions of umami taste on health

Improves food flavor and consumption

The umami taste is accepted worldwide. Its addition to dishes and processed foods can improve deliciousness and enjoyment (Miyaki et al. 2016). Recent investigations demonstrated that MSG alone or combined with ribonucleotides successfully improved the flavor of instant soup (Yuasa et al. 2017), chicken soup (Qi et al. 2018), Peking duck (Nwe et al. 2017), and more. There is an optimal concentration of glutamate in each type of food; generally, the ideal amount of glutamate is 0.1–0.8% of the weight of food. An excess amount worsens the taste of foods (Jinap and Hajeb 2010), and can even lead to the decrease of umami taste and diminish consumers' appetites (Noel, Finlayson, and Dando 2018).

Besides enhancing flavor, the addition of MSG in a savory soup improved the appetite and flavor memory of participants (Yeomans et al. 2008). The glutamate also regulates food digestion through the sensing system in the mouth, stomach, and pancreatic duct. Lindemann (2001) reported that MSG could accelerate food digestion by stimulating the mouth, stomach, and pancreatic duct to secrete more saliva and endocrine and exocrine fluids. MSG + IMP has been found to increase consumption of high protein foods without influencing energy metabolism in humans (Lejeune, Smeets, and Westerterp-Plantenga 2007; Masic and Yeomans 2017).

Improves nutritional intake of elderly and patients

Worldwide, the proportion of elderly persons is increasing vehemently (Huang, Dequan, and Yuan 2018). There is an irreversible decline or loss in the sensitivity to umami taste in the elderly (Shoji, Satoh-Ku, and Sasano 2016). This results in inadequate dietary ingestion and impaired nutritional status, sometimes even leading to anorexia in elderly (Shoji, Satoh-Ku, and Sasano 2016). The treatment of umami taste loss in elderly patients showed that umami taste seemed to contribute to their overall health (Sasano et al. 2014). Therefore, to prevent umami taste loss in old age, Kubota, Toda, and Nagai-Moriyama (2018) proposed teaching children to learn umami taste acuity.

Clinical data demonstrated that glutamate could accelerate gastric emptying in a high liquid protein diet. This effect of Glu can heal heavy stomach and decrease fat accumulation in humans (Zai et al. 2009). The effects of MSG on protein nutritional status of elderly inpatients seems different; Toyama et al. (2008) demonstrated that MSG (meals containing MSG for 11 elderly inpatients for 2 months) improved recognition ability and increased the amount of peripheral lymphocytes of the elderly, but their protein nutritional status remained unchanged. However, a similar experiment with 14 elderly inpatients showed that consumption of MSG could augment the amount of reductive state albumin. In this case, an addition of 0.5% MSG to rice porridge (3 times per day continually for 3 months) ameliorated behaviors and the nutrition indexes of the elderly inpatients (Tomoe et al. 2009). Recent investigation indicated MSG could increase desire and consumption of soup in older adults (Dermiki et al. 2015).

Protection of duodenum

The metabolism of glutamate in the gut increases mucosal defenses from injury brought by acid in the duodenum. Glutamate is the energy contributor and a substance used for the production of glutathione and other kinds of amino acids in intestinal mucosa (Reeds et al. 2000). Experiments performed in rat duodenums showed that glutamate might increase gut defense ability by activating receptors and afferent nerves in intestinal mucosa (Akiba et al. 2009). Burrin et al. (2009) adopted infant pigs as subjects to investigate the metabolization and function of glutamate in pig guts. They found that 4-fold higher than the normal dietary levels of glutamate was safe for infant pigs. Most glutamate molecules were transferred into other amino acids in the pig gut. Furthermore, recent investigation in rats showed that MSG not only protects the small intestine from damage, but also shows some enhancing healing effects (Amagase et al. 2015).

Reduces ingest of sodium chloride

Sodium chloride is a daily used seasoning agent. Medical diagnosis indicates that too much sodium ingestion will increase the risk of hypertension, cardiovascular diseases, and even cancer (He et al. 2018). These discoveries prompted extensive attention to the reduction of salt and sodium intake worldwide. The earlier study found that MSG can reduce salt content in food in 1984, Yamaguchi and Ninomiya (2000) reported that the palatability of soup could be maintained by the addition of glutamate when the salt content of the soup was reduced.

In addition to soup, MSG was reported to decrease salt addition in deep fried bread (Maheshwari et al. 2017), chicken rice (Jasmine et al. 2016), and other dishes. Ball et al. (2002) found that calcium diglutamate improved the umami taste of soup while decreasing sodium levels. Similarly, Kawano et al. (2015) found that using monomagnesium diglutamate had an approximately 25.9% reduction in daily dietary sodium of psychiatric patients without influencing their body health indexes. Recent research demonstrated that MSG could increase perception of saltiness in humans (Onuma, Maruyama, and Sakai 2018), which can reduce salt addition in foods.

Decreases consumption of fat

Bellisle (2008) discovered that when the fat contents of pasta and mashed potatoes reduced by 30%, their palatability also decreased, but adding MSG could make up for the lost palatability caused by reduction of the fat. Another study concluded that MSG alone or combined with salt could decrease the fat addition in foods (Jinap and Hajeb 2010). Therefore, MSG can be adopted to produce fat-reduced foods or diet-restricted foods without decreasing palatability.

Imada et al. (2014) found the addition of MSG to the broth decreased the subsequent consumption of fat. Takashi et al. (2016) further explored the effect of MSG on the energy intakes in overweight and obese adult women with normal eating habits, and found that the vegetable soup containing MSG resulted in decreased energy intake from fatty foods.

Improvement of oral functions

With the increase of age, the function of parasympathetic nerves decreases in elderly persons, resulting in the commonness of dry mouth among older adults. It affects the quality of older life greatly (Yamamoto et al. 2009). Based on a previous investigation of MSG stimuli on saliva secretion of 11 healthy elderly people, Satoh-Kuriwada et al. (2018) choose 56 human subjects (age range 19–42 years) to further investigate the effect of MSG stimuli on saliva secretion. They found that the saliva secretion of the individuals increased with stimulation of MSG, and the effect of MSG lasted longer than other tastes did.

Following the investigation of MSG stimuli and its ability to increase secretion of saliva, Schiffman and Miletic (1999) measured immunoglobulin A in the saliva of young and elderly subjects and found that the salivary immunoglobulin A concentration did not increase with the stimulation of MSG. However, increased saliva secretion made the mouth accumulate more immunoglobulin A, which helped ameliorate the oral immune deficiencies of the young and elderly individuals. Although MSG is effective in increasing saliva secretion in humans, habitual exposure to umami stimulation will deactivate perception of umami taste. Noel, Finlayson, and Dando (2018) found that young people (age 18–55) stimulated with umami taste for long periods of time showed decreased perception of umami taste and liking for savory foods.

Improvement of stomach function

Chronic atrophic gastritis (CAG)) happens frequently in the elderly, and can induce absorption disorders of nutrients and loss of appetite (Halter, Hurlimann, and Inauen 1992). Meals containing MSG were tested to increase the gastric acid output, and it was found that the meals with added MSG stimulated the maximum output of gastric acid near normal levels and ameliorated appetite (Kochetkov et al. 1992). Therefore, MSG is recommended as an adjuvant in combined therapy of atrophic gastritis.

Gastric emptying disorder is another unhealthy condition frequently appearing in the elderly; it makes gastric distension last longer, decreases hunger, causes satiety, and produces stomach discomfort (Yamamoto et al. 2009), even leading to pneumonia in elderly patients (Marik and Kaplan 2003). Zai et al. (2009) reported that a liquid diet rich in protein augmented with 0.5% MSG increased the gastric emptying rate of healthy 40-year-old adults. This gastric emptying may be a result of MSG's facilitation of duodenal motility (Nakayama and Teramoto 2016).

Others

In addition to the examples enumerated above, other positive effects of MSG on human health have been reported. Umami could be used as an effective tool for the treatment of hypogeusia (Sasano et al. 2010), to enhance positive emotions (Miyaki et al. 2016), to reduce the risk of metabolic problems (Chamoun et al. 2018), and to improve healthy eating and food choices in humans (Magerowski et al. 2018). Recent investigations with animals showed that MSG may have anticarcinogenic functions on female mice (Jurasek et al. 2017), and can reduce aggression actions of rat (Nishigaki et al. 2018).

Negative functions of umami taste

Even though umami has excellent flavor quality and the potential to improve human health, the debate on its positive effects is ongoing. In 1968, it was reported that a side effect of MSG was numbness in the neck, back, and arms, which were referred as Chinese Restaurant Syndrome (Geha et al. 2000). Nowadays, MSG has been reported to induce hepatotoxicity, asthma, migraine headaches, nervous system damages, and other ailments (Ganguly 2017; Kazmi et al. 2017).

Increases risk of diseases

Hepatotoxicity

Nakanishi et al. (2008) injected MSG (2 mg/g body weight for 5 consecutive days) into newborn mice, resulting in nonalcoholic fatty liver disease in all mice (6 and 12 months of age). When Tawfik and Albadr (2012) added MSG to adult albino rats' meals for two weeks, the liver weight and activities of liver enzymes (alanine aminotransferase and gamma-glutamyl transferase) of rats increased. These phenomena showed that MSG induced liver damage, but new discoveries also demonstrated that this damage can be reduced by additives such as taurine (El-Nashar (2010). N-acetylcysteine (Abbas and Hefnawy 2016) and an organic selenium compound (Quines et al. 2017) have been reported to show potent hepatoprotective and antioxidant effects in rats with MSG induced hepatotoxicity.

Asthma

Allen, Delohery, and Baker (1987) reported that 14 of 32 subjects appeared to have asthmatic symptoms after eating Chinese food containing MSG. However, their conclusion that MSG can induce asthma was controversial. Similar experiments performed by Moneret-Vautrin (1987) showed that only 2 of the 30 asthmatic participants had reduced pulmonary function when the participants were treated with 2.5 g of glutamate after controlling for the placebo effect. Further similar experiments were performed and none found that MSG induced a reduction in pulmonary function in animals (Jinap and Hajeb 2010). The conclusion advanced in Jinap and Hajeb (2010) has been further supported by Yoneda et al. (2011), who used an asthmatic mouse as an animal model and found that MSG did not cause asthma or acute asthmatic responses. From these investigations, it is clear that there is no strong correlation between glutamate and asthma.

Migraine headaches

Based on advice from a clinic, Radnitz (1990) reported that intake of glutamate can cause migraine headaches. Shimada et al. (2013) performed a double-blind, placebo-controlled experiment on 14 healthy adults (>18 years old) to examine the effect of repeated MSG intake (150 mg/kg body weight, 5 daily sessions for 7 days) on the presence of headaches, but they found that none of adults had headaches. Although Shimada et al. (2016) recently reported that drinking MSG (150 mg/kg body weight) in 400 mL soda water could aggravate muscle pain of myofascial temporomandibular disorder patients, there are no consistent data or evidence to confirm a direct link between glutamate and migraine headaches.

Nervous system damages

Lau and Tymianski (2010) suggested that excess consumption of MSG may lead to severe neuronal damage and disorders, such as amyotrophic lateral sclerosis (ALS), encephalitis periaxialis scleroticans, and Parkinson's disease. López-Pérez, Ureña-Guerrero, and Morales-Villagrán (2010) performed intracerebroventricular injections of MSG into newborn rats at 1, 3, 5, and 7 postnatal days. They found that Glu levels in rat brains increased significantly and there were behavioral changes among the rats, such as screeching and tail stiffness, which suggests an initial seizure. Subsequent research demonstrated that the effect of MSG on nervous system disorders depended on the duration of MSG used and the age of rats (Rosa et al. 2018). This suggests more evidence should be found to support the notion that MSG ingestion can result in nervous system damage. In particular, oral taste tests should be performed, because MSG has to pass through the digestive system before it is absorbed; injection of MSG into the animal body cannot replace oral taste. Recent investigations indicated ginger and propolis (Hussein et al. 2017) and seed extracts of solanum torvum (Mohan, Gangurde, and Kadam 2017) have the potential to ameliorate neuronal damage induced by MSG in mice.

Obesity

Newborn rats were tested for obesity symptoms after intraperitoneal injection with MSG for 5 days. Results showed that there were more late obesity occurrences and higher blood triglyceride levels in hypertensive rats compared to normotensive rats (Iwase et al. 2000). Nakanishi et al. (2008) reported injection of MSG in mice led to obesity and diabetes. In addition to animals, MSG has also reportedly induced obesity in humans. In a study with 752 Chinese subjects, the body weight of MSG users (mean intake of MSG 0.33 g/day) was higher than that of non-users regardless of physical work levels and total caloric intake (He et al. 2008). Recently, cell experiments indicated that higher dietary levels of MSG showed disruptive effects on the secretion of enteroendocrine hormones (Shannon et al. 2017). Therefore, the authors concluded that this may be the reason MSG intake leads to obesity. However, the results of Kondoh and Torii (2008) revealed that the spontaneous ingestion of a 1% MSG solution and water on male rats reduced body fat mass. These contrasting conclusions demonstrate that further investigations are needed to support the view that MSG intake can induce obesity.

Others

Most other negative functions of MSG were seen in experiments performed on rats or mice, including reduced birth weight of rat offspring (Hermanussen et al. 2006), decreased skeletal muscle growth of male rats (Igwebuike, Nwankwo, and Ochiogu 2010), atherosclerosis in normal adult male rats (Singh et al. 2011), damaged pancreas of adult wistar rats with prolonged MSG consumption (Boonnate et al. 2015), and suppressed female reproductive function in rats (Mondal et al. 2018).

Recent investigations showed that the ingestion of MSG could reduce the pain threshold of mice. In one study, MSG was given at a dose of 300 mg/kg body weight for 21 days (Zanfirescu et al. 2018). MSG combined with a high sucrose diet also induced diabetes and impaired memory in rats (Saikrishna et al. 2018). However, selenofuranoside (Ramalho et al. 2018) and ethanolic fermented garlic extract (Nurmasitoh, Sari, and Partadiredja 2018) could attenuate or prevent the memory impairment of rats following MSG exposure. MSG was also reported as a mutagenic agent when it was tested on recombined strains of *Salmonella typhimurium* (Amamarasekara, Logeswaran, and Kothalawala 2016).

Discussion about positive and negative functions of umami taste

Although there are many potential positive effects of MSG on human health, there are also some negative effects which should not be neglected. For reports discussing potential risks of MSG intake, many researchers also expressed opposite opinions. One such case is the Chinese Restaurant Syndrome. According to the results of reported and their own experiments, Geha et al. (2000) concluded that the Chinese Restaurant Syndrome was not reproducible. In addition, the reports that MSG can induce asthma were refuted by Freeman (2006), who concluded that all the investigations suggesting this negative impact were unreliable because of smaller sample size and objectionable study design. Furthermore, with regard to the suggestions that MSG induces fat deposition and obesity, Kondoh and Torii (2008) found that MSG was related to decrease of body weight and fat deposition. Shi et al. (2010) performed a 5-year experiment to evaluate the effect of MSG on obesity and weight gain in Chinese adults, and the results showed that MSG intake was not associated with weight gain. Additional investigation found that MSG could increase fullness and reduce desire to eat in healthy young men when it was consumed alone or mixed with whey protein to produce carrot soups (Anderson et al. 2018). Another experiment showed that vitamin D inhibited body weight gain in MSG-induced obese rats (Nandan et al. 2018). Therefore, more factors should be considered and further investigations should be conducted to confirm the correlation of MSG with obesity or other diseases.

The disputation on the effects of MSG on human health has lasted for decades, especially regarding the negative effect of MSG on human health. However, recent research has not supplied a strong and persuasive relationship between MSG or Glu intake and the occurrence of hepatotoxicity, asthma, migraine headache, or other ailments (Jinap and Hajeb 2010). What's more, most diseases allegedly induced by MSG or Glu involved injections performed on infant rats or mice. The effects produced by injecting MSG or Glu into an animal body cannot be compared with the effects produced by oral experiments. MSG and Glu directly interact with organs and cells as they are injected, but the digestion process can change their effect when ingested by mouth. Nonetheless, for the sake of food safety, ingredients containing MSG were removed from newborn food but remained in baby formula until the late 1970s (Kazmi et al. 2017). On the other hand, MSG and Glu are used as food additives. The main function of MSG and Glu is to make food delicious, but not supply nutrients. Therefore, the proper amount should be used to flavor food; an excessive amount will not only worsen the taste, but could also lead to toxic reaction. Similarly, drinking too much water or not drinking it properly will result in poisoning and even death (Roth 2017).

Conclusions

Based on previous and recent investigations, positive and negative functions of umami taste on human health have been concluded. Thirteen positive functions and 13 negative functions of umami taste have been reported. The positive functions of umami taste are including improvement of food flavor and consumption, improvement of nutritional intake in patients and the elderly, protection against duodenum cancer and so on. The negative functions of umami taste are including induction of hepatotoxicity, causation of asthma, induction of obesity, etc. Although there are many controversies regarding the negative effects of umami, the positive benefits outweigh the negative functions.

The umami is the latest confirmed basic taste in addition to sour, sweet, bitter, and salty. There are many functions and effects of umami awaiting investigation, such as the difference in effects between umami agents and umami enhancers on human health, new umami ingredients' effects on human health, combined effects of umami ingredients and other nutrients or food additives on human health, new chemicals' potential to ameliorate negative effects brought by umami taste, umami's effect on the health status of young and middle aged inpatients, and more. With the development of new research methods, the discovery of new umami agents and enhancers, and the exploration of new phenomena caused by MSG ingestion, researchers will be able to discern more positive and negative functions of umami taste.

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