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Umami Characteristics and Taste Improvement Mechanism of Meat

Abstract

Taste is one of the five senses that detect vital information about what we are eating. Comprehending taste is crucial for enhancing the flavor of foodstuffs and high-protein foods like meat. Umami has global recognition as the fifth elementary taste, alongside sweetness, sourness, saltiness, and bitterness. Umami compounds are known to enhance the sensation of recognized flavors such as salty, sweet, bitter, and others. This could end up in greater food consumption by consumption by consumers. With the rising global population, meat consumption is rising and is projected to double by 2025. It is crucial to comprehend the umami mechanism of meat and meat products, identify novel compounds, and employ laboratory methodologies to gather varied information. This knowledge will aid in the development of new consumer products. Although very limited information is available on umami taste and compounds in meat through research data. This article discusses recent advancements in umami compounds in other foodstuff as well as meat to aid in designing future research and meat product development. Moreover, another objective of this review is to learn present techniques in foodstuffs to enhance umami taste and utilize that knowledge in meat products.

Keywords: Taste, Umami taste, Meat, Umami mechanism, Umami compounds.

Introduction

The gustatory experience of eating stimulates the process of choosing, ingesting, assimilating, and digesting food. The capacity of taste refers to the ability to sense or perceive taste. Individual variation in taste perception and food choice play an important role in dietary choices and food intake (Wu et al., 2022).

There are five widely recognized and accepted basic tastes salty, sweet, bitter, sour, and umami (Lindemann, 2001). In addition, fat (Deepankumar et al., 2019; Khan et al., 2019) and kokumi (Rhyu et al., 2020) are among the proposed candidates for a sixth basic taste. Taste acts as a nutrient-toxin detection system in humans. For instance, sweet indicates carbohydrates as a source of energy, salt informs intake of sodium and dietary electrolyte balance. Umami reflects amino acids in protein (Chandrashekar et al. 2006), whereas the aversive taste of sour (acidic taste) and bitter indicate unripe or overripe foods, and potentially harmful poisons (Kinnamon 2012; Lee & Cohen, 2015).The fifth taste umami is more complex than the other four, and many say it takes more work to understand and identify. it. K Ikeda will be remembered forever for the discovery of the savory taste known as Umami in 1908. It was not until 2009 that it was acknowledged as a fundamental taste component (Kurihara et al., 2009). Nevertheless, it took almost a century for umami to be acknowledged by the larger scientific community, particularly in the West. One of the main reasons for the late recognition of umami taste is the difference in culinary culture between Europe and Japan. After the discovery of umami, Ikeda and Saburosuke Suzuki, an iodine manufacturer, developed a new seasoning, monosodium glutamate (MSG) in 1909, to add umami taste (Ninomiya, 2015). In present days, umami has spread widely not only in the scientific field but also in gastronomy. cooks and chefs from the culinary arts can express accurately the unique characteristics of umami taste using their expertise. Trends in collaborative works between chefs and researchers over the past two decades have allowed for the blending of science and cooking. This has accelerated the deepening and broadening of umami knowledge. Usually, umami creates a sensation in the taste buds. The other four enhance the flavor several times more. In a sense, umami is a pleasant taste but subtle enough to go undetected by many when eaten Umami. The protein flavor is an essential dietary flavor that seems distinct from those produced by sweetness, salt, cheese, and some vegetables, especially tomatoes and mushrooms. The five nucleotides and glutamates work harmoniously and create the umami taste (Ikeda, 2002; Yamaguchi 1967; Yamaguchi 1979). Umami stimuli include monosodium L-glutamate and inosine 5-monophosphate. Other amino acids than glutamic acids, like aspartic acid and theanine, also have an Umami taste and flavor. Remarkably, it has been found that numerous umami or umami-enhancing compounds and their analogs are found in dairy products like cheese, fermented milk, yogurt, plant-based products like soy sauce, tomato sauce, and meat protein hydrolysates. The presence of different umami taste related chemicals is critical for enhancing the pleasurable flavor of diverse food items (Zhang and Peterson 2018). With the growing demand for meat, it is essential to develop new products with diverse tastes and flavors for consumers, where umami could be an ideal and prospective option. This review discusses the basics of umami taste characteristics, their mechanism, their availability in different food compounds, and the analytical tools frequently used.

The evolution of Umami as the fifth fundamental taste

Umami is a flavor notion that has just been introduced to the Western world. Prior to the year 1980, it was widely believed that there existed solely four fundamental tastes: sweet, salty, sour, and bitter. Other alternative flavors were considered amalgamations of these four taste traits, similar to how primary colors blend to provide the entire range of colors. Scientists have just identified a fifth fundamental flavor, distinct from the other four, which plays a crucial role in our enjoyment of food items. This flavor is typically termed as umami (Ninomiya, 2002). The initial journey of umami taste discovery is illustrated in Figure 1.

Mechanism of umami flavor reception

Taste receptor cells, located primarily on the sensory receptors like taste buds distributed within the mouth cavity, such as the tongue, palate, and throat, perceive taste or gustatory sensation. Taste buds are bulbous structures resembling onions, primarily situated on the papillae of the tongue, each containing fifty to hundred specialized cells responsible for detecting taste. Consuming food or beverages causes a trace amount of the food to dissolve in saliva, diffuse through the pores that decide taste, and interact with the taste cells' surface. All five taste characteristics have an identified receptor located on the surface of the cell tissues of the tongue (Figure 2), associated with a distinct transduction process. The cell membrane enables the entry of salt and sour tartans through voltage-gated ion channels, while sweet, umami and bitter tartans attach to G-protein coupled receptors (GPCR) inside of the cell membrane (Roper and Chaudhari, 2017). Furthermore, The GPCR family members, namely T1R1, T1R2, and T1R3, act as heterodimers. A significant feature characteristic of the taste of amino acids in animals and the taste of umami in humans is their exceptional amplification by purine nucleotides, such as inosine-5-monophosphate (IMP) and guanosine-5-monophosphate (GMP) (Yamaguchi et al., 1967). Cell-based expression studies have demonstrated that the rodent GPCR's T1R1 and T1R3 interact to create a receptor sensitive to a wide range of l-amino acids (Nelson et al., 2002). The human T1R1 or T1R3 heteromeric proteins detect umami flavor stimuli using five ribonucleotides as enhancers (Zhang et al., 2019). These include IMP and GMP for the recognition of umami taste, respectively.

Compounds that enhance umami flavor

Umami receptors can detect a five-membered ring structure formed by the electrostatic interaction of the amino and carboxyl groups, which is the taste mechanism of umami amino acids (Ardö et al., 2006). Two types of components can augment the umami flavor in food: umami agents and umami enhancers (Zhang et al., 2019). Basic umami and umami-enhancing peptides have particular structural characteristics that give them an umami flavor and an umami-enhancing capability. Natural sources of umami include MSG, disodium guanylate (GMP), and disodium inosinate (IMP). Umami was mainly associated with MSG flavor before the umami receptor was discovered, and it was not acknowledged as one of the fundamental tastes.

However, it is most noticeable in glutamic acid (Zhao et al., 2019). Many additional chemicals, including 20 different types of naturally occurring amino acids that makeup purine nucleotides, such as 5′-inosinic acid(5′-IMP) and 5′-guanylic acid(5′-GMP), exhibit similar taste. Later, ninety-eight peptides have an umami taste, and dipeptides comprise 29.6% and 30%, respectively, of that peptide. Consequently, most identified umami-enhancing peptides comprise short linear amino acid chains or peptides with a molecular weight distribution usually below 5000 Dalton (Bao et al., 2020). Long linear peptides have also been discovered to have a vigorous umami intensity, although isolating and identifying a long-chain peptide is more challenging than dipeptides or tripeptides (Su et al., 2012). Additionally, the modified chains of short peptides Lys-Gly-Asp-Glu - Glu-ser-Leu-Ala were found as umami compounds in meat-based products, especially in beef hydrolysate in the ’80s, indicating a distinctive characteristic of taste peptides that may enhance the flavor of foods (Briand and Salles, 2023). Later, a growing number of peptides were discovered, including those from a plant-based product, enzymatic hydrolysate of deaminated gluten (wheat source), which were identified as MSG taste and flavor-improving substances having the capacity to amplify the associated taste of salt, glutamate, and acidulant (Schlichtherle and Amadò, 2002). It was assumed that hydrogen bonds and hydrophobic interactions were the basis of primary intermolecular forces of interaction between different tastes, which was recently confirmed by Wang et al., 2023 in a study of umami taste in sturgeon. For better understanding, table 1 illustrates examples of umami compounds, especially in meat products.

Acidic conditions are critical in the perception of umami flavor and taste. NH_3^+, COO, and pH substantially impact the flavor of umami amino acids. Between pH levels below 4.0, MSG has the mildest umami flavor, while between acidic to basic pH maximum up to 8.0, the umami flavor is often acknowledged as the post potent (Wu et al., 2014). MSG molecule was found to transform into disodium glutamate at pH eight or above, and the umami tastes all about to vanish. L-glutamic acid (L-Glu), L-aspartic acid (L-Asp), and their sodium salt are well-known Umami amino acids (Manninen et al., 2018). The global market substantially incorporates the salts of L-glutamate, 5’-inosinate, and 5’-guanylate, all referred to as umami compounds (Yamamoto & Inui-Yamamoto, 2023). The new categories of meat analogs or alternatives like cultured meat (Joo et al., 2022), hybrid cultured meat or restructured meat (Alam et al., 2024), and plant-based meat (Kumari et al., 2023) must be assessed for umami compounds and taste. These will aid in developing diverse product lines for consumers' growing demand for meat.

Umami attributes in different foods.

Umami, characterized by a savory or "meaty" taste, can intensify food flavor and reduce the appetite. Umami substances are inherently present in a variety of plant-based food items, including tomatoes, soybeans, mushrooms, dairy products like cheese (Kurihara & Kashiwayanagi, 2000), and meat and meat products (Chen et al., 2021). Different foods containing a strong umami taste with a global perspective are summarized in Table 2.

Glutamic acid, which is usually found in high-protein diets, is what gives food its flavor. As used scientifically, Umami describes the flavor of glutamate, inosinate, or guanylate. A typical amino acid in plant and animal proteins is glutamate, sometimes known as glutamic acid. While guanylate is more prevalent in plants, inosinate is primarily found in meats (Ghirri and Bignetti, 2012). Seaweeds are high in minerals and antioxidants but low in calories. Moreover, their high glutamate level makes them a fantastic source of umami flavor. These vegetables are fermented with Lactobacillus bacteria, which helps the bacteria produce digestive enzymes like proteases, lipases, and amylases that help break down the vegetables. Through proteolysis, proteases convert the protein molecules in kimchi into free amino acids. This increases the umami glutamic acid concentration in kimchi (Wang et al., 2017). Umami chemicals are prevalent in a variety of seafood. Inosinate, disodium inosinate, and glutamate can both be found in seafood in naturally occurring amounts (Fuke, 1994). Another cuisine category that often has a lot of umami flavor is meat, which naturally contains glutamate and inosinate, just like seafood. An analysis of the chemical composition of the meat has indicated that the presence of free amino acids contributes to the enhancement of the meat flavor over the preservation period (Rikimaru and Takahashi 2010). One of the best plant-based sources of umami flavor is tomatoes; their high glutamic acid level gives them a sweet-savory flavor (Jacobs et al., 2021). Additionally, when tomatoes ripen, their glutamic acid content keeps increasing. Mushrooms, particularly dried ones, are a tremendous plant-based supply of glutamic acid (Davila et al., 2022). Additionally, they are simple to incorporate into your diet, making them a simple approach to improving the overall umami flavor of your dishes.

Adding vegetable food items can improve the umami characteristics of meat products. Sabikun examined chicken nuggets' chemical components and umami properties by utilizing spent hen meat, milk fat, and potato mash. The use of milk fat and potato mash expressed a greater umami-taste than a whole meat nugget (Sabikun et al., 2021).

Adding umami flavor enhancers can be a compelling option to increase the taste of low-sodium products, as it can amplify the perceived salty (Mojet et al., 2004). Edible mushrooms contain an umami ingredient which serves as a flavor enhancer. This ingredient has potential benefits in regard to sustainability and healthiness. It can be seen as an intriguing natural flavor enhancer for low-salt beef burgers, according to França et al. (2022). Furthermore, different processing techniques can modulate the umami intensity in meat and meat products. Through proteolysis and osmotic pressure, salt-curing increases the amount of free amino acids, including glutamate, that in turn impact the umami intensity of meat (Lawrie et al.,2014). The mechanism behind this is an increase in extracellular osmotic pressure during the dry-curing stage that renders water inaccessible, increasing ADP, AMP, IMP, HX, and inosine, which are known umami compounds. Dry aging in beef causes water loss, proteolysis, lipolysis, and increased concentration of taste components containing exceptional flavor and palatability. Additionally, it acquires a flavor that is sweet, nutty, roasted nuts, buttery, brown-roasted, and meaty (Campbell et al., 2001; Warren et al., 1992). The high glutamate content in dry-aged beef and pig meat is responsible for umami flavor (Hwang et al., 2019; Kim et al., 2016). Fermented Meat acquires its distinct flavor through the enzymatic denature of nitrogen molecules found in its muscles by tiny peptides and amino acids such as alanine, leucine, valine, arginine, lysine, glutamic, and aspartic acids (Beriain et al., 2000).

Health benefits of umami compounds

Umami agents and umami enhancers are additives that augment the umami flavors in foods. The umami agents elicit the umami flavor through direct interaction with the umami receptors, while the umami booster amplifies the umami flavor by synergistically collaborating with the umami agents. L-glutamic acid and its sodium salt, sometimes known as MSG, provide the umami flavor by attaching to umami receptors. Researchers have so far discovered advantages and a few negative impacts on human health (Zhang et al., 2017). The beneficial impacts embrace improved food palatability and consumption, improved nutritional intake for elderly individuals and patients, protection against duodenal cancer, lower intake of salt, decreased fat consumption, and enhanced oral functions, among others. The negative effects encompass an increased risk of hepatotoxicity, obesity, asthma, migraine headaches, and various other additional medical conditions (Zhang et al., 2020). The population-level average of the 100% or universal incorporation of umami compounds into food items decreased the salt intake of Japanese adults by 12.8–22.3%, or 1.27–2.22 g of reduced salt, without sacrificing flavor. The daily mean salt consumption of the general population decreased from 9.95 g to 7.73 g as a result of the widespread use of umami compounds in food items: for men, this meant 10.83 g to 8.40 g and for women, it meant 9.21 g to 7.17 g. According to this study, only 7.6% of adult Japanese could fulfill the global recommendation of 5.0 g/day, although almost 60% could satisfy the national dietary goal of 8 g/day. (Tanaka et al., 2023).

Numerous aspects of umami require investigation to find out its effects on human health. It is essential to find out the interaction of umami with other ingredients to identify the specific causative agents. Various studies indicated that there are both sound and harmful effects of umami chemicals on human health. Umami compounds are known for considerable benefits upon ingestion. An illustration of the benefits is shown in Figure 3.

There are potential disadvantages of umami compounds, but they are mostly evaluated in laboratory animals only. The glutamate concentration in the facial muscle increased dramatically when an increased dose of MSG was administered, particularly in patients with myofascial temporomandibular disorders. Additionally, an increase in the intensity of spontaneous pain was noted. (Shimada et al., 2016).

Most of the observations came from trials in rats and mice. Impaired reproductive function and reduced weight at birth in the female rats (Mondal et al., 2018) were observed in the rats by Hermanussen et al. (2006). Another study in rat bit observed that umami compounds decreased skeletal muscle growth (Igwebuike et al., 2010). Umami compounds were found to be responsible for high blood sugar and memory malfunction in rats (Saikrishna et al.,2018). Other studies in rats and mice found umami compounds responsible for hepatotoxicity (Quines et al., 2017) and asthma (Yoneda et al., 2011), etc. presently, there are observations of hepatotoxicity, asthma, nervous system damage, and other illnesses associated with monosodium glutamate (Kazmi et al., 2017). The usefulness of considering "Umami" ingredients as potential salt substitutes should be reexamined by researchers and policymakers with an interest in global health, as they represent a workable solution that originated in Japan and maintain the availability, affordability, accessibility, and desirability of nutrient-dense food. Cutting back on salt will help combat the widespread COVID-19 pandemic as well as the high rates of diabetes, heart disease, hypertension, and other NCDs. By addressing these issues, nations will become more resilient to pandemic threats in the future (Nomura et al.,2021).

Evaluation of the umami flavor intensity

The intensity of umami enhances the mixing of flavors in food and influences culinary preferences, although a standardized method for quantifying this effect is currently unavailable. Discrepancies between the acknowledgment and understanding of umami persist today (Zhu et al., 2020). The existing research provides minimal data regarding the perception of umami intensity of foods (Wang et al., 2020). Furthermore, variations in methodology have resulted in inadequate comparison of data, particularly with regard to the intensity of umami.

Various methods, such as sensory panel evaluation, umami component test, and electronic tongues, have been created to assess the intensity of umami (Zhu et al., 2022). Using two-alternative forced choice during sensory evaluation is an effective method for assessing umami and other flavor intensity of foods (Bloom et al., 2019). Electronic tongues are highly regarded for their ability to evaluate the flavor of food quickly. They circumvent the extended duration needed for panelist training and the variability between subjects. They can produce signals by identifying soluble components in liquid samples using chemical sensors that exhibit cross-selectivity (Ross, 2021). An artificial neural network (ANN) has been utilized to construct quantitative prediction models to establish non-linear correlations between input and output variables of E-tongue data and sensory attributes (Khamparia et al., 2020). Nowadays use of near-infrared spectroscopy coupled with multivariate analysis has been found to be useful in measuring the qualitative traits of meat (Hashem et al., 2022), which can be helpful to in umami taste characteristics determination in meat and meat products as well. Different taste attributes of sourness, saltiness, umami, and umami enhancement of chicken oligopeptide powder and soybean oligopeptide powder were assessed using electronic tongue testing and sensory testing. Furthermore, it was established that the aforementioned taste characteristics have a positive correlation with the levels of malic, lactic, and succinic acids (Yang et al., 2024). A very recent study assessment of the intensity of umami taste and umami taste components present in chicken breast and chicken-spices blends were achieved via sensory and instrumental analysis techniques (Andaleeb et al., 2023). The elucidation of umami-taste features was more effectively achieved through the use of partial least squares regression (PLS-R) compared to other taste variables evaluated using an electronic tongue (Sabikun et al., 2021). In another study, electronic nose and sensory evaluation were successfully used to assess flavor profiles and umami taste in cooked meat (Qi et al., 2021). A study was conducted to assess and evaluate the ability of the electronic tongue system on the umami taste of sous-vide beef semitendinosus. The identification relied on the synergistic effect of umami chemicals, specifically 5'-nucleotides (IMP, GMP, AMP, inosine, and hypoxanthine) and free amino acids (glutamic and aspartic acid). This was accomplished by estimating the equivalent umami concentration and utilizing an electronic tongue system (Hwang et al., 2020). The gustatory nucleotides exhibited a strong and positive correlation with salty, umami, and umami enhancing qualities while having minimal impact on sour, sweet, and bitter tastes.

Several catalysts enhance the umami taste in a variety of animal-based and non-animal-based foods. Additionally, scientists are working nonstop to improve the umami taste of food. Wet and dry aging processes for cattle typically provide more soft meat and taste development (Campbell et al., 2001). Results of electronic tongue analysis showed that the umami and saltiness tastes of muscles were enhanced by the dry-aging process (Kim et al., 2001)

While numerous umami compounds in food have been extracted and recognized, their concentrations need to be revised to satisfy the growing demands of the food business, specifically for the sauce and ketchup industry. To readily obtain or create these umami chemicals, various processing techniques such as fermentation, enzymatic or acid hydrolysis, microwave heat treatment, ultrasonic aided water extraction, maillard reaction, and commercial chemical synthesis have been deployed (Manninen et al., 2018).

In addition, several scientists have found that combining enzymatic and Maillard processes can significantly enhance the taste and flavor of the products (Qi et al., 2018). The Maillard reaction is a process of non-enzymatic browning that occurs when food is heated, resulting in the formation of many complex compounds, intermediate products, and browning products. These substances are responsible for enhancing the aroma and flavor of the food (Zhang et al., 2019). Cysteine is acknowledged as a substance that enhances the meaty taste when Maillard reaction products are formed. The addition of cysteine during the Maillard process has been observed to greatly contribute to the suppression of color formation and the improvement of mouthfeel and continuity (Huijuan et al., 2018).

Enzymatic hydrolysis is distinguished by moderate processing conditions, high selectivity, fewer adverse reactions, and preservation of the resultant amino acids (Zhao et al., 2019). Several items have been discovered as sources of umami compounds through fermentation. According to Moritsen et al. (2017), they include fermented meat, milk, fish, beans, vegetables, tea, and cereals. Food fermentation is very dependent on the surrounding environment. The two most crucial factors preventing the growth of undesirable microbes and paving the path for the breakdown of proteins, carbohydrates, and nucleic acids are a high salt content and a low pH (Istiqamah et al., 2018).

Selecting the proper enzymes is essential for creating umami compounds. Currently, plant proteases, neutral proteases, alkaline proteases, acid proteases, and taste proteases are employed for this activity (Ermis, 2017; Li & Lu, 2008). Multiple enzymes can be coupled to create a sophisticated enzyme system when achieving the intended result with a single enzyme is challenging (Ermis, 2017; Song et al., 2016).

Acid hydrolysis is a straightforward, cost-effective procedure requiring minimal financial resources. Protein hydrolysis is a commonly employed technique (Zhao et al., 2019). During the process of breaking down vegetable proteins using acid hydrolysis, the production of chloropropanol occurs. It is worth noting that chloropropanol is known to possess toxicity and carcinogenic properties. Additionally, this process also yields umami compounds. A variety of techniques have been suggested for eliminating chloropropanol from acid-hydrolyzed protein solutions (Li et al., 2014).

The utilization of heat-pressure extraction shows promise in obtaining tiny peptides that possess significant nutritional and taste characteristics (Dong et al., 2014). According to Zhang et al. (2018), certain researchers have found that using ultrahigh-pressure processing alone can alter the levels of 5′-IMP in beef. One of the oldest extraction techniques is water extraction, which can be used to remove various materials. Given that umami compounds, like as certain amino acids and peptides, are typically can be solubilize in aqueous medium and water can easily be employed as an effective solvent to extract umami components from food materials containing umami. Prior research has documented extracting and measuring umami amino acids and nucleotides from specialty hams like Jinhua and Parma, fermented product doenjang and mushrooms (Poojary et al., 2017).

The synergistic mechanism behind the perception of umami taste

Umami characteristics in food substances can be enhanced or improved by using synergistic blends of different items and processing techniques. An effort successfully improved the taste characteristics of stewed meat by increasing the storage time. In this study the rich, savory, and salty characteristics achieved their highest levels when chicken meat was held for 6 weeks in freezing condition (Qi et al., 2021). L-glutamic acid and 50 nucleotides have a strong synergistic relationship; the ligand-binding model incorporating the Venus flytrap domain of T1R1 also reported on this synergistic mechanism (Zhang et al., 2008). Umami stimulating peptides have also synergized with MSG (Dang et al., 2019a; Dang et al., 2019b). Recently, Dang et al. used molecular docking and simulation techniques to illustrate the paradoxical effect of umami peptides and MSG based on taste receptor T1R1/ T1R3 (Dang et al., 2019a), and electronic tongue was employed to assess the synergistic effect of peptide and MSG (Dang et al., 2019b). When examined by expert sensory panel assessment and gustatory nerve recording (Narukawa et al., 2008), L-theanine from green tea not only produces umami taste by activating T1R1/T1R3-expressing cells, but it also exhibits a multiplicative reaction with inosine 50-monophosphate (Narukawa et al., 2014). Through magnetic resonance imaging and sensory assessment, glutathione has been shown to enhance the umami and salty tastes (Goto et al., 2016). L-Arginine is a strategic armament that can be utilized to change how tasters perceive sucrose, improve umami flavor, increase saltiness and bitterness from NaCl, and lessen sour taste from citric acid (Melis and Barbarossa 2017). When beta-cyclodextrin was used in the enzyme reaction, protein hydrolysate from wheat gluten exhibited a more umami taste, with the degree of hydrolysis and all free amino acid quantity, in particular Glu and Asp (Wang et al., 2016). Two other promising methods for enhancing umami taste are acid treatments and the deamidation caused by certain enzymes. For example, after three hours of glutaminase treatment on wheat gluten hydrolysates, the umami taste score rose almost 250 percent (1.62 to 4.27) (Liu et al., 2017). Umami compounds are known to interact with other taste and flavor substances as well. It known fact that umami compounds can improve salty taste in solution, employing the glutamate MAG and the nucleotides IMP and GMP (Rocha et al., 2020).Researchers in different studies identified positive and negative effects of umami substances on other four taste characteristics of food, which is illustrated in figure 4.

Conclusion

Comprehending taste is crucial for enhancing the flavor meat and other plant-based foods that are high in protein and fat. The presence of glutamate, aspartate, arginate, and other chemicals in food products can intensify the perception of salty and enhance the overall flavor. Umami compounds have the potential to decrease the intake of salts and fats among consumers. It can enhance food consumption as well. Discerning flavors is crucial in convincing consumers to embrace innovative food products and include them in their diets. Gaining insight into the mechanisms behind the umami taste can enhance the overall appeal and enjoyment of meat and meat products. Enhancing our comprehension of the interaction of umami compounds and the role of other compounds that bring synergy to enhance its effect on meat taste, consumption, and safety needs more exploration. Further study is required to identify functional umami compounds in meat and meat products to understand the health potential. Nevertheless, as recent developments in the meat industry in cultured meat, hybrid meat, restructured and plant-based meat, we suggest analyzing the umami potential of these products alone and in combination with potential materials and cutting-edge techniques to develop diversified food to attract meat consumers. The present techniques like curing, fermentation, and adding spices in conventional products may be adopted to enhance the umami attributes in meat products in the future.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

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18th Century

Seven primary tastes were outlined by Aristotle: sweet, sour, bitter, salty, hot (spicy), astringency, and sandy (Bartoshuk 2012)

Until the 19th century

The four basic tastes—sweet, sour, salty, and bitter—were not universally recognized

1909

Umami Terminology introduced by Ikeada

The contemporary scientific study of taste did not start until the 1920s

1913

Kodama examined the constituents of katsuobushi and reported that inosinate also had umami taste characteristics (Kodama 1913).

Further investigation of dried konbu by Kodama discovered the taste to be contributed by glutamate.

1960

Kuninaka identified guanylate as another important umami substance (Kuninaka 1960)

1961

Guanylate was found to occur naturally in dried shiitake mushrooms (Nakajima 1961)

1964

Kuninaka described the taste synergism between glutamate and nucleotides where together enhanced umami taste (Kuninaka 1960)

1985

The first symposium was held in Hawaii in

1998

Monosodium glutamate (MSG) and disodium 5'-inosinate (IMP) was discovered as umami (Yamaguchi & Ninomiya, 1998)

Figure 1. Evolution of Umami taste

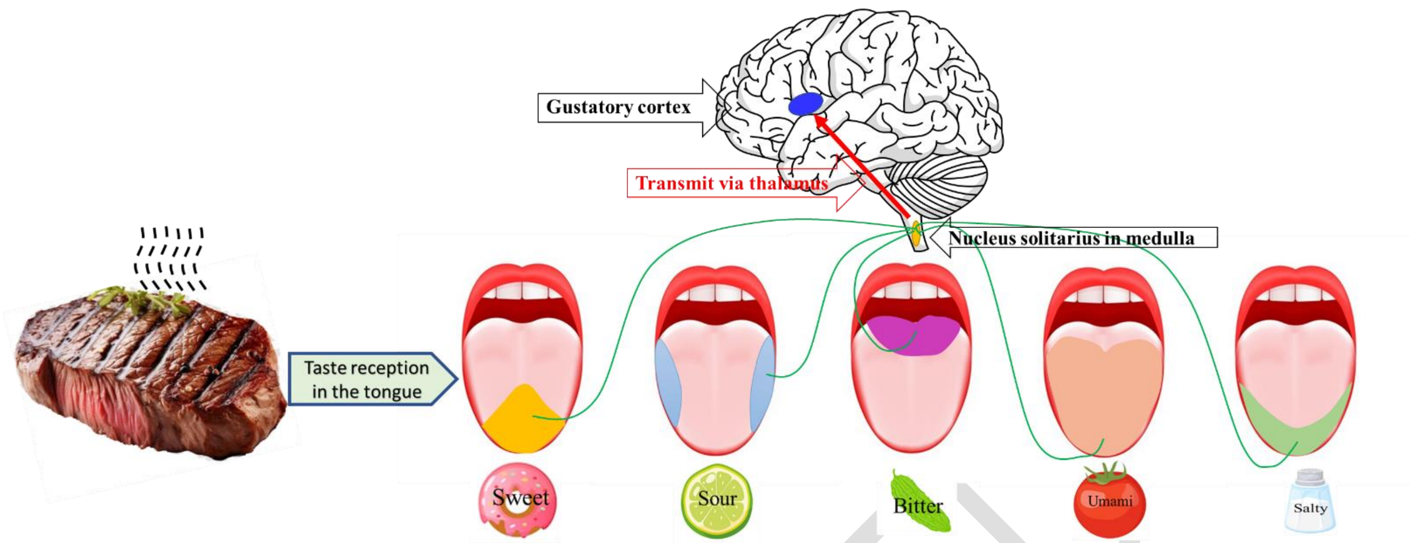

Figure 2. Umami reception site in tongue

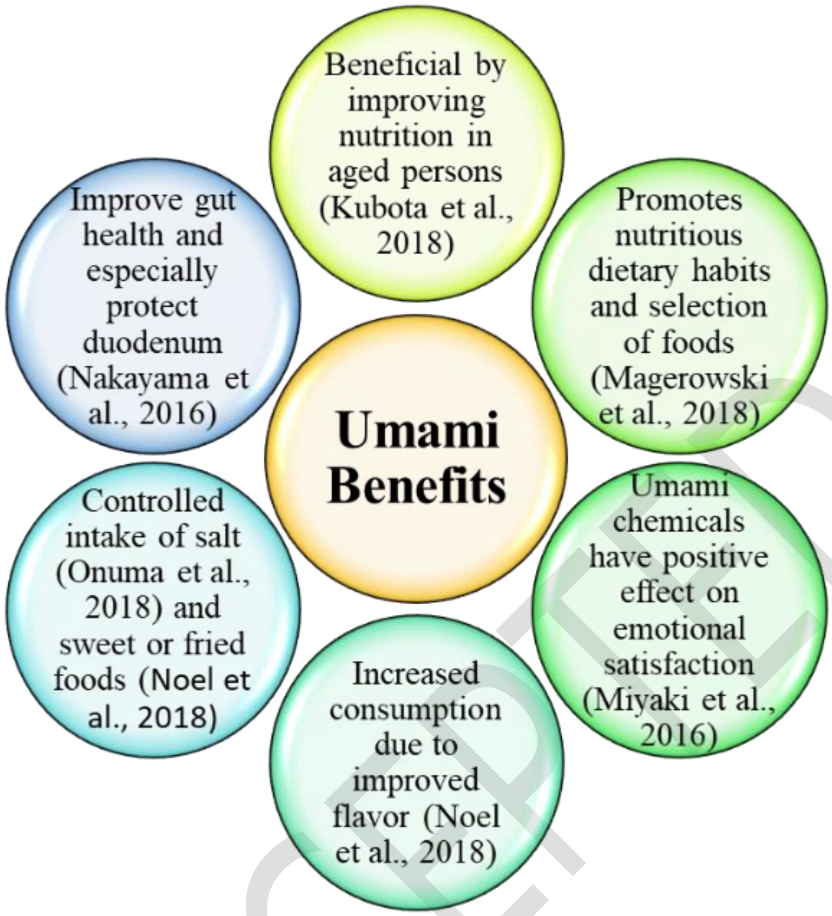

Figure 3. potential benefits of umami compounds

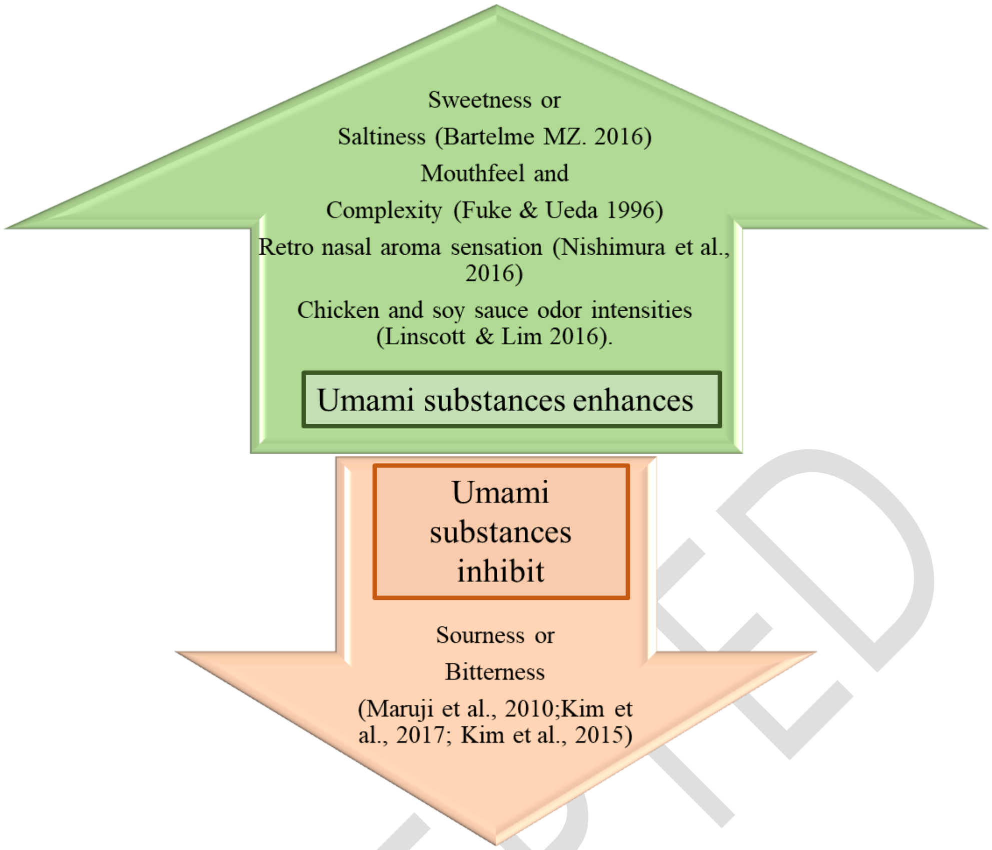

Figure 4 effect of umami compounds on other tastes

Table 1. Umami compounds in meat and plant foods

Species	Sample type	Analytical tools	Identified chemical	Reference
Cattle	stir-fried beef	Ultrafiltration, High Performance Liquid Chromatography (HPLC), and LC-Q-TOF-MS	Peptides	Huang et al., 2019
	Minced beef hydrolysate	Size exclusion chromatography, Ultra HPLC	Unrecognizable	Fu et al., 2018
	Sausage	HPLC	Unrecognizable	Kessler et al., 2019
Pig	Pork muscle extract	Principal component analysis,		Sasaki et al., 2005
	Dry cured ham	RP-HPLC and MALDI-TOF/TOF MS/MS	Modified amino acids having umami taste 1. G-25-J3-r1 (Cys-Cys-Asn-Lys-Ser-Val) 2. G-25-P4-r1 (Ala-His-Ser-Val-Arg-Phe-Tyr)	Dang et al., 2015
	pork *longissimus* and *biceps femoris* muscles	Amino Acid Auto Analyzer, HPLC, Spectrophotometric assay	During the cooking process, the muscle released glutamate, total free amino acids and IMP.	Sasaki et al., 2007
Chicken	chicken enzymatic hydrolysate	LC-Q-TOF-MS	A total of eight flavor peptides were identified, including four specific peptides.	Kong et al., 2017
Fish	Sturgeon fish meat	Ultrafiltration, Gel filtration chromatography, UPLC-QTOF-MS/MS	Peptides	Wang et al., 2023
Vegetables	Tomato	Capillary electrophoresis, GC−MS	L-Glutamic acid, Ribonucleotide	Oruna-Concha et al., 2007
	Potato	high-performance anion-exchange chromatography (HPAEC), HPLC	MSG, aspartate, Nucleotides	Morris et al., 2007
	Peanut	Gel filtration chromatography (GFC), UPLC−MS/MS	Peptides	Zhang et al., 2019

Table 2. Foods with umami taste globally (Modified from Strange Maps, 2023)

Meat and animal-based foods	Continent	Food with umami taste	Local name	Country
	North and South America	Bacon		USA
		Dried alpaca meat	Charqui	Peru
		Dried cod	Bracalhau	Brazil
	Asia	Soy paste, soy sauce, fish/shrimp	Doenjiang, Gangjiang, Jeotgal	Korea
		Dried fish	Shutki	Bangladesh
		Fish sauce	Nuoc mam	Vietnam
		Shrimp paste	Belacan	Malaysia
		Fish/shrimp paste	Bagoong	Phillipines
		Fish paste	Prahok, Tuk Trey	Combodia
		Fish sauce	Nampla	Thailand
		Shrimp paste	Tempe, Terasi	Indonesia
	Europe	Beef extract		UK
		Cured ham		Throughout Europe
		Long aged cheese		Throughout Europe
		Dried alpaca meat		Peru
		Smoked mackerel	Makrela wedzona	Poland
		Sausage	Kielbasa	Poland
		Fish sauce	Garum	Italy
	Africa	Shrimp paste	Shito	Ghana
		Ground cray fish		Nigeria
Plant based foods	**Continent**	**Food with umami taste**	**Local name**	**Country**
	North and South America	Tomato ketchup		USA
	Europe	Tomato paste	Salsa	Turkey
		Barbecue sauce		USA
		Gravy		USA
		Sauce from cooked tomatoes and spices	Mole	Mexico
	Asia			
		Fermented beans, soy sauce, soy curd	Douche/Jiang you, Furu	China
	Africa	Locust bean product	Soumbala	West Africa

	Australia	Yeast extract