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Harnessing in Gastronomy of Mountain Products by Fruiting the Umami Taste

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ABSTRACT

Taste is one of the five main senses and is connected to the sensations that result from the food and drink we eat. Known as the fifth taste, umami is one of the most present in the dishes we are eating daily. According to officials at the Umami Information Center (UIC), umami refers to the taste of glutamate, inosinate or guanilate. But beware: when it comes to umami and the "delicious" taste of glutamate, it's about that glutamate that we found naturally in foods such as seaweed, soy, ripened cheese, green tea, seafood, tomatoes, mushrooms, potatoes, etc. Umami taste is a sensory biomarker of food proteins. The degree of multiplication of the umami taste can increase up to eight times for the total taste of the ingredients taken separately. The harmonious combination of different foods containing umami allows the creation of a high level gastronomic experience, without the support of very sophisticated recipes. Owners of food establishments that use raw materials from the mountain area can successfully use this information to combine foods, so that they become even tastier and more attractive to consumers (use of grated emmentaler for gratin dishes, dried tomatoes in various sauces, berries in various desserts, etc.).

1. Introduction

Gastronomy, this path of knowing the specificity of a nation, was conditioned at the beginning by the local material resources, to then be able, due to the development of trade and infrastructure, to have the opportunity to talk about a migration of flavors, but also of the characteristic preparation techniques for each country's cuisine.

Taste, because it can not be received from a distance, it is considered the most intimate of the senses. Moreover, it is extremely personal, being influenced by a complex of biological, social, psychological, but also cultural factors (Prescott, 2012; Shepherd, 2011; Mouritsen et al., 2017). One of the characteristics of food, with a major impact on consumer preferences is the flavor, determined by the combination of volatile and non-volatile components (Maga, 1981; Song & Liu, 2018). For humans, taste is a vital sensation, as it can detect important nutrients or substances that are potentially toxic to the body (Sun et al., 2020).

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The primary organs used to perceive the aroma of food are the tongue and the nose. They respond to various substances in food with the help of receptors and generate signal patterns that are sent directly to the brain. Based on experience, but also on the identification of neural network models, the human brain makes judgments and in the same time classifies a given sensation (Ha et al., 2015). In 1987, Kurihara described the fundamental mechanism by which all taste stimuli are perceived. A chemical stimulus, such as a sweet, salty, sour, or bitter substance, is first absorbed by the receptor membranes of the taste buds. In the receptor cells, a chemical transmitter is released, which in turn, triggers an impulse in one of the nerves responsible for taste sensitivity (tympanic cord and / or glossopharyngeal nerve). Successive brain relays pass the message on to the primary and secondary cortex where is processed and recognized (Kurihara, 1987).

Sweet, salty, bitter and sour are the four fundamental tastes perceived by the taste buds. The fifth taste, umami, was discovered a century ago by a chemist of Japanese origin, Kikunae Ikeda (Lindemann et al., 2002) and can be translated as "pleasant, tasty taste" from the words *umai*, "delicious" and *mi*, "taste"; the name was given after its scientific identification in 1908 (Ikeda, 2002). The sensory message associated with umami taste has been studied and described from the receptors to the cerebral cortex. Receptor cells are innervated by related fibers that transmit information to the gustatory centers of the cortex through synapses in the brainstem and thalamus (Zhao et al., 2003).

In the study of umami, a very important role was played by the discovery of umami taste receptors: T1R1 / T1R3, mGluR1, mGluR4, taste-mGluR1 and taste-mGluR4 (Zhang et al., 2019).

There are three substances in nature: monosodium glutamate (MSG), a sodium salt of glutamic acid, a non-essential amino acid, naturally occurring, found in plant and animal proteins; disodium guanylate (GMP), is the sodium salt of guanilic acid, a natural acid used as a food additive with the role of flavor enhancer that is found especially in plants; disodium inosine (IMP), is the sodium salt of inosinic acid and is found mainly in meat (Kurihara & Kashiwayanagi, 1998).

Recently, due to the nutritional properties of umami-flavored ingredients, it has been studied for a long time (Beauchamp & Pearson, 1991; Fuke & Ueda, 1996; Yamaguchi & Ninomiya, 2000; Baryłko-Pikielna & Kostyra, 2007; & Yeomans, 2014; Wang et al., 2020). This is also the reason why the Umami Information Center (UIC) was established in 1982. The purpose of the Umami Information Center is to transmit in Japan, but also in other countries of the world, information obtained correctly, based on scientific research about umami[2].

Throughout the scientific approach when we talk about umami and the "delicious" taste given by glutamate, it is about glutamate that is found naturally in foods such as: ripened cheese, tomatoes, seaweed, soy, green tea, seafood, berries, mushrooms, potatoes, etc. Certain processes of preparation, drying or preservation

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[2] https://www.umamiinfo.com

lead to the breaking of protein bonds, the release of amino acids and the formation of salts, as is the case of glutamate. It should be noted not to be confused with synthetic sodium monoglutamate, an additive that is added in large quantities in fast food and vegeta spices. It is labeled as E621 and belongs to the category of food additives, but submissive to quantitative limits.

The acquisition of this information has applicability in gastronomy. The harmonious combination of different foods containing umami allows the creation of an unforgettable gastronomic experience, without having the support of very sophisticated recipes. In the mountain area there is a *real organic agriculture, and the food products obtained have a very good quality* (Rey, 2018: 200). The question we are asking ourselves is whether this information can be used successfully by owners of food units that use raw materials from the mountains, in order to combine the food so that it becomes even tastier and more attractive to consumers.

2. Literature Review

Although more than a century has passed since the discovery of umami (1908) by chemist Kikunae Ikeda of the University of Tokyo, Japan (Lindemann et al., 2002), only in the last decade umami has attracted worldwide attention. especially from researchers, chefs, but also from other people who show a strong interest in gastronomy (Miranda et al., 2021). The chemist Kikunae Ikeda detected this delicious taste in a traditional dish called *dashi* based on seaweed *Laminaria Japonica*, a raw material used since ancient times in Japanese cuisine (Behrens et al., 2011) in which he identified glutamic acid as a key component. Ikeda called this taste "umami" after the Japanese word *umai* (delicious) and claimed it as the fifth basic taste sensation (Ikeda, 2002). Using various chemical processes, Ikeda was able to isolate chemicals from algae and fungi and established that this new taste is perceived when our taste receptor cells interact with glutamic acid (Bellisle, 1999; Tomchik et al., 2007; Phat et al., 2016).

Ikeda's description of umami taste remained underappreciated by the Western scientific community (Behrens et al., 2011) until 1982, when researchers in fields such as: oral physiology, nutrition, taste physiology and food chemistry founded the Umami Research Association which aimed to promote research into this new taste (Kurihara, 2009). For more than 25 years, the Umami Research Association has organized a series of international symposia on umami, attended by scientists from Europe and the United States, facilitating the transfer of scientific information about umami both within and outside Asia (Fernstrom, 2009; Kurihara, 2009). In 1985, the First International Symposium Umami (Hawaii) was held and umami was recognized as a scientific term designating the taste of natural glutamates and nucleotides (Kurihara, 2009). In 2002, when receptors for umami taste were discovered (Lindemann, 2000; Nelson et al., 2002; Li et al., 2002), umami was internationally recognized as the fifth taste, joining the four already existing tastes (sweet, sour, bitter, salty).

Taste is detected by the papillas taste that contain the taste buds, where the taste sensory cells (CRTs) or taste receptors are located (Mouritsen & Styrbæk, 2014). Taste buds are small sensory organs composed of several taste cells (Kringelbach, 2015) that react to taste stimuli. Most taste sensory cells are located in the lingual papillas taste, but there are also taste buds located in the soft palate, pharynx, epiglottis (ZhuGe et al., 2020; Wu et al., 2022) and gastrointestinal tract (Crowe et al., 2019; Nunez-Salces et al., 2020). Chemicals from food and beverages are dissolved in saliva and make contact with the microvilli (ciliated extensions) of taste cells (Roper & Chaudhari, 2017) that are on the rough side of the tongue. When a stimulus reaches the microvilli of the taste cells that are in the papillas taste, these taste cells are immediately activated and a message is transmitted to the brain through the nerves responsible for taste sensitivity (Jyotaki et al., 2009; Nakamura et al., 2011; Roper et al., 2017).

There are several responsible receptors for the recognition of umami substances, and each of these receptors can be activated by different mechanisms (Zhang et al., 2019). A number of studies have focused on the identification and analysis of umami receptors (Zhao et al., 2003; Chaudhari et al., 2009; Behrens et al., 2018; Zhang et al., 2019; Servant & Frerot, 2021). The first umami receptor, called the 4 mGluR4 metabotropic glutamate receptor, was discovered in 2000 (Chaudhari et al., 2000). A metabotropic receptor is a cell membrane-receptor and its characteristic is that they are slow receptors (Conn et al., 1997). The second umami receptor T1R1 + T1R3 was discovered in 2002 (Li et al., 2002; Nelson et al., 2002; Liu et al., 2019; Wang et al., 2020) and the third mGluR1 was discovered in 2005 (San Gabriel et al., 2005). Of these receptors, T1R1 + T1R3 is broadly considered a major receptor for umami stimuli (Zhang et al., 2017).

A peculiarity of monosodium glutamate is that it does not have a pleasant taste on its own (Beauchamp, 2009). That sublime taste sensation is obtained only when monosodium glutamate (MSG) is combined with other substances that have a noticeable multiplier effect on the action of MSG and therefore monosodium glutamate is often characterized as a taste enhancer (Mouritsen & Styrbæk, 2014). Therefore, the taste of umami is extremely tender for those who work in the gastronomic field because by intelligently combining the raw materials, tasty dishes can be obtained.

The two important characteristics of umami taste are: synergism (the action intensification of two substances by their association) and interaction with other tastes (Kim et al., 2015; Zhang et al., 2019). Of the receptors identified, only T1R1 + T1R3 receptor shows synergism (Kurihara, 2015). Kuninaka (1964) was the first who explain how the combination of glutamate with 5′-nucleotides, such as inosinate or guanilate, greatly enhances the effect of glutamate and thus the intensity of umami taste (Ninomiya, 2015). Umami synergy characterizes the interaction between MSG (monosodium glutamate), IMP (disodium inosinate) and GMP (disodium guanylate) (Hajeb & Jinap, 2014).

To humans, the response to a mixture of umami-inducing substances is eight times faster than if monosodium glutamate existed alone (Marcus, 2005; Kurihara, 2015). Thus, umami taste may be enhanced when monosodium glutamate is combined with 5-nucleotides respectively 5-disodium-inosinate-IMP and 5′-guanylate-disodium-GMP (Li, 2009; Zhang et al., 2008).

In addition to monosodium glutamate (MSG), other substances that induce umami taste have been found: certain free amino acids, bifunctional acids, peptides (chains of amino acids that form certain proteins) and their derivatives or reaction products (Winkel et al., 2008; Zhao et al., 2016). All these are essential components of spices that play an important role in the preparation of delicious and healthy food. Moreover, certain peptides are indispensable elements for the realization of superior products, and for this reason the knowledge of the structure as well as the physico-chemical properties of these taste substances are important both in science and in the food industry (Zhang et al., 2019). Today, the phenomenon of synergism is recognized worldwide and practiced in gastronomy on a large scale, such as the combination of vegetables and meat or fish in various bases for soups and broths (Ninomiya, 2015).

We all have a preference for the umami taste since we were born. Both in amniotic fluid and in breast milk (Mastorakou et al., 2019; Wu et al., 2019) are abundant in amino acids that transmit the umami taste thus causing us to look for its aroma throughout life. Thus the attraction for umami taste is innate (Behrens et al., 2011; Mouritsen & Styrbæk, 2014).

3. Methodology

From the methodological point of view, the scientific approach is highlighted by an interdisciplinary analysis. Recognized as the fifth taste, starting from the Asian continent (discovered by the Japanese chemist Kikunae Ikeda), umami is one of the tastes that consumers are enjoying every day. It should be noted that when we talked about umami and the "delicious" taste of glutamate, we were referring to glutamate, which is found naturally in foods such as meat, ripened cheese, milk, fish, tomatoes, seaweed, soy, green tea, seafood, berries, mushrooms, potatoes, etc. Based on this information, we wanted to argue that the acquisition of this knowledge is extremely beneficial for the owners of food units who use raw materials from the mountains, because they can intelligently combine the ingredients, thus managing to provide a special culinary experience to consumers.

In order to achieve the objectives, we used the following as bibliographic and information sources:

- scientific articles published in national and international databases;
- specialized books published abroad by internationally recognized authors.

As research methods that I have used in the scientific approach I enumerate: documentation, through the analysis of the literature (especially theoretical documentation); statistical methods such as classification and synthesis and the method of interdisciplinary research that is based on knowledge from other fields, such as medicine, chemistry, biology, economics (tourism) and gastronomy.

4. Results and Discussion

The fifth basic taste, umami, is seen as a potential indicator of protein content in food (Luscombe-Marsh et al., 2008; Ghirri & Bignetti, 2012; Zhu et al., 2022) contributing to choose tasty foods, being also called the taste of proteins. Various constituents, including amino acids, purine nucleotides, organic acids, some peptides, etc., have a strong umami taste (Wang et al., 2020).

Glutamate is a permanent constituent of foods such as meat, milk, eggs, cheese, fish, mushrooms, peas, corn, spinach, grapes, tomatoes, etc. Glutamate can also be called a natural flavor enhancer because it transmits the umami taste in food.

Precious information for the food industry is that the amount of glutamate contained in certain foods and also, the flavor, increase as they undergo fermentation, maturation or drying (Barretto et al., 2018) compared to the amount of glutamate that is finds in the fresher equivalents. This explains why during the maturation of meat, some proteins undergo fermentation, which leads to an increase in content of free glutamic acid. During these processes (fermentation, maturation or drying) the proteins are completely broken down into several units, of which a molecule called L-glutamate is the single molecule responsible for the taste of umami.

Table 1. Evolution of free glutamate in a tomato in the process of ripening (mg / 100 g)

Green	Baked green (mind)	Partly red	Pale red	Red	Fully baked	Overbaked
20	21	30	74	143	175	263

Source: Mouritsen and Styrbæk (2014)

Table 2. Evolution of free glutamate in matured cheddar cheese (mg/100 g)

Maturation time (months)	0	1	2	3	4	5	6	7	8
Free glutamate (mg/100 g)	11	22	36	54	78	112	121	160	182

Source: Mouritsen and Styrbæk (2014)

As with other flavors, umami is felt when L-glutamate binds to characteristic receptors on the tongue, leading to a chain reaction of chemical processes that lead to umami taste. When glutamate is bound to sodium, it is called monosodium glutamate (MSG). MSG is the synthetic form of glutamate produced outside the body.

Although umami has been relatively recently discovered, it has become extremely attractive to the food industry, and those working in the field of gastronomy have cultivated their ability to improve flavor and now are experiencing its versatility (Gugino, 2003).

There are considerable differences between the ingredients responsible for umami taste used in the West and those used in the East. If the umami taste is difficult to recognize, it is very easy to enjoy (Marcus, 2007). If in Asia we are dealing with dishes that use raw materials such as seaweed, mushrooms, tomatoes, soy, anchovies, smoked fish responsible for umami taste, in America umami is the reason why Americans love pizza, pasta with Parmesan cheese, fried potatoes and ketchup burgers, raw salads that almost all contain tomatoes.

4.1. Culinary applications of umami with mountain products

By practicing the principle of umami taste (individual ingredients are not as tasty as their sum) and cleverly combining ingredients of mountain origin, tasty dishes can be obtained without too much effort.

Table 3. Umami substance content in various mountain products (mg / 100 g)

Vegetables products	mg/100 g	Animal products	mg/100 g	Traditional dishes	mg/100 g
Dried tomatoes	650-1140	Pork ham	340	Parmesan	1200-1680
Potatoes	30-100	Pork	230	Blue mold cheese (Roquefort)	450
Green peas	110	Chicken meat	230	Camembert (Năsal cheese	390
Garlic	110	Beef	80	Emmentaler	310
Corn	70-110	Egg yolk	50		
Beans	60-80	Eggs	20		
Cabbage	40-90	Goat milk	4		
Spinach	50-70	Cow milk	1		
Broccoli	30-60	Breast milk	19		
Strawberries	45				
Raspberry	44				
Onion	20-50				
Celery	20-30				
Apples	4				

Source: Authors' elaboration

Primary data: Kurihara (2015); https://www.umamiinfo.com/richfood/

Science has now demonstrated what great chefs around the world have instinctively known: foods that contain responsible substances for the umami taste can be cleverly combined to contribute to a delicious taste and to complete and enhance the flavor of food.

Umami is a combination of flavors that confer many unique properties:

▪ intensity and long persistence in the oral cavity (Marcus, 2005);

▪ increased saliva secretion (Uneyama et al., 2009);

▪ reduction of the amount of salt used in food preparation by up to 20% (Simões do Couto Rosa et al., 2018);

▪ intensifying the taste of other food preparations (Ninomiya, 2015).

Foods that have a particularly intense umami taste are often not consumed individually, but they are the golden ingredient in many recipes, enhancing and amplifying the taste of the final dishes. By doing an exercise of imagination, we immediately answer how delicious is feta cheese when it is served with fresh tomatoes, what flavor it brings to the au gratin preparations a little grated Parmesan cheese or how tempting is a cheesecake with fresh raspberries. The clever combination of ingredients of mountain origin can transform a simple meal in a real celebration of taste. Cow's, sheep's and goat's milk are a rich source of glutamic acid. Glutamic acid is released when milk is grown with enzymes, bacteria or culture mold. The stronger and older the cheese is, such as Parmesan or Swiss cheese, the higher the glutamate content is and the more effective for flavoring is the product.

Delicious and highly flavorful dishes that contain umami-flavored mountain ingredients can be important tools in meeting food and nutrition needs as well as creating memorable dining experiences. It is very important to remember that the ingredients enhance each other's taste, and the result will be an irresistible preparation. The long and slow stew of bones, meat and vegetables remains the star of the umami taste for mountain products, being extremely rich in natural glutamate and can be used in many dishes: soups / soups, sauces. A classic tomato sauce is an easy way to add an umami element to many dishes. If a tasteless alcohol, such as vodka, is added to the tomato sauce, the flavor increases even more. Vodka acts as a solvent and releases umami from tomatoes. From the moment when umami was defined as the fifth taste, the combinations of mountain raw materials can be created so as to obtain the maximum flavor in the final preparation:

▪ lamb / pork steak with mushroom sauce and cream;

▪ grilled lamb / pork / beef with sweet and sour berry sauce and potatoes au gratin with Parmesan cheese;

▪ beef with butter and thyme;

▪ mushrooms au gratin with bellows cheese and Parmesan cheese;

▪ chicken escalope with ripe tomato sauce and polenta;

▪ potatoes au gratin with blue cheeses;

▪ lamb ribs with sweet sour cream sauce, horseradish and garlic;

▪ smoky soup;

▪ trout in sour cream sauce with fine cheeses;

▪ potato salad with mayonnaise and smoked trout;

▪ lamb / pork chop with pea puree garnish with poached egg;

▪ Parmesan omelette and spinach salad;

▪ berry ice cream seasoned with fresh fruit;

▪ cheesecake with berries and fresh raspberries.

More than the pleasure of taste, umami also activates the memory of taste. Thus, through food, our memories or moments that connect us to our past, to our roots. can be reactivated, This is how mountain products can become a vector of nostalgia for people and places in our lives because unconsciously when you choose to eat something (especially when you are relaxed, for example staying at a agrotourism pension) you make associations with memories, places and people.

Table 4. The different expressions of umami taste by culinary experts

Tasty
Delicate and subtle
Soft feeling
Raw, moldy, like mushroom taste
It makes your mouth water
The feeling of satisfaction after a pleasant taste
Persistent sensation
Subtle and ambiguous
Full of taste
Deep aroma and a harmonious balance

Source: Ninomiya (2015)

5. Conclusion

There are many mountain products that naturally contain components that produce umami taste and for this reason it has become very important to understand how flavors match in the final preparation with the recommended use of ingredients that have the ability to further improve umami taste such as free glutamate or nucleotides. The names of the final preparations listed above (from a - n) in which I used mountain products as raw materials (Table 3) show us that by correctly associating the raw materials with mountain origin, we can obtain appetizing final preparations by offering the consumer an unforgettable dining experience. All this information can provide to food technologists and/or product developers additional options to make final dishes more flavorful and appetizing. All this knowledge can be put into practice to improve current recipes or to formulate new ones and to develop umami menus that promote mountain product and gastronomic tourism. The challenge for the future is the analysis of free glutamate from all existing mountain products in the National Register of Mountain Products and their association for the production of new culinary preparations.

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