# Natural Monosodium Glutamate in Geographically Indicated Cheeses in Turkey

**Emir Hilmi ÜNER**
Ankara University, Vocational School of Beypazarı, Ankara
emirhilmiuner@gmail.com
ORCID: 0000-0003-2642-9852

**Fügen DURLU ÖZKAYA**
Hacı Bayram Veli University, Faculty of Tourism,
Department of Gastronomy and Culinary Arts, Ankara
fdozkaya@gmail.com
ORCID: 0000-0003-2893-9557

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**Abstract**

Monosodium Glutamate (MSG) is the most determinant component of umami taste and is formed in cheeses naturally. The main purpose of this research is to determine the amounts of MSG in geographically indicated cheeses in Turkey and the changes in MSG content after 60-day storage. In this study, the amount of MSG in 42 samples of seven cheese types (6 of each type), were measured by the AOAC method, and sensory analyses were conducted in 14 samples. Additionally, samples from each type were stored for 60 days and MSG contents in 6 samples were remeasured. MSG was found between 0.007 and 2.205 mg/100 g in 41 samples. The amount of MSG increased in 4 samples and decreased in 2 samples after storage. Results showed that the type and ripening time is highly determining on MSG content and, taste is the strongest factor on overall liking followed by odour, texture, and appearance.

***Keywords:*** *Cheese, geographical indication, natural MSG, sensory analysis, umami taste*

## Türkiye'deki Coğrafi İşaretli Peynirlerde Doğal Monosodyum Glutamat

**Öz**

Temel umami tat bileşiği olan Monosodyum Glutamat (MSG), peynirlerde doğal olarak oluşmaktadır. Bu araştırmanın temel amacı, Türkiye'deki coğrafi işaretli peynirlerde bulunan doğal MSG miktarlarını ve 60 günlük depolama sonrasında MSG miktarlarında meydana gelen değişimleri belirlemektir. Bu çalışmada, yedi peynir çeşidinden 6'şar örnek olmak üzere toplam 42 peynir örneğindeki MSG miktarı AOAC yöntemi ile ölçülmüş ve 14 örnek için duyusal analizler gerçekleştirilmiştir. Ayrıca her peynir çeşidinden bir örnek 60 gün süreyle bekletilmiş ve 6 örnekteki

MSG miktarı yeniden ölçülmüştür. 41 örnekte 0.007 ile 2.205 mg/100 g aralığında MSG ölçülmüştür. Depolama sonrası 4 örnekteki MSG miktarı artarken, 2 örnekte azaldığı tespit edilmiştir. Sonuçlar, peynir örneklerinde çeşit ve olgunlaşma süresinin MSG miktarı üzerinde belirleyici bir etkiye sahip olduğunu göstermektedir. Duyusal analiz sonuçlarına göre tat, genel beğeni üzerinde en belirleyici faktör olurken, diğer belirleyici faktörler sırasıyla koku, doku ve görünüm olarak belirlenmiştir.

***Anahtar Kelimeler:*** *Coğrafi işaret, doğal MSG, duyusal analiz, peynir, umami tat*

## Introduction

Taste is the human sense which regulates the ingestive behavior and, is the result of the chemical reaction between taste compounds and the papillae on the tongue, palate, and throat. Sweet, sour, salty, and bitter tastes were accepted as basic tastes until the late 20th century (Stańska & Krzeski, 2016). Prof. Kikunae Ikeda from Tokyo University realized that there was a fifth taste which he was familiar with, different from four basic tastes in foods such as asparagus, tomato, and cheese, which he had the opportunity to taste for the first time during his studies in Leipzig-Germany between 1899-1901. When returned to Japan, he started to search the source of this novel taste. In 1907, he noticed that the "kombu" seaweed, used for making "dashi" (a stock widely used in Japanese cuisine) had the same taste intensively and named it as "umami" which means delicious in Japanese (Beauchamp, 2009; Ninomiya, 2015). Ikeda distinguished the source of this taste is Monosodium Glutamate (MSG) in foods and succeeded in separating the glutamic acid crystals in water by using dried kombu seaweed in 1908. Ikeda neutralized the water-soluble glutamic acid with NaOH and managed to obtain 30 g MSG out of 12 kg kombu seaweed (Kurihara, 2015).
In 1913, Kodama examined the components of "katsuobushi" (dried and fermented fish) and revealed that the inosinate was also a source of umami. In 1957, Kuninaka found that guanylate is another important source of umami during a study on ribonucleotide production by biochemical degradation of yeast RNA. It was reported that guanylate is naturally found in dried shiitake mushroom, commonly used in Japanese and Chinese cuisine. In 1964, Kuninaka described the umami taste synergism between glutamate and nucleotides. He revealed that when glutamate and 5p-ribonucleotides were used together, the umami taste intensified significantly (Ninomiya, 2015; Yamaguchi and Ninomiya, 2000). At the International Umami Symposium in 1985, the existence of umami taste receptors on the tongue was proven by Prof. Yamaguchi and umami was accepted as the fifth basic taste (Ninomiya, 2015).

As in many foods MSG exists naturally or added artificially, various methods have been used to measure the amount of MSG or umami taste intensity. Conacher, Iyengar, Miles & Botting (1979) determined MSG ranged from approximately 0.2% in some condensed soups to 13.1% in bouillon cubes by gas-liquid chromatography (GLC). The MSG contents of over 200 samples of manufactured foods were measured by AOAC Procedure and estimates of the dietary intake of MSG in the UK population were calculated (Rhodes, Titherley, Norman, Wood & Lord 1991). Soyseven & Arli (2021), developed a simple and effective high-performance liquid chromatography (HPLC) using fluorescence (FLD) method and carried out for determination of MSG in 57 various food samples. Natural MSG exists in many foods such

as meat, mushroom, fermented dairy products, breast milk, various vegetables, and sea foods, gives these foods a distinct umami taste (Maga, 1994, s.99-100). Drake et al. (2007) identified the compounds responsible for umami taste in Cheddar and Swiss cheeses and revealed that MSG played the largest role in umami taste of both Cheddar and Swiss cheeses. Sinesio, Comendador, Peparaio & Moneta (2009) investigated umami taste properties of traditional Italian recipes prepared with umami-rich ingredients. Results showed, that in recipes containing parmesan cheese, umami enhancement was clearly perceived by the panelists and this enhancement also improved the perception of other basic tastes. Effects of sensory interactions between basic tastes and ten cheese aroma compounds, on perception of cheese flavor were examined. The study showed that increasing amount of MSG caused an increase in the sense of cheese flavor in the product with low and medium aroma levels.

Since the amount of MSG is positively related with the perceived taste, many chefs and home cookers add MSG in their plates. Today, artificial MSG is used widely as a food additive in food industry, restaurants and even in home kitchens as it is a very effective flavor enhancer, inexpensive and easily accessible. The use of artificial MSG as a food additive, however, has been argued to be associated with nutritional diseases such as obesity and diabetes due to-creat the illusion effect on the consumer (Cooper, 2015, s.127). Particularly due to this reason, some consumers concern about the safety of foods which include artificial MSG. Some durable ingredients with high natural MSG such as truffle oil, powdered parmesan or dried porcini are also used as flavor enhancer in restaurant and home kitchens, but they are usually very expensive and not easily available globally. Therefore, detecting safe and healthy local or affordable gastronomic products with natural umami taste and spreading their area of use has a great importance for both producers and consumers (Wijayasekara & Wansapala, 2021). It is known that the amount of natural MSG in food increases in some processes such as cooking, drying and fermentation. One of the most important sources of natural MSG is fermented milk products (Drake et al., 2007). Cheese, for this reason, is the ideal product as a source of high natural MSG. Since the specific combination of MSG with NaCl is well determined (Baryłko-Pikielna & Kostyra, 2007; Chi & Chen, 1992; Okiyama & Beauchamp, 1998), being able to know the correct ripening time to achieve the optimum levels of natural MSG for different purpose of use, deems desirable. For this reason, in this research, cheese types, which are fermented milk products, were examined. The cheese types in the current research were limited to the ones which were geographically indicated in Turkey. The most important reason for including geographically indicated cheeses in this research is that the locality and authenticity of these products are registered. In addition, the raw materials and processes used in production have to comply with the standards. Geographically indicated products can be considered as original, local and standard samples.

It's known that the amount of MSG in cheeses varies depending on the type and the ripening time. The main purpose of this research is to determine the amounts of MSG in geographically indicated cheeses in Turkey and the changes in the amount of MSG after 60-day storage. It's also aimed to reveal the effects of likings of appearance, odour, texture and taste on overall liking.

## Material and Method

The current research was conducted in three consecutive stages. In the first stage, the amount of natural MSG in 42 cheese samples were measured by AOAC 970.37. A total of 42 sam-

ples, six measurements from each seven cheese types, was studied (Diyarbakir Orgu, Edirne White, Erzurum Civil, Erzurum Blue Civil/Erzurum Gogermis Cheese, Erzincan Tulum, Ezine and, Kars Kashar Cheesse). Samples were purchased from different local producers in six different cities. The analyses were performed by an accredited food analysis laboratory (Nano Lab Laboratory Group).

In the second stage, the hedonic scale tests of 14 samples (two samples from each cheese type) were conducted. The samples were randomly selected in their cheese types and subjected to hedonic scale tests by 106 consumers to determine the likings of appearance, odor, texture, taste and overall likings. Individual participation method was used at this stage. The tests were conducted in Ankara Hacı Bayram Veli University, Gastronomy and Culinary Arts Department's Sensory Analysis Laboratory. Cheese samples were cut into 2×3 centimeters pieces and were served on white plain plastic plates. Each participant was seated comfortably and instructed to taste the samples under a white light. One participant conducted the hedonic test at a time and there was no time limit. Immediately after tasting each sample, the participants were asked to rate the samples in terms of each sample's appearance, odour, texture, taste and overall likings. The participants rated their liking on a 10-point Likert type scale (1 = Did not like at all, 10 = liked a lot) (Durlu-Özkaya & Üner, 2016). In the third stage of the current research, the change in MSG amounts during storage was examined. One sample from each cheese type was stored at +4 °C for 60 days in closed containers. At the end of the storage period, the sample of Edirne White Cheese was observed to be spoiled and excluded from this part of the study. The changes in the MSG amounts of remaining six cheese samples were determined by using the AOAC 970.37 method.

**Statistical Analysis**

Regression analysis was conducted to determine the sensory factors affecting the overall liking level. The analyses were conducted by a statistical package program (IBM SPSS.22).

**Results**

By April 2016, when the research began, there were seven cheese types geographically indicated, in Turkey. In the scope of this study, the amount of MSG in 42 samples, six from 7 cheese types, were measured by AOAC 970.37 method. 41 of 42 samples were found to contain natural MSG at rates ranging from 0.007 to 2.205 mg/100 g. The highest average amount of MSG (1.026 mg/100 g) was detected in Erzurum Blue Civil Cheese, while Erzurum Civil Cheese was the cheese with the lowest average amount of MSG. The mean, minimum, and maximum MSG amounts (mg/100 g) in cheese types are given in Table 1.

**Table 1.** Amounts of MSG in cheese types

| Type of cheese | n | MSG (mg/100 g) | | |
|---|---|---|---|---|
| | | Minimum | Maximum | Mean |
| Kars Kashar Cheese | 6 | 0.096 | 0.657 | 0.297 |
| Ezine Cheese | 6 | 0.021 | 0.379 | 0.243 |
| Edirne White Cheese | 6 | 0.007 | 0.884 | 0.222 |
| Erzincan Tulum Cheese | 6 | 0.046 | 1.850 | 0.757 |
| Diyarbakır Orgu Cheese | 6 | ~ 0 | 1.584 | 0.171 |
| Erzurum Civil Cheese | 6 | 0.011 | 0.205 | 0.060 |
| Erzurum Blue Civil Cheese | 6 | 0.153 | 2.205 | 1.026 |

After first analyses, one sample from each cheese type was randomly selected and stored at +4 ºC for 60 days to determine the change in MSG amounts during storage. At the end of the storage, the sample of Edirne White Cheese was observed to be spoiled and excluded from this part of the study. The amounts of MSG in 6 samples were remeasured with AOAC 970.37 method. As a result of the analyses, it was revealed that the amount of MSG in 4 cheese samples increased between 120-1169% and decreased in 2 samples by 20% -89% (Table 2).

**Table 2.** Changes in the amount of MSG samples during storage

| Cheese Type | 1.Measurement (mg/100 g) | 2.Measurement (mg/100 g) |
|---|---|---|
| Kars Kashar Cheese | 0.117 | 1.485 |
| Ezine Cheese | 0.379 | 0.836 |
| Erzincan Tulum Cheese | 0.434 | 0.046 |
| Diyarbakır Orgu Cheese | ~ 0 | 0.134 |
| Erzurum Civil Cheese | 0.061 | 0.756 |
| Erzurum Blue Civil Cheese | 2.205 | 1.755 |

To determine the sensory factors affecting overall liking level Regression analysis was conducted. Likings of appearance, odour, texture and taste were assumed as independent factors which affect the overall liking dependent variable (Table 3).

**Table 3.** Sensory factors affecting the overall liking

| Sensory factor | Mean±SD | B | Beta | t | P |
|---|---|---|---|---|---|
| **1. Appearance** | 7.62 ±2.16 | .084 | .081 | 3.739 | .000 |
| **2. Odour** | 7.22 ±2.31 | .219 | .224 | 8.248 | .000 |
| **3. Texture** | 7.17 ±2.39 | .87 | .092 | 4.032 | .000 |
| **4. Taste** | 7.15 ±2.54 | .553 | .624 | 26.076 | .000 |
| **Overall liking** | 7.34 ±2.25 | | | | |

Findings of the research show that likings of appearance, odour, texture and taste are significant predictors of the participants overall liking. The analysis revealed that liking of taste (Beta: 0.624) is the strongest factor on overall liking and followed by odour (Beta: .0224), texture (Beta: 0.092) and appearance (Beta: 0.081).

## Discussion

In line with the main purpose of the research, natural MSG amount of 42 cheese samples and the changes in MSG amount in six samples after 60-day storage were measured by AOAC. 970.37 method. Results of the study show that in 41 of 42 cheese samples, natural MSG was found in amounts ranging from 0.007 to 2.205 mg/100 g. According to Umami Information Center (2022)'s data, the cheese type with the highest MSG content is Parmesan cheese (1.68 mg/100 g). In this study. a sample of Erzurum Blue Civil Cheese has been established to contain natural MSG by 2.205 mg/100 g. and it has been the highest natural MSG content ever reported for cheese types. Considering the concerns of consumers about artificial MSG and high cost of products with natural MSG already used in restaurants and home kitchens, healthy and affordable gastronomic products with high natural MSG can be an alternative. As umami taste concept has been very popular around the

world, these products can be promoted internationally and also innovative receipts and variety of novel use of the product can be developed.

Considering the average MSG values of the cheeses, Erzurum Blue Civil Cheese has the highest average amounts of MSG (1.026 mg/100 g), the cheese type with the lowest average amount of MSG is Erzurum Civil (0.060 mg/100 g). Erzurum Blue Civil Cheese is a matured cheese produced by fermenting Erzurum Civil cheese alone or together with curd cheese for a second time. The main difference between these two types of cheese is aging time. It is known that during fermentation, proteins and peptides are degraded as a result of microorganism activities and turned into amino acids and other cleavage products. Due to degradation, the amount of free Glutamic acid in foods increases significantly during maturation (Chen et al., 2021; Hajeb & Jinap, 2012). Results of the study confirm that the maturing process is very important and determinant in terms of MSG and umami taste intensity in foods. Changes in the amount of MSG after 60-day storage also confirm this result. According to the result of the second analyses, it was established that the amount of MSG in 4 cheese samples increased by 120-1169%, while in 2 samples, it decreased by 20% and 89%. In the sensory control, the signs of deterioration and decay were also detected in these two samples. In the light of these findings, it is possible to say that the amount of MSG in two samples, increased to a certain point during ripening and then started to decrease during storage, while continuing to increase in four samples. At this point, it can be said that glutamic acid, which is released as a result of degradation of protein and peptides (Amin, Kusnadi, Hsu, Doerksen & Huang, 2020), began to degrade. This result is further important because many studies showed that acceptance of foods with umami taste depends on the combination of NaCl and MSG amounts (Baryłko-Pikielna & Kostyra, 2007; Chi & Chen, 1992; Okiyama & Beauchamp, 1998). Revealing the relationship between ripening time and the amount of MSG will enable producers to determine the optimal combinations for various purposes of usage.

## Conclusion

In this study, six cheese samples were analyzed for two times with an interval of 60 days and the changes in amount of MSG was measured during storage. For future studies, it can be recommended to measure the amounts of MSG and other umami taste components more frequently in longer storage times for better understanding of relationship between ripening time and umami taste intensities of fermented foods.

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