# A Fuzzy Approach Analysis of Halloumi Cheese in N.Cyprus

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## ABSTRACT

*Sensory evaluation of food has become an important factor in new product development and marketing, as it brings a detailed view of both consumer behavior and quality control. The Applications of Multi-Criteria Decision Making (MCDM) techniques allow multiple attributes to be compared between many alternatives and the best alternatives to be selected. The aim of this study is to determine the sensory differences between traditional and industrial Halloumi cheeses and select the ones that contain unique and characteristic features in respect of authenticity. In this study, the similarity-based fuzzy TOPSIS method is used to determine the contribution of sensory attributes, and to order Halloumi samples based on respondents' decisions. A total of 11 industrial and homemade Halloumi cheese samples from North Cyprus in Lefkoşa, Girne, Karpaz, Güzelyurt, Lefke, and Gazimağusa regions is collected from markets and villages and transported to the laboratory without breaking the cold chain. A total of 8 panelists joined in the sensory analysis. Looking at the ranking results, it is seen that industrial Halloumi cheeses are more prominent as a result of the sensory evaluation by decision-makers, while homemade Halloumi cheeses are less appreciated. Research should be expanded to develop sample data in the future to strengthen the results of the research and find factors affecting attitudes regarding product quality, satisfaction, and food safety.*

**Keywords:** Halloumi Cheese, Sensory Attributes, MCDM, Fuzzy Topsis

## INTRODUCTION

Halloumi cheese is a semi-hard white cheese type unique to Cyprus. It can be cut easily and its colors range from white (when using sheep's milk or goat's milk) to yellowish especially when cow milk is used. The most significant characteristic of Halloumi cheeses produced by the traditional and industrial processes is that they are made from raw milk without using culture. Halloumi cheese, which can be consumed fresh or matured in brine. One of the most well-known and widely-consumed cheeses of this group and it has gained increased popularity in recent years (Papademas, 2006; Kaminarides et al., 2007). Industrial production Halloumi cheese sold in the cities is marketed in a plastic vacuum package whereas it is preserved in brine in rural regions (Hayaloglu et al., 2007). Local products are also famous in production of a specific region, they are considered to have superior quality characteristics than similar products, and are generally referred to the name of the region where they are produced. Local products have an important contribution to the economy of the region and promotion of the producing country. Additionally, researchers are working on the application of Multi-Criteria Decision Making (MCDM) technics for sensory analysis and the quality of food products (Perrot et al., 2006). MCDM methods can be utilized to combine all criteria in sensory analysis. TOPSIS is an MCDM strategy that chooses arrangement choices from a limited set based on expanding the distance from the negative ideal point and limiting the distance from the positive ideal point (Olson 2004). Lazim & Suriani (2009) proposed and applied to rank the picked coffee items and decide the best of value properties attributable to sensory assessment utilizing a fuzzy decision-making technique. Jaya &

Das (2003) were used Fuzzy logic analysis for detection to the best of three market place mango drinks.

## Statement of the Problem

Sensory evaluation of food has become an important factor in new product development and marketing, as it brings a detailed view of both consumer behavior and quality control. The Applications of MCDM techniques allow multiple attributes to be compared between many alternatives and the best alternatives to be selected. This study is to determine the sensory differences between traditional and industrial Halloumi cheeses and to select the ones containing original and characteristic features in terms of originality.

A total of eleven different Halloumi samples, five traditionally produced at home, and six industrially produced are tested by a trained panel to reveal the most important sensory attribute as well as their contribution to the overall sensory quality of Halloumi cheeses.

## Purpose and Significance of the Study

This study aims to determine the sensory differences between traditional home-made and industrial Halloumi cheeses and select the ones that contain unique and characteristic features in respect of authenticity. A total of eleven different Halloumi samples, five traditionally produced at home and six industrially produced are by tested a trained panel to reveal the most important sensory attribute as well as their contribution to the overall sensory quality of Halloumi cheese. The fuzzy procedure for request execution by likeness to the ideal solution (TOPSIS) method, has been applied to the assessment of Halloumi cheese tests sensory properties. Local food products have different quality characteristics in terms of their flavors, hence they will have superior value in the eyes of consumers. Dairy products, like cheese, can be an incentive for the improvement of healthy foods. Although the demand for healthy foods is increasing, the acceptability of foods by the consumer always depends on satisfying textural and different sensory properties (Fagan, et al., 2006). The sensory feature of an item like appearance, flavor, color, and taste are significant criteria for buyers to acknowledge or dismiss an item, and these are controlled by human detects (Gurmeric et al., 2013). Especially flavor and taste are the most be determined by human senses in the selection of products. The sensory analysis includes the examination and commenting of reactions by specialists (Cruz et al., 2010).

# METHODOLOGY

## Limitation of Methodology

Research should be expanded to develop sample data in the future to strengthen the results of the research and find factors affecting attitudes regarding product quality, satisfaction, and food safety.

## Data Collection

### Data Samples

A total of 11 industrial and homemade Halloumi cheese samples from North Cyprus in Lefkoşa, Girne, Karpaz, Güzelyurt, Lefke, and Gazimağusa regions is collected from markets and villages and transported to the laboratory without breaking the cold chain.

To prevent the growth of microorganisms and to preserve the freshness of the food, the cold chain must not be “broken” at all stages from production to consumption. Temperature is a

very important parameter in the protection of sensitive foods. Temperature changes cause the growth of microorganisms and the physical, sensory, and chemical structure of these products.

### Data Collection Tools

This study aims to determine the sensory differences between traditional home-made and industrial Halloumi cheeses and select the ones that contain unique and characteristic features in respect of authenticity. A total of eleven different Halloumi samples, five traditionally produced at home and six industrially produced are by tested a trained panel to reveal the most important sensory attribute as well as their contribution to the overall sensory quality of Halloumi cheese.

## Proposed Method

### Similarity-Based Fuzzy TOPSIS

According to the fuzzy TOPSIS, the ranking of the suppliers is determined by calculating the closeness coefficient(CC). The closeness coefficient is calculated using the matrix that occurred the distance measures to the fuzzy positive ideal solutions (FPIS) and fuzzy negative ideal solutions (FNIS). In this study, the closeness coefficient is calculated using the similarity-based method proposed by Luukka (2011) instead of the distance measures to determine the ranking of the suppliers. The fuzzy similarity is calculated and then the average of the similarities is used as a similarity measure to determine the ranking.

The recommended method is able to summarize as follows:

Step 1. Decision-makers evaluate the importance of criteria using the linguistic weight factor shown in Figure 1. The significance weights of the criteria can be seen in Table 1.

Step 2. Using the linguistic rating variables shown in Figure 2, decision-makers evaluate the rankings of suppliers against each criterion. The ratings obtained are shown in Table 2.

Step 3. The linguistic evaluations in Tables 1 and 2 are converted into trapezoidal fuzzy numbers and the fuzzy weight of each criterion is determined.

Step 4. Normalize the fuzzy-decision matrix.

Step 5. Table 3 shows the weighted normalized fuzzy decision matrix.

Step 6. FPIS and FNIS is determined as in Table 4.

Step 7. Calculate the similarity of each supplier using the weighted normalized fuzzy decision matrix and similarity matrix (using FPIS) and then calculate the average similarity for each supplier as in Table 5.

Step 8. The ranking determines according to the average similarity given in Table 6.

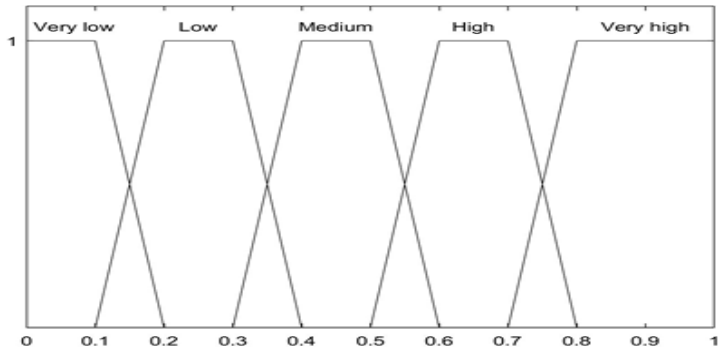


**FIGURE 1**
**LINGUISTIC VARIABLES FOR IMPORTANCE WEIGHT OF EACH CRITERION**

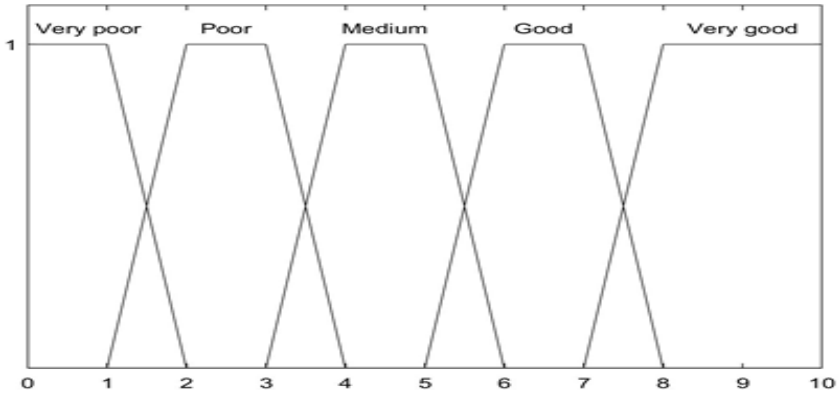


**FIGURE 2**
**LINGUISTIC VARIABLES FOR RATINGS**

## Linguistic Variables

The importance grading of qualitative criteria and the weights of various criterion as linguistic variables. Since linguistic assessments only approach the subjective decision of the decision-maker, linear trapezoidal membership functions are used to capture the ambiguity of these linguistic assessments. (Herrera & Herrera-Viedma, 2000). Linguistic variables can be expressed with positive trapezoidal fuzzy numbers. The Criticality weight of each rule can be used direct task or relatively binary comparison (Pérez et al., 2011). The language variables in this study are shown in figures 1 and 2. It is used to evaluate the importance of criteria and ranks of alternative criteria for qualitative criteria. For instance, the linguistic variable be able to defined as "Medium" (3, 4, 5, 6) and "Good" (5, 6, 7, 8). Membership functions in such cases:

$$\mu_{\text{Medium}}(x) = \begin{cases} 0 & x < 3, \\ \dfrac{x-3}{4-3} & 3 \le x \le 4, \\ 1 & 4 \le x \le 5, \\ \dfrac{x-6}{5-6} & 5 \le x \le 6, \\ 0 & x > 6, \end{cases} \quad (1)$$

$$\mu_{\text{Good}}(x) = \begin{cases} 0 & x < 5, \\ \dfrac{x-5}{6-5} & 5 \le x \le 6, \\ 1 & 6 \le x \le 7, \\ \dfrac{x-8}{7-8} & 7 \le x \le 8, \\ 0 & x > 8, \end{cases} \quad (2)$$

## VALIDITY AND RELIABILITY OF THE STUDY

Sensory evaluation is one of the methods used to determine market worthiness, particularly in food items. It is valuable for item advancement and improvement by recognizing the main factor for a specific market (Uprit & Mishra, 2002). Sensory measurement is withal required for their products to be successful in the market. It is very important for producers and consumers to determine the preferences and perceptions of consumers on the sensory evaluation of food products. Without a proper sensory analysis, the risk of disappointment in the market is

high. MCDM approach assists the decision-maker to distinguish the best favored alternate throughout a lot of different options, concerning numerous criteria which characterize the acceptability of individual decision options (Ziemba, 2018).

MCDM is a trending scientific field concerned with evaluating a set of different alternatives through the application of quantitative and/or qualitative criteria aimed for selecting or sorting the best alternatives and determining their order of preference (Saaty, 2013; Ren & Liu, 2015).The Fuzzy TOPSIS method can help determine the correct method to produce high-quality food products for sensory evaluation and evaluate various alternatives of various criteria. It determines the reliability of the study by applying the fuzzy TOPSIS decision making technique to determine the best alternative for the selection of sensory assessment methods. The results of the fuzzy TOPSIS method analysis are expected to be used as information or recommendations to assist consumers and producers in determining the best alternative to homemade and industrial Halloumi cheeses.

## RESULTS

Halloumi, a local Cypriot product, wants to choose which of the many kinds of Halloumi sold in the market by suppliers to stand out and buy. Eleven candidates ($A_1$, $A_2$, $A_3$, $A_4$, $A_5$, $A_6$, $A_7$, $A_8$, $A_9$, $A_{10}$ and $A_{11}$) remain for further evaluation. A panel of eight panelists, ($D_1$, $D_2$, $D_3$, $D_4$, $D_5$, $D_6$, $D_7$ and $D_8$) is formed to select the most suitable supplier. Homemade Halloumi cheeses ranked third, fifth, sixth, tenth, and eleventh. Panelists didn't show any better preferences. However, industrial Halloumi cheeses are preferred more by panelists by ranking first, second, fourth, seventh, eighth, and ninth. Four preference criteria are aforethought:

(1) General Appearance ($C_1$),
(2) Color ($C_2$),
(3) Taste and Odor ($C_3$),
(4) Mouth Feeling ($C_4$),

**Table 1**
**IMPORTANCE WEIGHT OF CRITERIA TAKEN FROM DECISION-MAKERS**

| | Decision-makers | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Criteria** | **$D_1$** | **$D_2$** | **$D_3$** | **$D_4$** | **$D_5$** | **$D_6$** | **$D_7$** | **$D_8$** |
| $C_1$ | H | M | M | H | VH | M | H | M |
| $C_2$ | H | M | H | H | VH | H | M | M |
| $C_3$ | VH | H | VH | VH | VH | VH | VH | H |
| $C_4$ | VH | H | M | VH | M | H | VH | VH |

**Table 2**
**RATINGS OF THE SUPPLIERS BY DECISION-MAKERS UNDER FOUR CRITERIA**

| | | Decision-makers | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Criteria** | **Supplier** | **D1** | **D2** | **D3** | **D4** | **D5** | **D6** | **D7** | **D8** |
| $C_1$ | $A_1$ | G | G | VG | VG | VG | G | G | M |
| $C_1$ | $A_2$ | M | G | G | VG | G | G | VG | G |
| $C_1$ | $A_3$ | VG | M | VG | VG | G | M | G | M |
| $C_1$ | $A_4$ | G | P | VG | VG | VG | G | VG | VG |
| $C_1$ | $A_5$ | M | G | VG | G | VG | VG | G | G |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| $C_1$ | $A_6$ | VG | G | VG | M | VG | VG | G | G |
| $C_1$ | $A_7$ | G | VG | G | G | M | M | M | M |
| $C_1$ | $A_8$ | G | G | VG | VG | G | G | M | G |
| $C_1$ | $A_9$ | G | G | M | M | VG | VG | G | VG |
| $C_1$ | $A_{10}$ | G | VG | VG | G | M | M | VG | G |
| $C_1$ | $A_{11}$ | VG | VG | VG | G | VG | VG | G | G |
| $C_2$ | $A_1$ | M | G | VG | G | VG | G | G | M |
| $C_2$ | $A_2$ | P | G | VG | G | VG | M | G | M |
| $C_2$ | $A_3$ | G | M | G | VG | G | P | M | M |
| $C_2$ | $A_4$ | P | P | VG | VG | VG | G | G | VG |
| $C_2$ | $A_5$ | M | G | VG | M | VG | VG | G | M |
| $C_2$ | $A_6$ | VG | G | VG | M | VG | VG | VG | G |
| $C_2$ | $A_7$ | G | G | G | M | G | M | G | M |
| $C_2$ | $A_8$ | G | VG | VG | G | G | G | P | G |
| $C_2$ | $A_9$ | M | G | G | M | VG | VG | VG | VG |
| $C_2$ | $A_{10}$ | G | VG | VG | G | M | VG | M | M |
| $C_2$ | $A_{11}$ | VG | VG | VG | VG | VG | VG | G | G |
| $C_3$ | $A_1$ | G | G | VG | G | VG | M | M | M |
| $C_3$ | $A_2$ | M | VG | M | M | G | G | VG | M |
| $C_3$ | $A_3$ | G | P | G | VG | VG | G | G | G |
| $C_3$ | $A_4$ | M | P | M | VP | M | VP | VP | G |
| $C_3$ | $A_5$ | G | G | G | G | G | G | M | M |
| $C_3$ | $A_6$ | VG | G | G | M | G | VG | VG | M |
| $C_3$ | $A_7$ | P | VG | G | M | M | M | G | P |
| $C_3$ | $A_8$ | G | VG | VG | G | G | M | M | VG |
| $C_3$ | $A_9$ | M | M | G | M | VG | VG | M | VG |
| $C_3$ | $A_{10}$ | M | G | VG | G | G | G | M | M |
| $C_3$ | $A_{11}$ | VG | G | VG | M | VG | VG | G | VG |
| $C_4$ | $A_1$ | G | VG | G | VG | VG | M | M | M |
| $C_4$ | $A_2$ | M | VG | M | M | G | G | VG | M |
| $C_4$ | $A_3$ | VG | P | VG | VG | VG | G | G | G |
| $C_4$ | $A_4$ | M | P | M | P | M | VP | P | VG |
| $C_4$ | $A_5$ | G | M | G | VG | G | G | G | P |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| $C_4$ | $A_6$ | VG | G | VG | M | M | VG | VG | M |
| $C_4$ | $A_7$ | M | G | G | M | M | M | M | P |
| $C_4$ | $A_8$ | G | G | VG | VG | G | G | G | G |
| $C_4$ | $A_9$ | G | G | G | M | VG | VG | G | VG |
| $C_4$ | $A_{10}$ | M | G | VG | G | M | VG | M | M |
| $C_4$ | $A_{11}$ | VG | VG | VG | M | G | VG | G | G |

**Table 3**
**WEIGHTED NORMALIZED FUZZY DECISION MATRIX**

| | **$C_1$** | **$C_2$** | **$C_3$** | **$C_4$** |
|---|---|---|---|---|
| $A_1$ | (0.09, 0.34, 0.5, 1) | (0.09, 0.33, 0.48, 1) | (0.15, 0.43, 0.64, 1) | (0.09, 0.39, 0.59, 1) |
| $A_2$ | (0.09, 0.32, 0.47, 1) | (0.03, 0.3, 0.44, 1) | (0.15, 0.41, 0.62, 1) | (0.09, 0.35, 0.54, 1) |
| $A_3$ | (0.09, 0.31, 0.47, 1) | (0.03, 0.27, 0.4, 1) | (0.05, 0.45, 0.67, 1) | (0.03, 0.42, 0.64, 1) |
| $A_4$ | (0.03, 0.35, 0.53, 1) | (0.03, 0.33, 0.49, 1) | (0, 0.18, 0.32, 0.8) | (0, 0.21, 0.35, 1) |
| $A_5$ | (0.09, 0.34, 0.5, 1) | (0.09, 0.33, 0.48, 1) | (0.15, 0.41, 0.6, 0.8) | (0.03, 0.35, 0.53, 1) |
| $A_6$ | (0.09, 0.35, 0.52, 1) | (0.09, 0.38, 0.57, 1) | (0.15, 0.46, 0.7, 1) | (0.09, 0.4, 0.62, 1) |
| $A_7$ | (0.09, 0.27, 0.4, 1) | (0.09, 0.28, 0.41,0.8) | (0.05, 0.33, 0.52, 1) | (0.03, 0.27, 0.42,0.8) |
| $A_8$ | (0.09, 0.32, 0.47, 1) | (0.03, 0.33, 0.48, 1) | (0.15, 0.46, 0.7, 1) | (0.15, 0.42, 0.62, 1) |
| $A_9$ | (0.09, 0.32, 0.48, 1) | (0.09, 0.35, 0.53, 1) | (0.15, 0.43, 0.65, 1) | (0.09, 0.42, 0.63, 1) |
| $A_{10}$ | (0.09, 0.32, 0.48, 1) | (0.09, 0.33, 0.48, 1) | (0.15, 0.41, 0.61, 1) | (0.09, 0.35, 0.54, 1) |
| $A_{11}$ | (0.15, 0.38, 0.56, 1) | (0.15, 0.41, 0.61, 1) | (0.15, 0.52, 0.79, 1) | (0.09, 0.43, 0.66, 1) |

**Table 4**
**FUZZY POSITIVE-IDEAL SOLUTIONS AND FUZZY NEGATIVE-IDEAL SOLUTIONS**

| | **$C_1$** | **$C_2$** | **$C_3$** | **$C_4$** |
|---|---|---|---|---|
| $A_{id}^{\oplus}$ | (1, 1, 1, 1) | (1, 1, 1, 1) | (1, 1, 1, 1) | (1, 1, 1, 1) |
| $A_{id}^{\ominus}$ | (0.03, 0.03, 0.03, 0.03) | (0.03, 0.03, 0.03, 0.03) | (0, 0, 0, 0) | (0, 0, 0, 0) |

**Table 5**
**SIMILARITIES BETWEEN FPIS AND WEIGHTED NORMALIZED FUZZY DECISION MATRIX**

| | **$C_1$** | **$C_2$** | **$C_3$** | **$C_4$** | **Average** |
|---|---|---|---|---|---|
| $S(A_1, A_{id}^{\oplus})$ | 0.1956 | 0.1931 | 0.2296 | 0.2058 | 0.2060 |
| $S(A_2, A_{id}^{\oplus})$ | 0.1927 | 0.1735 | 0.2257 | 0.1991 | 0.1977 |

| | | | | | |
|---|---|---|---|---|---|
| $S(A_3, A_{id}^{\oplus})$ | 0.1899 | 0.1675 | 0.2074 | 0.1975 | 0.1906 |
| $S(A_4, A_{id}^{\oplus})$ | 0.1843 | 0.1794 | 0.1459 | 0.1483 | 0.1645 |
| $S(A_5, A_{id}^{\oplus})$ | 0.1956 | 0.1932 | 0.2392 | 0.1849 | 0.2032 |
| $S(A_6, A_{id}^{\oplus})$ | 0.1984 | 0.2048 | 0.2369 | 0.2089 | 0.2123 |
| $S(A_7, A_{id}^{\oplus})$ | 0.1809 | 0.1919 | 0.1855 | 0.1738 | 0.1831 |
| $S(A_8, A_{id}^{\oplus})$ | 0.1927 | 0.1792 | 0.2369 | 0.2281 | 0.2092 |
| $S(A_9, A_{id}^{\oplus})$ | 0.1927 | 0.1991 | 0.2294 | 0.2123 | 0.2084 |
| $S(A_{10}, A_{id}^{\oplus})$ | 0.1927 | 0.1932 | 0.2259 | 0.1991 | 0.2027 |
| $S(A_{11}, A_{id}^{\oplus})$ | 0.2192 | 0.2259 | 0.2466 | 0.2153 | 0.2267 |

**Table 6**
**RANKING OF THE SUPPLIERS**

| Suppliers | $CC_i$ | Rank |
|---|---|---|
| $A_{11}$ | 0.5494 | 1 |
| $A_6$ | 0.5209 | 2 |
| $A_8$ | 0.5091 | 3 |
| $A_9$ | 0.5089 | 4 |
| $A_1$ | 0.5009 | 5 |
| $A_{10}$ | 0.4914 | 6 |
| $A_2$ | 0.4841 | 7 |
| $A_3$ | 0.4824 | 8 |
| $A_5$ | 0.4763 | 9 |
| $A_7$ | 0.4156 | 10 |
| $A_4$ | 0.4064 | 11 |

## DISCUSSION

Sensory evaluation is defined as a discipline that creates, measures, analyzes, and interprets the responses of the senses of sight, smell, taste, touch, or hearing to various characteristics of foods. It is the most important sensory quality properties that affect the decision to buy, prepare, or consume a product. The selection and application of the method suitable for the purpose of the sensory analysis are very important in obtaining reliable results. Therefore, quality criteria that affect the acceptance of foods by the consumer can only be determined by sensory tests. It is ensured that the best sample or samples are selected in sensory evaluation. The samples are observed for any variation or deterioration. The samples are classified for odor, taste, mouth feel, color, and general appearance and are evaluated for the admissibility and sensory quality of Halloumi cheese. 11 different homemade and industrial-made Halloumi cheeses are measured able to a 5-point hedonic scale. A total of 8 panelists joined in the sensory analysis. Participants tasted all the examples coded in letters and sensory qualities are evaluated by experts trained. A total of 4 women and 4 men from different countries, between the ages of 25 and 60, participated as panelists. The procedures are explained

to the panelists, and the Halloumi cheese samples are served on white plates. Using a 5-point hedonic scale from the panelists (1: Not Satisfactory; 2: Fair, 3: Medium, 4: Good, 5: Excellent) to evaluate the mouth feel, general appearance, color, and taste of eleven varieties of Halloumi cheese.

In addition, they are asked to select the general quality characteristics of their Halloumi cheese samples on a hedonic scale of 5 points ("Not at all important", "somewhat important", "Important" and "Very important", "Extremely important"). It is necessary to continue the research of the quality characteristics of Halloumi cheeses produced with different raw materials and production techniques in terms of quality and standard product production. Determining the desired color, general appearance, mouthfeel, taste, and odor characteristics of Halloumi cheese, taking into account the consumer taste, is important in terms of target and control in cheese production. "Taste and Odor" impacted the most and "General Appearance "is the least significant attribute. Looking at the ranking, it is seen that industrial Halloumi cheeses are more prominent as a result of the sensory evaluation by panelists, while homemade Halloumi cheeses are less appreciated. Fuzzy TOPSIS method is utilized to evaluate the acceptability of eleven Halloumi cheese varieties through sensory analysis and to reveal the most important attribute, as well as the contributions of each attribute to the overall sensory quality of the Halloumi cheese, such as color, flavor, mouth feel and appearance. This research introduces a new ranking approach for generalized fuzzy numbers. In the literature, studies are scarce which employed effects of MCDM techniques for sensory assessment of food crop (Dogan et al., 2016). Furthermore, no study applied these techniques to synergistically evaluate the contributions of each sensory property to the overall admissibility of food products, and these techniques are not previously applied in the sensory evaluation of Halloumi cheese samples. In this study, the fuzzy TOPSIS technique will add new dimensions to the sensory quality characteristics of Halloumi cheeses produced in Northern Cyprus on behalf of both producers and consumers. The specific aims of this study are:

(1) To evaluate the quality resulting from the sensory evaluation among the Halloumi cheeses available in the market in Northern Cyprus.
(2) To evaluate the organoleptic properties of Halloumi cheeses produced in Northern Cyprus such as color, appearance, mouth feel, texture, and taste through the human senses of taste, smell, sight, and touch senses.

## CONCLUSION

This study, similarity-based fuzzy TOPSIS method was performed to define the weights of sensory attributes quality traits and to compare Halloumi samples based on panelist's decisions and sensory scores. Eight panelists utilized the showed linguistic weighting variables to decide the centrality of the measures.

The expressions "Very Good" and "Good" are used extensively, "Medium "is used moderately and "Poor" and "Very Poor "are used rarely. In other words, decision-makers rated these suppliers with very high scores. According to the average similarity of Halloumi cheeses, they were ranked $A_{11}>A_6>A_8>A_9>A_1>A_{10}>A_2>A_3>A_5>A_7>A_4$. Looking at the ranking, it is seen that industrial Halloumi cheeses are more prominent as a result of the sensory evaluation by decision-makers, while homemade Halloumi cheeses are less appreciated. Halloumi cheeses are composed of cow, goat, and sheep's milk. As a result of the selection of suppliers in terms of milk content of Halloumi cheese, It is observed that cow's milk is the most prominent, followed by goat's and sheep's milk.

## RECOMMENDATIONS

In this study, conducted with cheese samples purchased from the market to compare the sensory properties of industrial and home-made Halloumi cheeses produced in Northern Cyprus, it is observed that the characteristics of the production methods of Halloumi cheeses are different. The reason for these differences; It is thought to be related to the way of raising dairy animals, the fodder plants used, the vegetation of the regions, the differences in the variety of animal breed, and especially the preference of cow's milk or mixtures of goat, sheep, and cow milk in production. The production of industrial Halloumi cheese production at the desired level will contribute to the country's economy and exports. Homemade Halloumi cheese, on the other hand, will contribute more to the economy in the domestic market with the cheeses produced by rural producers, when their product reaches the desired level. It will be beneficial to pay attention to compliance with hygienic control programs at all critical points of the production of Halloumi cheeses. Homemade and industrially produced Halloumi cheeses, together with the inspections, are an invaluable product that has survived to the present day and is still produced by the public according to the cultural structure and history of the country. It will bring its value to the desired level with the correct recognize of Halloumi cheese bydomestic and foreign consumers and increasing the production of Halloumi cheese.

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