MEANS FOR MEASURING THE ELECTRIC AND MAGNETIC QUANTITIES

DENTIFICATION OF FOOD PRODUCTS WITH ADDITIVE E621 ACCORDING TO ADMITTANCE PARAMETERS

Yehen Pokhodylo, Dr.Sc., Prof.; Yuriy Stasyshyn, Ph.D. student,
Lviv Polytechnic National University, Ukraine; e-mail: evgenp@meta.ua

Abstract. Methods and means of identification of food products containing the additive E621 are considered in the work. The results of studies of food products with/without an additive are analyzed by the method of impedance spectroscopy. To detect an additive in a food product, identifying features that can be used have been determined. Informative parameters are the active and reactive components of the admittance of the food product.

Key words: Additive, food product, admittance, impedance spectroscopy.

1. Introduction

To ensure certain organoleptic characteristics of falsified food products (FPs), additives are usually attached to them. They enhance taste, aroma, and color or preserve consistency [1]. Monosodium glutamate (food additive E 621) is such an additive that unscrupulous manufacturers often apply it to hide food fraud, and enhance flavor in food groups. Quite often, the labeling does not contain information about its presence. To detect additives in an FP, it is necessary to conduct complex and laboratory tests including liquid chromatography [2]. The method [3] based on recording the light absorption capacity of monosodium glutamate enables the quantitative determination of monosodium glutamate in FPs. The biosensor method is also used to determine the additive E621 [4]. Recently, the method of impedance spectroscopy is widely applied to assess food quality and safety, for example, for fruits and berries [5-6], olive oil [7], meat products [8-9], milk [10], fresh fish [11], etc. As shown by previous studies of FPs, it can also be used to identify products with the E621 additive [12].

2. Disadvantages

The disadvantage of the mentioned methods is the impossibility of quick and selective detection of E621 additive. Thus, the methods are complex and do not ensure the efficiency of monitoring.

3. The Goal of the Work

The purpose of the work is to analyze the results of studying the food products with/without the additive E621 by defining certain identification features, as well as to propose methods for the rapid detection of the additives and their implementation.

4. Identification of signs of additive detection

The analysis of the dependences of the active and reactive components on the frequency of the test signals obtained [12] revealed signs of additive identification in the FP. They are based on the differences in the curves of the active and reactive components of the admittances for the monitored and based (without the additive) samples. They were considered as changes in values as well as in the shapes of the curve. As an example, we have determined the differences in the curves describing the dependences of the active and reactive components of the impedance for juice and mashed potatoes. They form the identification signs of the E621 additive detection.

Identification signs by absolute changes of active and reactive components. The values of the active component of the conductivity of food samples with E621 additive at frequencies above 10 kHz significantly exceed the similar values at the same frequencies for samples without the studied food additive. Such a difference can be considered an identification feature for determining an additive in an FP. The reactive components of the conductivity of FPs with the additive at frequencies 100 …1000 Hz significantly exceed in values the active components in the same frequencies (for samples without the additive).

Identification of signs by changing the nature of the curve of reactive components.

According to the nature of the change in the frequency dependences, there were espied the clearly expressed extreme value for FPs containing the food additive. That is, for an FP containing the additive E621, the reactive component of admittance increases with frequency to a certain value, and then decreases. For a sample with an FP that does not contain the specified additive, the reactive component of the admittance permanently increases. That is, the presence of an extreme value can be an identifying feature of additive detection.

5. Methods of detecting additives in an FP

The mentioned identification features give the possibility to identify certain additives. Let's describe them.

Method 1. Identification of the additive by detecting the extreme value of the reactive component. The revealed extreme value of the admittance reactive component of the juice with the additive envisages the effect in the frequency band 100 … 1000 Hz. A similar value for mashed potatoes was caught out in the range of 200-2000 Hz [15].

To detect the extreme value of the reactive component, two options are offered. The 1st one is that the reactive component is measured while changing the frequency in a given range, fixing its extreme value. A multi-frequency reactive component meter provides such measurements. The 2nd option detecting an extreme value aimed at the measurement of the reactive component at two selected fixed frequencies of a given range. An illustration of the implementation of this method is shown in Fig.1.

Here, a curve with an extreme value corresponds to a product (mashed potatoes) with an additive, while a curve without an extreme value corresponds to a product without an additive. It can be seen that with frequency the value of the reactive component decreases for an FP without an additive and increases for an FP with an additive. This can be considered an identifying sign of additive detection. That is, to identify the product with an additive, it is enough to measure the reactive component of the admittance of the studied object at two fixed frequencies. It should be noted that while using a primary converter of dissimilar dimensions and designs (different cell constant), the fixed frequencies may be displaced. Therefore, to obtain new frequency dependences of the reactive component for another primary converter, additional studies are recommended.

Method 2. Identification of the additive by measuring the reactive component at a fixed frequency. Implementation of the method is shown in Fig.2. Here, the best results are evident at 1000 Hz, since the difference in values between the reactive components is the largest.

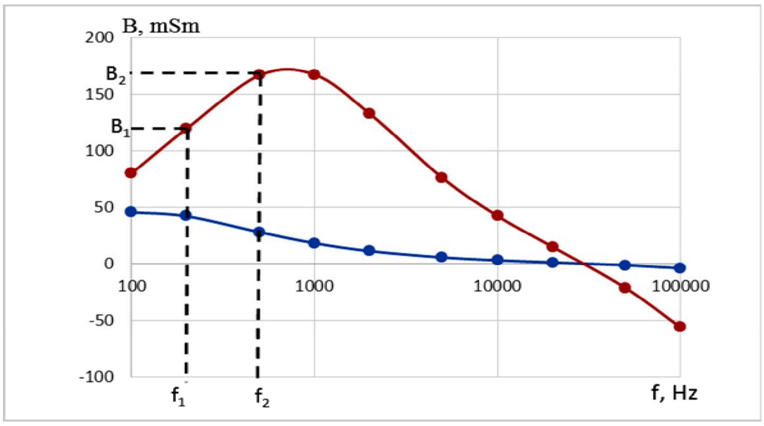

Fig.1. Method of two frequencies for additive determination

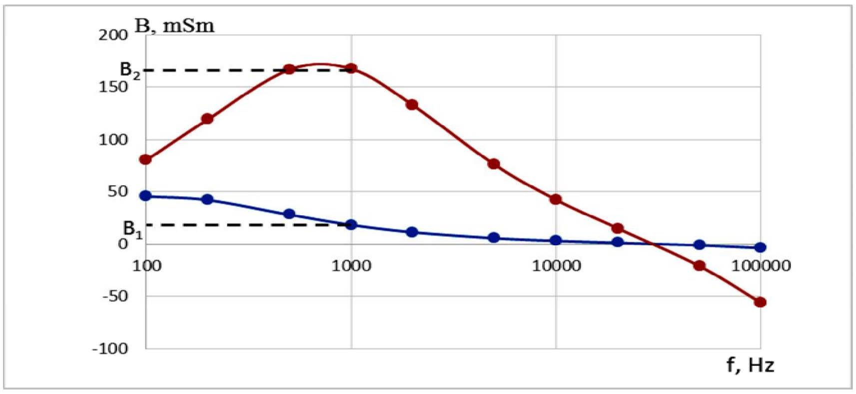

Fig.2. Method of one frequency for additive determination

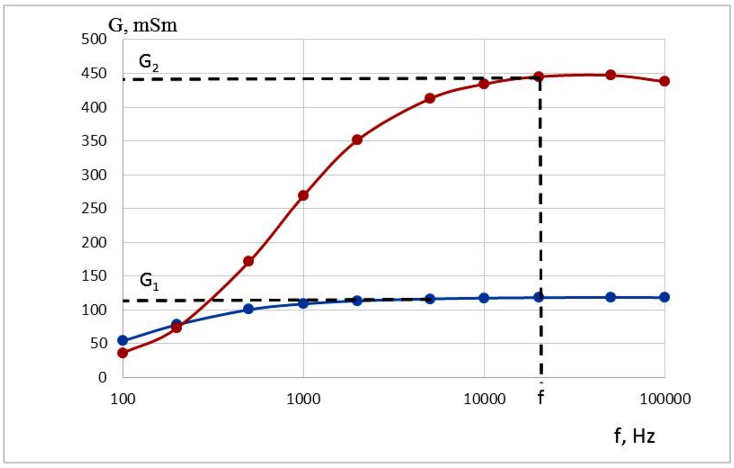

Fig.3. Method of measuring the active component at one frequency for additive determination

To implement this method is necessary to measure the reactive component of the FP at the selected frequency and compare the result with the value of the reactive component of the base sample at this frequency.

Method 3. Identification of the additive by measuring the active component at a fixed frequency of a given range.

Fig. 3 demonstrates that it is best to choose a frequency higher than 10 kHz for additive identification since the difference between the values in the active components here is significant. To implement this method, it is necessary to measure the active component of the studied product sample at the selected frequency and compare the result with the value of the reactive component of the base sample at the same frequency. The greater the difference between the values, the higher level of its content.

Method 4. Detection of the additive by active and reactive components of admittance. This method is implemented due to the simultaneous measurement of the active and reactive components of the admittance at the frequencies specified above. Based on the results of the measurement of the reactive component, the presence of an additive in the product is detected (Fig.1), and based on the results of the measurement of the active component (Fig.3), the content of the additive is estimated.

6. Conclusions

Based on the results of a performed study of additive E621 in food products with the method and means of admittance spectroscopy we can conclude the next.

1. The curves reflecting changes in the frequency of the reactive components of the admittance of the food product containing additive have a clearly expressed extreme in a certain frequency range. The active component of the food product with the additive significantly outweighs the similar component of the product without the additive at frequencies above 500 Hz. The reactive component of the food product with an additive significantly outweighs the reactive component of the product without the additive in the frequency range (500-2000) Hz.

2. Four methods of identification of the food product with the additive E621 were studied. Their concrete application depends on the goal of the issue, mainly on demands of sensitivity and exactness, the velocity of determination, etc.

7. Gratitude

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8. Conflict of Interest

The authors state that there are no financial or other potential conflicts regarding this work.

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