A comparison of tetrad and triangle test: case study on sweetener products using consumer panels

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Abstract. The development of sensory test methods in the food industry is increasing with the need for product development to meet consumer acceptance. The food industry examine the presence or absence of production differences using appropriate sensory tests is discriminatory tests (different tests). The most popular and widely used different test in the food industry is the triangle test, but it has the disadvantage of developing a tetrad test that is supposed to have a more powerful statistical advantage. The study aimed to compare triangle test with tetrad test on sweetener products. The panelists used in this research were consumer panelists of sweetener product aged 20–65 years old based on medical history catagorised into 3 groups: (1) non-diabetic without diabetic offspring, (2) non-diabetic with diabetic offspring, (3) and diabetic. Total panelists were 100 with duplicate. Different tests were analyzed with the concept of signal detection theory and Thurstonian models (Proportion correct response, Pc, d', p value, perceptual noise, and test power). The result showed that tetrad test can replace triangle test on sweetener product A and C using non-diabetic panelists without diabetic offspring and combination of all panelists group, as well as sweetener B with combination of all panelist group, because having perceptual noise less than 50% (1.64–32.09%), and is supported by power value that stated strength of tetrad test is more powerful (test power triangle: 0.215–0.994, test power of tetrad test: 0.445–1.000).

Keywords: consumers, sweetener, diabetic,

1. Introduction
Sweetener is an ingredient used to produce a sweet sensation for food and beverage. The sweet sensation obtained from natural sugar such as sucrose, fructose, and glucose has a certain amount of calories. Compared to natural sugar, the artificial sweetener has a lesser amount of calories, several types of it don't even have the calorie content. Based on that fact, artificial sweetener or alternative intense sweetener can be used to control the blood sugar of diabetes mellitus and obesity patients [1]. Nowadays, artificial sweetener is very popular in the world, including Indonesia. Food industry fulfill consumer's needs by producing tabletop sweetener made from various artificial sweetener to support a healthy life, especially for people with diabetes mellitus.
Sweetener product’s demand by the food industry is increasing as much as 59% (food ingredient), 14% (tabletop), and 2% (dietary supplement). The global sweetener market achieves 1.2 billion US dollars [2].

The development and demand of artificial sweetener are rapidly increased, resulting sweetener industry to make product suits consumer’s acceptance. To overcome it, sensory evaluation can be used as an important tool to develop products comply with consumer expectations in this case for sweetener products. Sensory test method is a scientific method to measure, analyze, and interpret reaction about characteristic of material and food as they perceived by sense of sight, smell, taste, touch, and hearing [3]. Sensory testing in food industry contributes to develop artificial sweetener products and minimize the risk of decision making. Development of food product is conducted by evaluating the product with different ingredient or production process. Food industries need to conduct suitable sensory evaluation which is a discriminative test (difference test) to know whether the difference is presented between products.

| Table 1. Comparison of triangle and tetrad tests. |
|-----------------------------------------------|
| Parameter                                      | Triangle Test | Tetrad Test                  |
| Number of stimulus [4]                        | Three         | Four                        |
| Decision[5]                                    | One sample is different | a. Specified tetrad: specified attribute determined, example: “higher” intensity |
|                                                |               | b. Unspecified tetrad: categorizes as two groups based on sensory similarity (Group A and B) |
| Panelists [4] Correct Probability[6]          | ≥ 18 persons 1/3 | 1/3 from total panelists of triangle test |
|                                                |               | a. Specified tetrad: 1/6 |
|                                                |               | b. Unspecified tetrad: 1/3 |
| Advantage[3] Specification of difference is not required |               | a. Specification of difference is not required |
|                                                |               | b. The statistic is more powerful |
|                                                |               | c. More sensitive |
|                                                |               | d. Testing time is shorter |
|                                                |               | e. The number of sample needed is lesser |

2. Materials and methods

2.1. Materials and equipment
Materials used in this research were 3 types of sweetener product (sweetener A, B, and C), mineral water, cracker as neutralizer, warm tea as solvent of sweetener for triangle and tetrad test, sucrose (sugar).

2.2. Research method

First Stage: Panelist Selection
The selection of panelists is conducted with aim to determine panelists based on the needed criteria in this research. Panelists used in this research are consumers of low-calorie sweetener with age ranging from 20 to 65 years old and categorized based on medical history, such as non-diabetic without diabetic offspring, non-diabetic with diabetic offspring, and diabetic patient. As much as 100 panelists are consist of 34 panelists non-diabetic without diabetic offspring (group 1), 35 non-diabetic with diabetic offspring (group 2) and 31 panelists are diabetic patients (group 3). The questionnaire of panelists's data was
distributed through several methods such as online with google form through social media and offline by directly meet the panelist candidate.

**Triangle Test**

The sample for triangle test of sweetener product consisted of 2 cups same control (serving is based on serving suggestion written on the packaging of sweetener product) and one cup of different sample as testing sample (control -3%). The sweetener tested consists of sweetener A, B, and C. The determination of testing sample (control-3%) based on upper control limit (UCL) and bottom control limit (BCL) ability of production process in the company with hypothesis ± 3% will not make the taste significantly different. Testing samples for triangle test consist of three samples (sweetener A, B, and C), these samples were served one by one sequentially from set 1 to set 3. Triangle test has 6 probable combinations (AAB, ABB, ABA, BAB, BAA, and BBA).

The triangle test of sweetener product was served with warm tea. The tea should be ± 60°C same as the standard stated by internal standard procedure. To get 60°C water, 1000 mL water (±85°C) was mixed with 250 mL of water (room temperature ± 25°C). The preparation was done ± 15 minutes before the specified time to make sure the water temperature constant at 60°C. The testing conducted not more than ± 1 hour to prevent the water temperature to change significantly. Warm tea used as a controlled solvent and testing sample. Around 15–30 mL warm tea poured into testing cup sized 60 mL with code consist of random 3 digits number.

**Tetrad Test**

The sample for tetrad test of sweetener product consisted of 2 cups same control (serving is based on serving suggestion written on the packaging of sweetener product) and two cups of different sample as testing sample (control -3%). The determination of testing sample (control-3%) same as triangle test, based on upper control limit (UCL) and bottom control limit (BCL) ability of production process in the company with hypothesis ± 3% will not make the taste significantly different. Tetrad test consists of three testing set (sweetener A, B, and C), these samples are served one by one sequentially. This testing type has 6 probable combinations (AABB, ABAB, ABBA, BBAA, BABA, and BAAB).

Warm tea used for tetrad test was prepared in the same way as for triangle test (stated standard form company). As much as 15–30 mL warm tea poured in testing cup sized 60 mL as control and testing sample. Every plastic cup was given code consist of 3 random digits number.

**Third stage: data processing and analysis**

**Triangle and Tetrad Test**

Processing and analysis of triangle and tetrad test’s data were carried out with the comparison test concept named Signal Detection Theory and Thurstonian Models, with description as follows.

**Signal detection theory and Thurstonian models**

Signal Detection Theory (SDT) and Thurstonian Models (TM) are statistical model that studies human performance in systematically conducting sensory tests and provides a basic framework for use in sensory and consumer test methods. Thurstonian models is closely related to Signal detection theory originating from the field of communication. Signal detection theory uses a human's nervous system as a communication system and determines how well a person’s sensitivity at detecting signal and noise by considering the perceptual variations inherent in the sensory system and the effectiveness of the decision strategies used by that person when conducting the sensory test. Both of these models are used together in sensory science which provides an integrated framework for studying and understanding the mechanisms of sensory measurement [7].

The main important parameter in signal detecting theory is $d'$, this parameter shows signal’s strength (relative to noise), despite next parameter named Criterion (C) (it’s variant called as $\beta$) which reflects the response of panelist[8]. Noise can be sourced from inside (internal) and outside (external). According to [8], there are four probable of responses in the SDT described in table 2.
### Table 2. Four probable types of responses in SDT.

| Reality          | Yes          | No           |
|------------------|--------------|--------------|
| **signal present** | Hit Rate (HR) | Miss Rate (MR) |
| **signal absent** | False Alarm Rate (FAR) | Correct Rejection Rate (CRR) |

According to concept signal detection theory (SDT), both of the testing methods are compared to $d'$ value states the distance between the peak of noise distribution and the peak of signal-noise distribution, explained by [9] and can be seen in figure 1.

![Signal detection theory representation](image)

**Figure 1. Signal detection theory representation.**

Thurstonian Models are used to determine the estimation of effect size ($d'$) value and variance of $d'$ value. According to Garcia et al (2013), estimation of effect size ($\delta$) is a ratio that exists between signals or can also be called the intensity of sample differences that are felt and symbolized by $d'$. SDT and TM applications are used to compare the two methods directly and make it possible to develop strategies about what differences will be considered by consumers (Hout 2014).

Some parameters are calculated to compare triangle tests and tetrad tests, namely:

a. $P_c$ [10]

The proportion of correct ($P_c$) is the number of proportions out of the correct answers from each test conducted and calculated using the following equation:

$$P_c = \frac{N_{\text{correct}}}{N_{\text{total}}}$$

$N$: the number of answer

The smaller $P_c$ value indicates that the panelists have difficulty while doing triangle and tetrad test. If the $P_c$ value of the tetrad test is bigger than $P_c$ value of triangle test shows that opportunity for the panelist to answer right with tetrad test is higher than triangle test.

b. $d'[^{10}]$

The value of $d'$ is sample’s difference which can be perceived, this value can not be calculated when the $P_c \leq 0.33$. The $d'$ value is obtained from sensehub, web based application for sensory data processing (www.htt://sensolutionid) by choosing discrimination test processing and filling number of correct responses and total trial or panelists. The smaller $d'$ 'values indicate the harder for two samples to be distinguished, as well as the greater the value of $d'$ means two samples are easier to be distinguished.
The d'value will decrease the other values, such as Bvalue, variance of d' value, Zvalue, Pvalue, and perceptual noise. d' value of tetrad is lower than d'value of triangle test showing that tetrad test has the ability to distinguish two samples more difficult compared to triangle test.

c. Variance d' [11]; [12]
Variance d' value is a distance between panelist’s answer related to d’ value. After that, determine the value of Bvalue seen in the Bvalue table on [11] for the triangle test and [12] for the tetrad test's Bvalue. The value is obtained by knowing the value of d’, then matching the value of d' in the Bvalue table (see the number on the far left and top). The number as intersection of the leftmost column and the uppermost row for d' value is Bvalue. Calculating variance d' value uses the following equation:

\[ \text{Variance } d' = \frac{B}{N} \]

Where:
B: B value
N: The number of all panelist
The smaller the variance d’ value of tetrad test compared to triangle test shows that tetrad test is better than triangle test and appropriate to replace triangle test [11]; [12].

d. Pvalue [10]
P value is significance level of triangle and tetrad test based on number of correct response and number of total panelists. P value is stated to be significantly different if the value is < 0.05, whereas it is not significantly different if the value is > 0.05

e. Perceptual noise [10]
Determination of sensory evaluation's effectivity using perceptual noise value, internal noise indicating the difficulty level of panelists at detecting the difference between samples. The equation to calculate perceptual noise between methods is as follow:

\[ \text{Perceptual noise} = \frac{d'\text{triangle} - d'\text{tetrad}}{d'\text{tetrad}} \times 100\% \]

The value of perceptual noise shows the difficulty level of panelists at detecting the difference between samples, for a new method in this case tetrad test will be better if perceptual noise value is less than 50%. It means the potential of tetrad test to replace triangle test is good because this method will not lead panelists to be fatigue while doing the test. The smaller the value means tetrad test is better to replace the triangle test with the chance of noise getting smaller impacting to an accurate and valid result

f. Test Power [13]
Calculating the test power of triangle and tetrad test needed to determine those method’s strength. According to [13] the value of test power is depended on d’ and variance d’ value. The calculation of test power conducted with Microsoft Excel with formula as follow:

\[ \text{Power} = 1 - \text{NORMDIST}((-\text{NORMSINV} (0.05/2)),(d'/\text{SQRT} (2*\text{variance } d'))),1.1)+\text{NORMDIST}(\text{NORMSINV}(0.05/2)), (d'/\text{SQRT} (2* \text{variance } d'))),1.1) \]

3. Result and discussion

3.1. Panelist’s profile
Panelists for triangle and tetrad test were chosen from questionnaire distribution in Jabodetabek area. This questionnaire has been filled by 541 prospective panelists, consists of respectively 420 and 121 prospective panelists who filled online and offline questionnaire. As much as 441 participants were not
qualified, because they were not met the required standard such as age range and were not the company’s consumer target. The panelists who were qualified are 100 persons with 34 panelists among them are non-diabetic panelists without diabetic offspring, 35 panelists are non-diabetic with diabetic offspring, and 31 panelists are person with diabetes. The age of panelists ranging from 20–65 years old, the majority of them were 20–30 years old (44%), while the origin area of them was Jabodetabek with the majority of them coming from Bogor (73%). The data of panelists who are non-diabetic offspring mostly taken around the campus, data of panelists who have diabetic offspring are taken from all around Jabodetabek area, while data of panelist who are diabetic patients as well were taken from several hospitals in Bogor, West Java.

3.2. Triangle and tetrat test

### 3.2.1. Theoretical calculation.
Triangle test is one of the most well-known difference test used by many food industries. But nowadays, tetrad test is introduced as a new method to know the difference between samples as it advantages such as more powerful and sensitive compared to triangle test. Tetrad test is difference test aiming to replace triangle test because it is more effective in term of testing and more powerful in term of statistical calculation. Therefore, tetrad test has to be tested first to know it’s effectivity in term of replacing triangle test on various products, several conditions to be considered, so that tetrad test can replace triangle test according to [14] are as follow:

1. $P_c$ of tetrad test > $P_c$ of triangle test
2. $d'$ value of tetrad test < $d'$ value of triangle test
3. $P$ value < 0.05
4. Perceptual noise < 50%

**Table 3.** The calculated parameters based on signal detection theory and Thurstonian models.

| Sample                  | sweetener A | sweetener B | sweetener C |
|-------------------------|-------------|-------------|-------------|
|                         | triangle    | Tetrad      | triangle    | Tetrad      | triangle    | Tetrad      |
| **Pc**                  |             |             |             |             |             |             |
| Group 1                 | 0.485       | 0.632       | 0.485       | 0.471       | 0.471       | 0.647       |
| Group 2                 | 0.429       | 0.443       | 0.443       | 0.414       | 0.443       | 0.543       |
| Group 3                 | 0.387       | 0.452       | 0.355       | 0.484       | 0.468       | 0.532       |
| ALL                     | 0.4337      | 0.509       | 0.428       | 0.456       | 0.460       | 0.5741      |
| **$d'$**                |             |             |             |             |             |             |
| Group 1                 | 1.388       | 1.471       | 1.399       | 0.915       | 1.309       | 1.521       |
| Group 2                 | 1.066       | 0.807       | 1.152       | 0.685       | 1.152       | 1.171       |
| Group 3                 | 0.785       | 0.842       | 0.488       | 0.964       | 1.293       | 1.135       |
| ALL                     | 1.080       | 1.040       | 1.013       | 0.855       | 1.251       | 1.276       |
| **Var $d'$**            |             |             |             |             |             |             |
| Group 1                 | 0.105       | 0.039       | 0.105       | 0.052       | 0.110       | 0.039       |
| Group 2                 | 0.132       | 0.058       | 0.121       | 0.071       | 0.121       | 0.041       |
| Group 3                 | 0.226       | 0.062       | 0.497       | 0.054       | 0.122       | 0.047       |
| **Perceptual noise**    |             |             |             |             |             |             |
| Group 1                 | 5.635       | 52.974      | 13.945      |             |             |             |
| Group 2                 | 32.092      | 68.030      | 1.643       |             |             |             |
| Group 3                 | 6.815       | 49.404      | 13.918      |             |             |             |

Note: Group 1: non-diabetic without diabetic offspring, Group 2: non-diabetic with diabetic offspring, and Group 3: diabetic patient

The value of theoretical calculation between triangle test and tetrad test with non-diabetic panellists without diabetic offspring, non-diabetic with diabetic offspring, and panellists with diabetes is detailed in table 3.
Calculation of triangle test results and tetrad test is done with the concept of Signal Detection Theory and Thurstonian Models which determine the comparison between two tests with the results of the decision whether or not the new method (tetrad test) replaces the existing method (triangle test). Signal
Detection Theory involves the main parameters $d'$ and C (criterion), while Thurstonian Models has a parameter $d'$. Signal Detection Theory states the size of the differentiation between stimulus or signal given with noise that can interfere with the stimulus. $d'$ value indicates the strength of the signal, while C (criterion) is the response given by the panelist in the test.

Signal Detection theory has 4 probable responses which are hit rate (HR) ("yes" response given to the old stimulus is the correct response), miss rate (MR) (true rejection without answer to old stimulus), false alarm rate (FAR) (responding to the new stimulus), and correct rejected (CRR) (there is no response to new stimulus). The responses expected from panelists are HR and CRR as it proves if there is no interference (noise), so the resulting data is accurate and valid [8]. Parameters for determining whether tetrad test can replace the triangle test or not consist of:

1. **Pc**
   The correct proportion states the number of opportunities for correct answers per number of panellists overall. The smaller Pc value indicates that the panellists have difficulty at conducting triangle test and tetrad test, the number of correct answer by panelist is very different compared to the number of overall panelists who conducted the test [11]. Tetrad test for sweetener A and C shows that the proportion of correct answer is greater than triangle test for the same samples. This states that the application of the tetrad test on sweetener A and sweetener C is better than the triangle test for the three groups of panellists based on medical history. Tetrad test for sweetener B has a proportion value of correct answer smaller than triangle test in non-diabetic panellists without diabetic offspring and non-diabetic with diabetic offspring. As a conclusion, for sweetener B triangle test is better to be conducted compared with tetrad test because the probability to answer correctly with this test is bigger than tetrad test.

2. **d'** and variance $d'$
   The value of $d'$ states how much two samples can be distinguished, the smaller $d'$ value indicates that two samples are difficult to be distinguished, as well as the greater $d'$ value means two samples are easier to be distinguished. The variance of $d'$ value shows the distance between panelist’s answer. The smaller the value of variance $d'$ means that the method is better and more appropriate to be applied on difference test [11]; [12]. The results of the study in table 3 show that $d'$ value of tetrad test for sweetener C is greater than $d'$value of triangle test, this means tetrad test is not effective to be conducted on sweetener C. Tetrad test can be applied on sweetener A using panelists non-diabetic with diabetic offspring and all types of panelist, as well as sweetener B using all types of panelists except panelist with diabetes. The variance $d'$ value of tetrad test for all sweetener samples (A, B, and C) tested by all types of panelists is smaller than variance $d'$ value of triangle test.

3. **Perceptual noise**
   Perceptual noise value indicate the degree of difficulty for panelist to detect difference between sample, for new method in this case tetrad test will be better if perceptual noise is less than 50%, it means tetrad test's potential to replace triangle test is bigger as it will not lead to panelists fatigue while test going on. The smaller perceptual noise value indicates that tetrad test is better in replacing the triangle test with the chance of noise getting smaller so that the test results are accurate and valid. Perceptual noise value of triangle and tetrad test for A and C sweetener tested by three types of panelist based on medical history is less than 50% showing that tetrad test are accepted to replace triangle test for A and C sweetener, but preferably not used for B sweetener due to its probability causing panelist fatigue while test is going on. Triangle and tetrad test of B sweetener has perceptual noise value more than 50% for non-diabetic panelists affecting data accuracy because of too many noises.

3.2.2. **Parameter compatibility to theory.** Parameters calculated and shown in table 3 have to be adjusted with theory to decide whether tetrad test can replace triangle test or not. The correspondence between
parameters and theory are detailed in table 4, so can be known panelist’s groups and sweetener sample that effective using tetrad test as the replacement of triangle test. The main parameter at deciding the properness of tetrad test to replace triangle test based on perceptual noise. Tetrad test can replace triangle test on a particular sample and supported by perceptual noise below 50%, showing tetrad test are appropriate to be used because it will not lead to panelists fatigue while doing the test.

Table 4. The suitability parameter to theory parameter.

| Sample   | Group | Pc tetrad > Pc triangle | d' tetrad < d' triangle | Perceptual noise | Decision |
|----------|-------|-------------------------|-------------------------|------------------|----------|
| Pemanis A| 1     | Yes                     | No                      | Yes              | Good     |
|          | 2     | Yes                     | Yes                     | Yes              | Excellence |
|          | 3     | Yes                     | No                      | Yes              | Good     |
|          | All   | Yes                     | Yes                     | Yes              | Excellence |
| Pemanis B| 1     | No                      | Yes                     | No               | Not Good |
|          | 2     | No                      | Yes                     | No               | Not Good |
|          | 3     | Yes                     | No                      | Yes              | Good     |
|          | All   | Yes                     | Yes                     | Yes              | Excellence |
| Pemanis C| 1     | Yes                     | No                      | Yes              | Good     |
|          | 2     | Yes                     | No                      | Yes              | Good     |
|          | 3     | Yes                     | No                      | Yes              | Good     |
|          | All   | Yes                     | No                      | Yes              | Good     |

Note: group 1: non-diabetic without diabetic offspring, group 2: non-diabetic with diabetic offspring, and group 3: diabetic patient

The research’s results show that sweetener A and C tested toward all panelist as well as sweetener B towards panelists with diabetes and combination of all panelists can be conducted with tetrad test to replace triangle test because Pvalue is greater than 0.05 and perceptual noise is less than 50%, so that the result is not significantly different and will not lead to panelist fatigue. Tetrad test cannot be conducted at sample sweetener B with non-diabetic panelists neither without diabetic offspring nor with diabetic offspring, because resulting significantly different data and can lead to panelist fatigue while doing the test.

3.2.3. Test power. Test power is a value indicating the strength of a particular testing method if its value is greater than 0.99 (>0.99) means the method is stronger than another testing method. Test power has an important parameter named d'value and variance d' for each test. Presentation of test power to support comparison result between triangle and tetrad test processed and analyzed by Signal Detection Theory and Thurstonian Models. The calculation of test power value for triangle and tetrad test are shown in table 5.
Table 5. Test power of triangle and tetrad tests.

| Sample   | Grup | Test power Triangle | Tetrad |
|----------|------|---------------------|--------|
| Sweetener A | 1 | 0.857 | 1.000 |
|  | 2 | 0.545 | 0.663 |
|  | 3 | 0.215 | 0.668 |
|  | All | 0.961 | 1.000 |
| Sweetener B | 1 | 0.857 | 0.813 |
|  | 2 | 0.647 | 0.445 |
|  | 3 | 0.078 | 0.837 |
|  | All | 0.943 | 0.993 |
| Sweetener C | 1 | 0.796 | 1.000 |
|  | 2 | 0.628 | 0.983 |
|  | 3 | 0.743 | 0.959 |
|  | All | 0.994 | 1.000 |

Note: group 1: non-diabetic without diabetic offspring, group 2: non-diabetic with diabetic offspring, and group 3: diabetic patient

Research result shows that the value of power varied, some of medical history group have power value above 0.99 for tetrad test, but there are some below than 0.99. A and C sweetener as a whole has a power value for tetrad test greater than the triangle test. Especially for tetrad test of A and C sweetener using panelist non-diabetic without diabetic offspring and combination of all panelists group who have a power value of 1.00, it means the test’s result is valid. Sweetener B only the combination of all panelists group who have a power value of tetrad test greater than triangle test.

Table 6. Decision table of triangle and tetrad test based perceptual noise and test power.

| Sample   | Group | Perceptual noise | Test power |
|----------|-------|------------------|------------|
| Pemanis A | 1  | Yes  | Yes  |
|  | 2  | Yes  | No   |
|  | 3  | Yes  | No   |
|  | All | Yes  | Yes  |
| Pemanis B | 1  | No   | No   |
|  | 2  | No   | No   |
|  | 3  | Yes  | No   |
|  | All | Yes  | Yes  |
| Pemanis C | 1  | Yes  | Yes  |
|  | 2  | Yes  | No   |
|  | 3  | Yes  | No   |
|  | all | Yes  | Yes  |

Note: group 1: non-diabetic without diabetic offspring, group 2: non-diabetic with diabetic offspring, and group 3: diabetic patient

Considering overall evaluation form tetrad and triangle test to decide whether tetrad test can replace triangle test or not. Decision result can be seen in table 6. Based on this table, the conclusion is tetrad test can replace triangle test on sweetener product A and C using non-diabetic panelists without diabetic offspring and combination of all panelists group, as well as sweetener B with combination of all panelist group, because having perceptual noise less than 50% (<50%), and is supported by power value that stated strength of tetrad test is more powerful.
4. Conclusions
Tetrad test cannot be generalized to replace triangle test in the different sample, due to its probability causing fatigue towards panelists and the data result is not powerful. Based on parameter Pvalue and perceptual noise, tetrad test can be applied to replace triangle test for sample sweetener A and C at all panelist's groups. Based on the value of test power, only sweetener A and C at non-diabetic panelist without diabetic offspring and combination of all panelist's groups, as well as sweetener B using a combination of all panelist's groups where tetrad test can be conducted to replace triangle test because it is more powerful. The decision of tetrad test’s effectivity to replace triangle test, with Pvalue and perceptual noise parameters there are more sample passed on three different medical history groups, so that test power parameter is used to determine tetrad test’s power at resulting more accurate and valid data of difference test.

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