World Journal of Advanced Engineering Technology and Sciences
eISSN: 2582-8266
Cross Ref DOI: 10.30574/wjaets
Journal homepage: https://wjaets.com/

(RESEARCH ARTICLE)

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Organoleptic evaluation of tomato (*Lycopersicum esculentum,* Mill.) sauce with the addition of kandis (*Garcinia cowa,* Roxb.) acid extract as an acidifier

Rina Yenrina [1,*], Cesar Welya Refdi [1], Dian Hafsari [2] and Jihan Rahma [2]

[1] *Lecturers at Faculty of Agricultural Technology, Andalas University, Limau Manis-Padang, Indonesia.*
[2] *Alumni of Food Technology and Agricultural Product, Andalas University, Limau Manis-Padang, Indonesia.*

World Journal of Advanced Engineering Technology and Sciences, 2024, 11(02), 212–219

Publication history: Received on 01 February 2024; revised on 11 March 2024; accepted on 14 March 2024

Article DOI: https://doi.org/10.30574/wjaets.2024.11.2.0094

Abstract

The research aimed to determine the effect of adding kandis extract as an acidifier to tomato puree and the best formulation based on organoleptic characteristics of tomato sauce. The research design used was a Completely Randomized Design (CRD) with 5 treatments and 3 replicates. In this research, kandis extract was added with treatments A (0%), B (3%), C (3.5%) D (4%), and E (4.5%) base on tomato puree weight. The results of each research parameter were analyzed statistically using Analysis of Variance (ANOVA) and if the effect was significantly different, it was continued with Duncan's New Multiple Range (DNMRT) analysis at the 5% level. The results showed that the addition of kandis had a significantly different effect on organoleptic taste and texture of tomato sauce. However, it did not have a significantly different effect on color, and aroma organoleptics. The best treatment for the addition of kandis extract based on organoleptic characteristics of tomato sauce is treatment D (addition of 4% kandis extract) with the criteria of organoleptic acceptance rate for color 4.00 (like), aroma 4.07 (like), texture 4.20 (like), and taste 4.43 (like).

Keywords: Tomato; Kandis; Tomato sauce; Organoleptic; Evaluation; Acidifier

1. Introduction

Tomato fruit is a horticultural commodity that is easily damaged (perishable), this damage is mainly caused by physiological, mechanical damage, and pest and disease disorders [1]. The potential reduction in quality of vegetables, including tomatoes, during post-harvest handling ranges from 30% to 50% [2]. Tomatoes are one of the seasonal crops that are produced in large quantities every year in Indonesia. Based on [3], total tomato production in Indonesia in 2020 reached 1.08 million tons and in 2021 will increase to reach 1.11 million tons.

With the high yield of tomatoes in Indonesia, efforts are needed to prevent damage to tomato fruit. One alternative is to process tomatoes into a processed product. The processed product from tomatoes that is widely commercialized and consumed by Indonesian people is tomato sauce.

Tomato sauce is a flavoring ingredient and enhances the taste of food, usually as an accompaniment to chicken noodles, meatballs, grilled sausages and various other foods. Tomato sauce is made by mixing tomato paste with food additives such as sugar, salt, spices, cornstarch, vinegar and sodium benzoate [4]. The addition of sugar, salt and spices mainly serves to flavor and improve the aroma of tomato sauce. Cornstarch functions as a thickener for tomato sauce. Viscosity is the most important physical characteristic of tomato sauce products, which determines the texture of tomato sauce [5]. The viscosity value of the sauce can be increased by increasing the dissolved solids, according to SNI 01-3546-2004, the amount of dissolved solids in tomato sauce is at least 30 ^{0} Brix.

* Corresponding author: Rina Yenrina; Email: yenrinarusdi@ae.unand.ac.id

Making tomato sauce, acidifying ingredients are added which are used to acidify or lower the pH. The pH limit for tomato sauce is 3.8 – 4.4 [6]. The ingredient that is often used as an acidifier in making sauces is vinegar. Vinegar acid (CH3COOH) is an organic compound that contains a carboxylic acid group, which is known as a sour taste and aroma in food [7]. Vinegar is produced through the fermentation stage, namely the alcoholic fermentation process accompanied by the acetic acid fermentation process [8]. In this research, the author wants to use an alternative substitute for vinegar with another acid in making tomato sauce, namely a natural acid source such as kandis acid. Kandis acid is made from the dried skin of kandis fruit (*Garcinia cowa Roxb*), belonging to the Garcinia genus of plants which are distributed in tropical areas of Asia. Kandis acid is usually used as a food flavoring by people because it tastes very sour when consumed directly. Kandis acid fruit contains the ethyl acetate fraction which contains phenolic compounds, flavonoids, alkaloids and saponins, and has a role as an antioxidant [9]. Dried kandis acid peel is reported to contain organic acids such as hydroxycitric acid, citric acid and oxalic acid [10]. Thus, the use of kandis acid has the potential to be used as an acidifier in making tomato sauce.

Based on this background, research was conducted with the title "Organoleptic Evaluation of Tomato(*Lycopersicum esculentum*, Mill*.)* Sauce with the Addition of Kandis (*Garcinia cowa* Roxb) Acid Extract as an Acidifier.

2. Material and method

2.1. Materials and Tools

The raw materials used in this research are vegetable tomatoes, round and oval in shape which are dark red in color and kandis acid which is brownish red in color. Ingredients were obtained from sellers at Pasar Raya Padang. Additional ingredients used are cornstarch, sugar, salt, garlic powder, cloves, pepper, cinnamon and water.

The tools used in this research were scales, stove, blender, stainless steel knife, Czech sieve, pan, stirrer, jar bottle, magnetic stirrer, and beaker. And for organoleptic evaluation carried out by 30 panelists.

2.2. Research Design

The design used in this research was a Completely Randomized Design (CRD) with 5 treatments and 3 replications. The observation results of each parameter were statistically analyzed using the F test and continued with Duncan's New Multiple Range Test (DNMRT) at a significance level of 5%. The treatment in this research is the level of addition of kandis acid extract to the amount of tomato puree used in making tomato sauce, which is as follows:

- A = Without adding kandis acid extract
- B = Addition of 3% kandis acid extract
- C = Addition of 3.5% kandis acid extract
- D = Addition of 4% kandis acid extract
- E = Addition of 4.5% kandis acid extract

2.3. Implementation of Research

2.3.1. Making Tomato Puree

Tomatoes that have been sorted, washed with running water to remove dirt attached to the tomatoes. Tomatoes that have been cleaned are then blanched at a temperature of ± 80 ℃ for 3 minutes or until the epidermis of the tomato is peeled off. The blanched tomatoes are crushed using a blender and then filtered using a Czech sieve to separate the seeds until tomato puree is obtained.

2.3.2. Making Kandis Acid Extract (Modification of [11])

The dried kandis acid fruit was sorted, then the kandis acid was weighed according to the treatment, namely 3 g, 3.5 g, 4 g, and 4.5 g. Then wash with running water to remove stuck dirt. Soaking is carried out using 100 ml of hot water at a temperature of 100℃. The aim of using hot water is to speed up the release of the extract from kandis acid. Soak for 30 minutes, then filter using a cloth filter to obtain a solution of kandis acid by separating the kandis acid extract from the dregs.

2.3.3. Making Tomato Sauce (Modification of [12])

Cook the tomato puree for ± 15 minutes over low heat at 60 ℃ - 70 ℃. Prepare additional materials that will be used. Make a spice extract by dissolving pepper, cloves, garlic and cinnamon in 50 ml of water and boiling for 5 minutes. Then strain the spice extract and take the juice. Mix the cooked tomato puree with cornstarch. Add sugar, salt and spice extracts then stir well and continue heating for ± 15 minutes until the desired consistency is formed. Add the kandis acid solution according to the treatment and stir well for 2 minutes then turn off the heat. Remove the tomato sauce and immediately package it in a sterile glass bottle and tightly close it. Perform sterilization by immersing the bottle filled with tomato sauce in boiling water for 30 minutes.

2.3.4. Tomato Sauce Formulation

Table 1 Formulation for making tomato sauce with the addition of Kandis acid extract as an acidifier

Material	**Treatment**				
	A	**B**	**C**	**D**	**E**
Tomato Puree (ml)	300	300	300	300	300
Kandis Acid Extract (ml)	0	10	10	10	10
Cornstarch (g)	3.6	3.6	3.6	3.6	3.6
Sugar (g)	37.5	37.5	37.5	37.5	37.5
Salt (g)	4.5	4.5	4.5	4.5	4.5
Garlic (g)	0.3	0.3	0.3	0.3	0.3
Cloves (g)	0.3	0.3	0.3	0.3	0.3
Cinnamon (g)	0.3	0.3	0.3	0.3	0.3
Pepper (g)	0.45	0.45	0.45	0.45	0.45

Source: [13]'s modified

3. Results and discussion

3.1. Analysis of Raw Materials

The analysis carried out on the raw materials in this research was tomato puree and kandis acid. The results of the analysis can be seen in Table 2 below:

Table 2 Raw Material Analysis Results

Analysis	**Tomato Puree ± SD**	**kandis acid ± SD**
Water content (%)	95.67 ± 1.90	-
pH value	4.62 ± 0.05	2.13 ± 0.02
Total Acid (%)	1.17 ± 0.10	11.53 ± 0.10

Note: (-) no test was carried out

Based on Table 2, the analysis of the raw material for tomato puree showed a pH value of 4.62, total acid of 1.17%, and water content of 95.67%. Meanwhile, for the kandis acid raw material, the pH value was 2.13 and the total acid was 11.53%.

The results of the analysis of the water content of the tomato puree raw material obtained in this study were 95.67%. The results obtained were not much different from the results of analysis by [14], which stated that the water content of tomato puree was 95.73%. In the analysis of the raw material for tomato puree, a pH value of 4.62 was obtained. The results of this study were not much different from the results of the analysis by [15], who obtained a pH value from tomatoes of 4.64. Meanwhile, the results of the analysis of the raw material for kandis acid obtained a pH value of 2.13.

Testing the total acid of tomato pulp raw materials obtained a value of 1.17%. The results of the total acid analysis obtained were much different from the results of research from [13], which obtained a total acid value from tomato pulp of 1.33%. This is because there may be differences in the varieties and levels of ripeness of tomatoes used in the literature and the materials used by the author for this research, so that the chemical composition of tomatoes is also different. Meanwhile, in testing the total acid from kandis acid, a value of 11.53% was obtained. The high total acid value in kandis acid is because the dried rind of kandis acid contains organic acids such as citric acid, oxalic acid, and hydroxycitric acid [10].

3.2. Organoleptic Evaluation

Organoleptic evaluation were carried out by 30 panelists to determine the panelists' level of acceptance of tomato sauce with the addition of kandis acid extract as an acidifier. The following are the results of tomato sauce products with the addition of kandis acid as an acidifier.

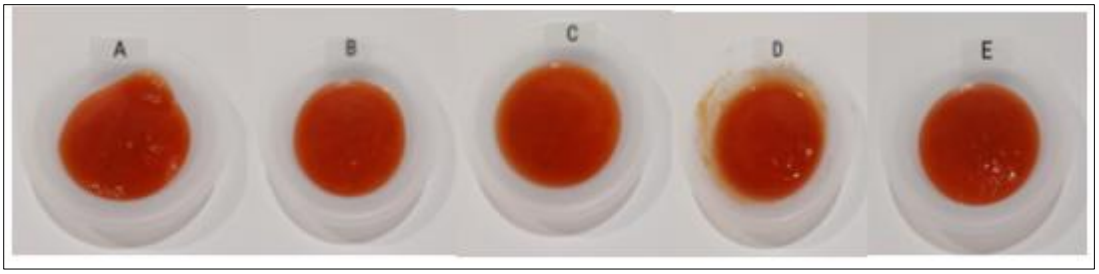

Figure 1 Tomato Sauce with the Addition of Kandis Acid

3.2.1. Color

Based on the results of variance testing, it shows that the addition of kandis acid extract as an acidifier has a non-significant different effect at the 5% level ($\alpha = 0.05$) on color. The results of the analysis of the color of tomato sauce can be seen in Table 3.

Table 3 Color analysis results of tomato sauce with the addition of Kandis acid extract as an acidifier

Treatment	Color (Average ± SD)
B (Candis acid 3%)	3.87 ± 0.57
E (Candis acid 4.5%)	3.93 ± 0.74
A (Kandis acid 0%)	3.97 ± 0.76
D (Candis acid 4%)	4.00 ± 0.83
C (Candis acid 3.5%)	4.10 ± 0.55
CV = 17.61%	

Note: Organoleptic scores range from 1 to 5, with 1 = dislike very much, 2 = dislike, 3 = normal, 4= like, and 5 = like very much.

The organoleptic evaluation results for the color of tomato sauce with the addition of kandis acid extract in this study ranged from 3.87 – 4.10. The highest level of panelist acceptance of the color of tomato sauce was in treatment C (addition of 3.5% kandis acid extract) with a value of 4.10, which means the color of tomato sauce was liked by the panelists. Meanwhile, the lowest level of panelist acceptance was in treatment B (addition of 3% kandis acid extract), namely 3.87, which was still in the liking value category.

The addition of kandis acid extract did not significantly affect the color of the tomato sauce. This is because the red color of the tomato sauce produced tends to be the same color in each treatment and does not show significant differences. The red color in this sauce comes from the carotenoids contained in tomatoes. According to [16], tomatoes contain carotenoid pigments, especially lycopene and β-carotene, which are the main components that determine the characteristics of ripe tomato fruit which gives them a dark red and orange color.

Color is one of the sensory factors used by humans in assessing a food product. Especially in the case of food, color has its own important place in consumer evaluation. The results of a study show that color for food is in second place in the assessment criteria, namely after food freshness [17], In the organoleptic test, the color of the tomato sauce produced had a value range that was still in the favorable category for each treatment.

3.2.2. Aroma

Based on analysis of variance, it shows that the addition of kandis acid extract as an acidifier has a non-significant different effect at the 5% level (α = 0.05) on the aroma. The results of the analysis of the aroma of tomato sauce can be seen in Table 4.

Table 4 Results of Aroma Analysis of Tomato Sauce with the Addition of Kandis Acid as an Acidifier

Treatment	Aroma (Average ± SD)
B (Candis acid 3%)	3.73 ± 0.69
E (Candis acid 4.5%)	3.80 ± 0.55
C (Candis acid 3.5%)	3.90 ± 0.61
A (Kandis acid 0%)	3.93 ± 0.78
D (Candis acid 4%)	4.07 ± 0.69
CV = 17.24%	

Note: Organoleptic scores range from 1 to 5, with 1 = dislike very much, 2 = dislike, 3 = normal, 4 = like, and 5 = like very much.

Table 4 shows that the organoleptic test results for the aroma of tomato sauce with the addition of kandis acid extract in this study ranged from 3.73 – 4.07. This shows that the aroma of tomato sauce with the addition of kandis acid can be accepted by the panelists at the normal to favorable level. The highest level of panelist acceptance was in treatment D (addition of 4% kandis acid extract) with a value of 4.07, while the lowest level of panelist acceptance was in treatment B (addition of 3% kandis acid extract) with a value of 3.73.

The addition of kandis acid extract to tomato sauce did not make a significant difference to the aroma of the resulting tomato sauce. The aroma of the tomato sauce produced in this study has a typical tomato aroma. The aroma of tomatoes comes from the volatile compounds contained in them. According to [18], the combination of volatile compounds found in tomatoes causes tomatoes to have a strong odor and distinctive aroma.

Based on the panelists' assessment of the organoleptic aroma of tomato sauce with the addition of kandis acid, it has a typical tomato aroma. Overall, tomato sauce with the addition of kandis acid was acceptable to the panelists in terms of aroma.

3.2.3. Texture

Table 5 Results of texture analysis of tomato sauce with the addition of Kandis acid extract as an acidifier

Treatment	Texture (Average ± SD)
A (Asam kandis 0%)	3.73 ± 0.64 a
B (Asam kandis 3%)	3.83 ± 0.75 ab
E (Asam kandis 4.5%)	3.97 ± 0.67 abc
C (Asam kandis 3.5%)	4.10 ± 0.61 bc
D (Asam kandis 4%)	4.20 ± 0.61 c
CV = 16.55%	

Note: Organoleptic scores range from 1 to 5, with 1 = dislike very much, 2 = dislike, 3 = normal, 4 = like, and 5 = like very much. The numbers in the columns followed by different lowercase letters are significantly different at the 5% Duncan's New Multiple Range Test (DNMRT) level.

Based on the variance results, it shows that the addition of kandis acid extract as an acidifier has a significantly different effect at the 5% level (α = 0.05) on the texture. The results of the analysis of the texture of tomato sauce can be seen in Table 5.

The results of the organoleptic texture test in Table 5 show that the tomato sauce with the addition of kandis acid extract in this study ranged between 3.73 – 4.20. The highest level of panelist acceptance was in treatment D (addition of 4% kandis acid extract) at 4.20. Meanwhile, the lowest level of panelist acceptance for texture was in treatment A (without the addition of kandis acid extract), namely 3.73.

The texture of a food ingredient is one of the important physical properties of food ingredients. This is related to the taste when chewing the food [19]. In this study, the texture assessment refers more to the thickness of the tomato sauce. Based on the panelists' assessment, the addition of kandis acid extract to tomato sauce had an influence on the texture of the resulting tomato sauce. Overall, the texture of the resulting tomato sauce was acceptable and liked by the panelists.

In this organoleptic evaluation, tomato sauce was served using a supporting ingredient, namely fried potatoes. Panelists can feel the texture by dipping French fries into the tomato sauce to feel the texture and taste when consumed. The resulting tomato sauce has a characteristic texture that is semi-solid or not too thick.

3.2.4. Flavor

Based on the results of variance analysis, it shows that the addition of kandis acid extract as an acidifier has a significantly different effect at the 5% level (α = 0.05) on the taste. The results of the analysis of the taste of tomato sauce can be seen in Table 6.

Table 6 Results of flavor analysis of tomato sauce with the addition of Kandis acid extract as an acidifier

Treatment	Flavor (Average ± SD)
A (Kandis acid 0%)	3.57 ± 0.63 a
B (Candis acid 3%)	3.80 ± 0.55 ab
E (Candis acid 4.5%)	3.93 ± 0.74 bc
C (Candis acid 3.5%)	4.23 ± 0.73 cd
D (Candis acid 4%)	4.43 ± 0.68 d
CV = 16.13%	

Note: Organoleptic scores range from 1 to 5, with 1 = dislike very much, 2 = dislike, 3 = normal, 4 = like, and 5 = like very much. The numbers in the columns followed by different lowercase letters are significantly different at the 5% level of Duncan's New Multiple Range Test (DNMRT).

Table 6 shows that the organoleptic evaluation results for the taste of tomato sauce with the addition of kandis acid extract in this study ranged from 3.57 – 4.43. The highest level of panelist acceptance was in treatment D (addition of 4% kandis acid extract) with a value of 4.43. Meanwhile, the lowest level of panelist acceptance was in treatment A (without the addition of kandis acid extract), namely 3.57.

The resulting tomato sauce has a typical tomato taste which is characterized by not being too sweet and sour. In this research, other ingredients were added to make tomato sauce, such as sugar which gives a sweet taste, salt which gives a savory or salty taste, and spices which improve the aroma and taste [4]. The addition of kandis acid to tomato sauce has an influence on the organoleptic taste evaluation. This is because kandis acid can give a sour taste to tomato sauce, but does not change the typical taste of tomatoes so that the organoleptic value of the taste can be accepted by the panelists.

Taste is an important factor in determining consumers' decisions to accept or reject a food. Taste is very difficult to fully understand because human tastes are so diverse. Even though other parameters have good values, if the taste is not good or is not liked then the product will be rejected [19]. Overall, tomato sauce with the addition of kandis acid was acceptable to the panelists in terms of taste. The taste of a food ingredient can come from the taste of the raw material and if it has received processing treatment, the taste can be influenced by the ingredients added during the processing process, for example spices or flavoring agents [18].

According to [20], the quality requirement for tomato sauce is that it has a normal taste typical of tomatoes. So, based on the panelists' assessment of the organoleptic taste of tomato sauce with the addition of kandis acid, it meets SNI requirements.

3.3. Recapitulation of Organoleptic Value

Recapitulation of organoleptic values is carried out using radar charts. The purpose of using this radar graph is to see and help identify differences in each panelist's acceptance of tomato sauce with the addition of the kandis acid extract produced. The organoleptic recapitulation results of all parameters can be seen in Figure 2 below.

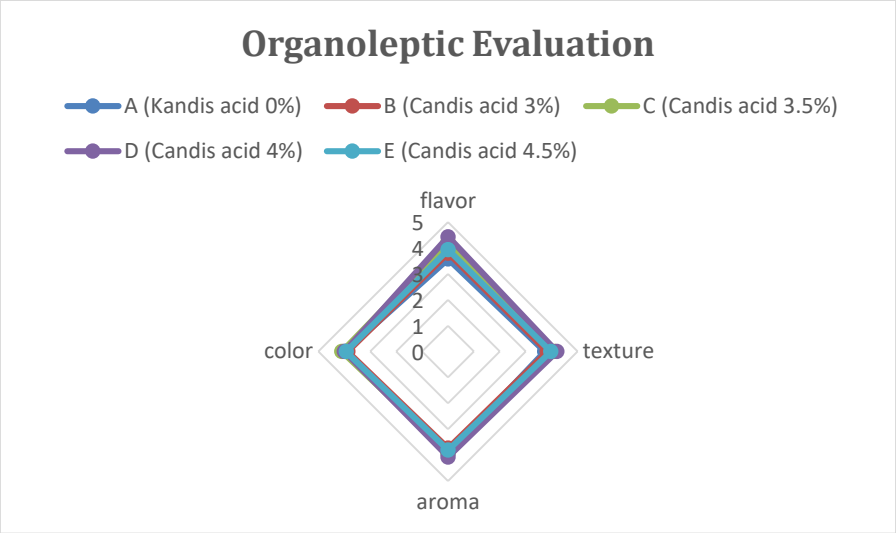

Figure 2 Organoleptic Recapitulation

Based on the results of the organoleptic recapitulation radar graph of tomato sauce with the addition of kandis acid extract as an acidifier, it shows that all treatments were categorized as favored by the panelists. The product with the most preferred average by the panelists based on the organoleptic radar was treatment D (addition of 4% kandis acid extract). With an average score of liking for color 4.00 (like), aroma 4.07 (like), texture 4.20 (like), and taste 4.43 (like).

4. Conclusion

Based on the results of the research that has been carried out, it can be concluded that the addition of kandis acid extract has a significantly different effect at the 5% level ($\alpha = 0.05$) on the organoleptic taste and organoleptic texture. However, there was no significant different effect on the color number and aroma and the level of addition of kandis acid extract as the best acidifier for the tomato sauce produced in treatment D (4% addition of kandis acid) with a color preference level of 4.00 (liked), aroma 4.07 (like), texture 4.20 (like), and taste 4.43 (like).

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

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