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DETERMINATION OF ETHANOL AND ACETIC ACID CONTENT IN LOCAL BRANDS OF APPLE VINEGAR: GAS CHROMATOGRAPHY TEST FOR HALAL REQUIREMENTS

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ABSTRACT

Apple vinegar is commonly made from fermented apple juice, which involves two consecutive stages of fermentation: alcoholic and acetic acid fermentation. Both *Saccharomyces cerevisiae* and *Acetobacter acetii* are involved in fermentation. Apple vinegar has various benefits, such as stabilizing blood pressure, treating rheumatism, and detoxifying toxins. Excessive consumption of this product may cause damage to the esophagus, low blood potassium levels or hypokalemia, diarrhoea, and ulcers due to the high acetic acid content. Moreover, the ethanol content also needs to be determined. It should be lower than 0,5% to fulfil the halal requirements for certification. The local brands of apple vinegar in Indonesia are generally produced by small-medium enterprises (SMEs), especially in Malang, Indonesia. Commercial brands of various apple vinegar, XCJO, YSW, THT, NTF, and BST, were sampled for their ethanol and acetic acid content in one method of analysis: gas chromatography, utilizing the high volatility properties of ethanol and acetic acid. The samples contain 17.73%, 11.45%, 6.43%, 2.67%, and 1.49% v/v of acetic acid, respectively, for XCJO, YSW, THT, NTF, and BST. At the same time, the ethanolic content is 0.11 and 0.02% v/v for XCJO and YSW, respectively, which are lower than the label value informed. Meanwhile, the rest of the brands' content is 4.00%, 2.39%, and 3.21% ethanol for THT, NTF, and BST, respectively. In addition, the acetic acid content of XCJO is high. A consumer should be aware of dilution before consuming the XCJO apple vinegar. It is unnecessary in the case of YSW, THT, NTF, and BST.

Keywords: Analysis, Fermentation, Halal, Small-medium enterprises

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INTRODUCTION

Indonesia is a country that is rich in natural resources such as fruits. Malang, a town in East Java Province, is one of the cities with abundant fruit products such as apples, oranges, avocados, and bananas. Many varieties of apples can be found in Malang, especially in Batu. Unfortunately, some varieties of Apple are not so popular with customers due to their size, flavour, and appearance. Hence, many apples are left unutilized. Therefore, some small-medium enterprises use it as raw materials for local apple vinegar, utilize non-qualified apples for new products, and benefit economically. Subsequently, many local apple vinegar brands in Indonesia originate from Malang, i.e., XCJO, YSW, NTF, and BST.

Apple vinegar is a drink derived from the fermentation of apple juice. Apple vinegar is believed to have many benefits in the everyday life of humans, including being a food preservative and flavour enhancer (Budak et al., 2014), as well as for human health (Zuccotti and Fabiano, 2011; Akanksha and

Sunita, 2017). The antibacterial effect of apple vinegar may help it function as a food preservative. It may help to regulate blood sugar levels (Akanksha and Sunita, 2017). It can control glucose levels in type-2 diabetes mellitus patients by delaying gastric emptying and carbohydrate absorption, reducing glycolysis in the liver, increasing glycogen in the skeletal muscle, and increasing insulin secretions (Zuccotti and Fabiano, 2011).

Moreover, it may maintain the skin's beauty (by using apple vinegar as an ingredient in cosmetics). Many traditional drinks in Indonesia add apple vinegar to their mixture of recipes. Apple vinegar is also a substitute for Orang Tua, a Kolesom drink in Jamu, a traditional drink in Indonesia.

The fermentation process of apple vinegar is simple. It may also be done at home individually. Principally, apple vinegar can be produced by fermentation and purification. The apple sap just added a starter of yeast. The yeast will convert the sugars into alcohol (ethanol), while adding *Acetobacter sp*. will change the alcohol into acetic acid. Therefore, the product is sour and contains ethanol because not all is converted into acetic acid. The *Acetobacter acetic*, a native bacteria of apple juices, fermented the sugar content of apple juice into vinegar (Isda et al., 2020). The final step is purification, producing a clean apple vinegar. The fermentation process will take 5-6 months (de Gorie, 2009, Wartini et al., 2015). However, an antiseptic process is mandatory to obtain high-quality apple vinegar.

Apple vinegar quality is determined by the content of both acetic acid and ethanol. The ethanol content in apple vinegar is the most important due to the halal certification of this product (Jamaludin et al., 2016). An ethanol content of more than 0.5% is not allowed to be halal certified (Fatwa MUI No. 10, 2018), and it may cause an intoxicating effect (Riaz and Chanudry, 2003). Hence, determining both ingredients is vital in terms of quality and halal. In addition, the acetic acid content in apple vinegar also needs to be mentioned on the label. Due to the acetic acid content, apple vinegar has a pH = 2-3; a pH level that is too low will not be suitable for human health. Low pH levels will irritate the stomach. Therefore, performing a simple and rapid ethanol and acetic acid analysis using one method is essential. It may be achieved by gas chromatography. Gas chromatography (GC) is preferable to apply due to its retention time consistency of each peak, ease of handling, and fastness.

A simple method for analyzing ethanol and acetic acid in apple vinegar samples is developed. It establishes a simple method for rapid ethanol and acetic acid analysis in apple vinegar samples that eases a customer and the regulation body, i.e., the National Agency of Drug and Food Control of Indonesia (BPOM), to determine the ethanolic and acetic acid content in the vinegar-based on government regulations.

METHODOLOGY

Commercial local brands of apple vinegar were bought at e-commerce. They were NTF, BST, and THT. All the brands are produced in Malang, except THT from Pasuruan. In comparison, the import brand of XCJO and YSW are used. The XCJO and YSW are bought in the local market in the Rungkut area, Surabaya, Indonesia but they also available in other supermarket in Surabaya. The brands' names are chosen due to their popularity. Two bottles with different batch numbers of productions are bought for each brand. Ethanol and acetic acid glacial in high purity for standard grade are from Merck (Darmstadt, Germany). Meanwhile, ethanol absolute (99.99%) and acetic acid glacial (100%) are commercially purchased from Merck (Darmstadt, Germany). Moreover, glass lab apparatus such as beaker glass, pipette volume, volumetric flask, magnetic stirrer, and micropipettes were also used.

Gas Chromatography Analysis. A gas chromatography mass-spectrometer (GC-MS-QP 2010 SE) with a 50 m RTX-5MS column was used with an AOC-20i auto-injector. The GC uses Helium gas as a gas carrier at a constant flow rate of 0.5 mL/min. It was programmed at 250 °C for the inlet temperature and 60 °C for the initial oven temperature. The oven temperature increases at a rate of 5 °C /min and increases until 200 °C.

Calibration curve preparations. Both ethanol absolute (99.99%) and acetic acid glacial (100%) from Merck (Darmstadt, Germany) were used for working standard reference.

The standard ethanol (EtOH) solution (99.99%) is pipette at 10.0, 20.0, 30.0, 40.0, and 50.0 μL and diluted into 100.0 mL in the volumetric flask. The standard ethanols were injected at first. Afterward, acetic acid (HOAc) glacial was added into the Ethanol standard solution, i.e., 6.0, 7.0, 8.0, 9.0, and 10.0 mL, successively in a row. Finally, the standard mixture containing both EtOH and HOAc was obtained. For the dilution, an aquabidistillate was applied as a solvent. The diluted standard solutions were

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filtrated with a syringe using the No. 41 Whatman filter membrane. The final filtrate was then ready and injected into the GC column.

Sample Preparations. Each sample of apple vinegar was transferred into a beaker glass, approx. 50.0 mL; then pipette 6.0 mL, diluted into 10.0 mL in a volumetric flask, and shaken homogeneously. An aquabidistillate was used to dilute the apple vinegar. Like the standard solution, the diluted sample was filtrated with a syringe using the No. 41 Whatman filter membrane. The final filtrate was then ready and injected into the GC column.

RESULTS AND DISCUSSION

Establishing The Analysis Condition of Gas Chromatography

Firstly, a series of the standard solution of ethanol (EtOH) absolute, ca. 0.01, 0.02, 0.03, 0.04, and 0.05%-v/v, were injected into the GC column. Afterwards, a standard EtOH and Acetic acid (HOAc) mixture was injected. The obtained chromatograms are shown in **Figure 1**, while their retention time and area are shown in **Table 1.** Fulfilling the requirement of good analysis conditions of gas chromatography for both EtOH and HOAc in samples of apple vinegar, a calibration curve of both Ethanol and Acetic acid was constructed and analyzed based on data in **Table 1 (Figure 2)**, as well as the selectivity **(Table 2)**, limit of detection (LOD), limit of quantification (LOQ).

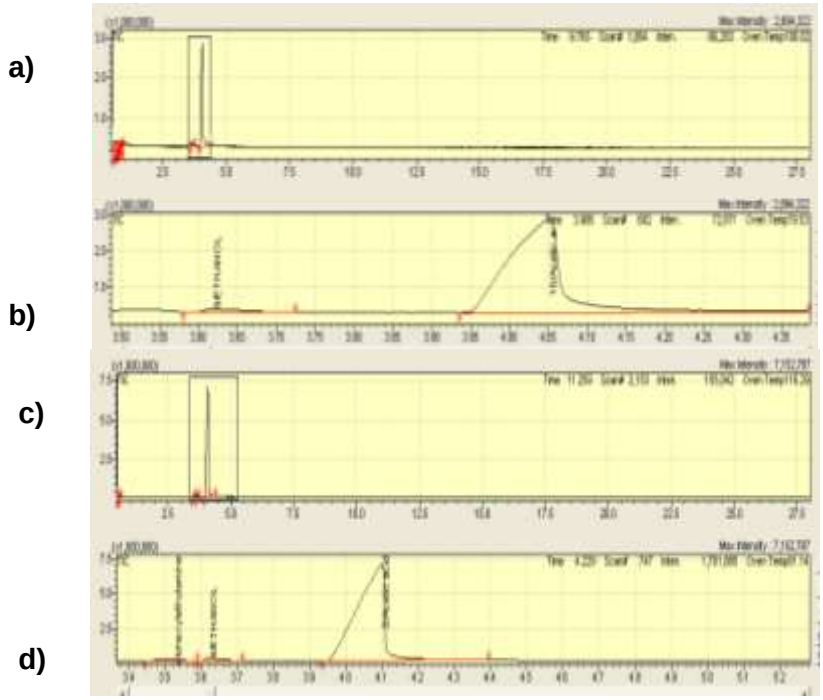

Figure 1. Chromatogram of standard solution a) Ethanol at 0.0099%-v/v, b) Ethanol at 0.0099%-v/v and HOAc at 6.0%-v/v, c) Ethanol at 0.0495%-v/v, b) Ethanol at 0.0495%-v/v and HOAc at 10.0%-v/v.

Table 1. Retention Time and area for the Ethanol absolute and Acetic Acid glacial standard.

Concentration (%-v/v)	Retention time (Rt, min)	Area
Standard Ethanol		
0.0099	3.625	198,936
0.0198	3.621	321,989
0.0297	3.620	388,002
0.0396	3.621	520,276

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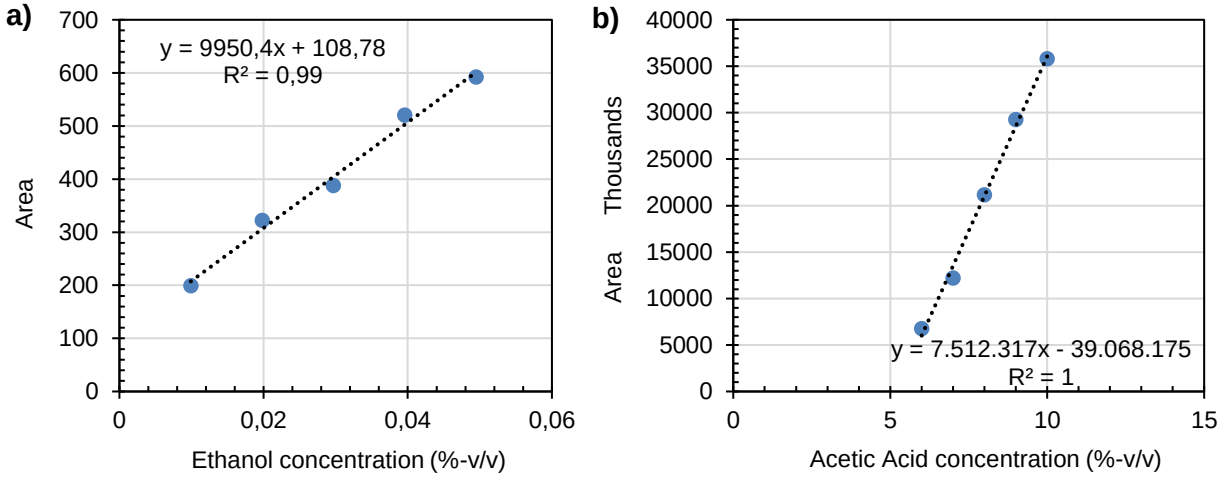
0.0495	3.622	592,337
Eacetic Acid glacial		
6.0	4.044	6,747,187
7.0	4.050	12,215,981
8.0	4.077	21,145,238
9.0	4.088	29,253,283
10.0	4.099	35,790,122

Ethanol and acetic acid calibration curves are generated (Figure 2) by analyzing the data (Table 1). The curve fits the requirement for linearity with a correlation coefficient (r-value) of 0.99 and 1.00, respectively, for the Ethanol and Acetic acid standards. The correlation coefficients fulfil both the United Nations Office on Drugs and Crime (UNODC) and the Indonesian Pharmacopoeia (4th Ed.) requirements, $r^2 \geq 0.98$.



the selectivity between them is necessary to evaluate.

Selectivity (specificity) is determined based on the resolution value, calculated based on ethanol and acetic acid retention time following equation (1). It is defined as an analytical method's ability to accurately and precisely measure an analyte in the presence of other components in the sample matrix.

$$R = \frac{2(R_{t,b} - R_{t,a})}{w_a + w_b} \quad (1)$$

Wherein $R_{t,a}$ and $R_{t,b}$ are the retention time of ethanol and acetic acid peak, respectively. At the same time, w_a and w_b are the peak width of the ethanol and acetic acid peaks at baseline, respectively.

Table 2. Selectivity of the separation of Ethanol and Acetic acid

Concentration (%-v/v)		$R = \frac{2(tRb - tRa)}{wa + wb}$	Resolution
Ethanol	**Acetic acid**		
0.0099	6.00	$R = \frac{2(4,044 - 3,625)}{0,14 + 0,08}$	3.8090
0.0198	7.00	$R = \frac{2(4,050 - 3,621)}{0,21 + 0,056}$	3.2256
0.0297	8.00	$R = \frac{2(4,077 - 3,620)}{0,25 + 0,1}$	2.6114
0.0396	9.00	$R = \frac{2(4,088 - 3,621)}{0,24 + 0,08}$	2.9188
0.0495	10.00	$R = \frac{2(4,099 - 3,622)}{0,26 + 0,08}$	2.8059

Following equation (1), the selectivity for ethanol and acetic acid separation is informed in **Table 2.** Ideally, a good separation between two peaks is expressed by a resolution value ≥ 1.5 (Meri Susanti and Dachriyanus, 2017). Hence, the developed method meets the selectivity requirements for separating ethanol and acetic acid in the apple vinegar sample matrix.

Moreover, the LOD and LOQ are analyzed further. The LOD (Limit Of Detection) value is the *minor* level for the device to detect is 0.005%, and for LOQ (Limit Of Quantification), the *minor* level for the device to detect quantitatively (with good precision and accuracy) is 0.018%.

Table 3. Data for calculating the LOD and LOQ of Ethanol

No.	Ethanol concentration (%-v/v) (x)	Area (y)	$\hat{y}$	$(y - \hat{y})$	$(y - \hat{y})^2$
1.	0.0099	198.936	207,290.2	-8,354.2	69,792,657.64
2.	0.0198	321.989	305,799.1	16,189.9	262,112,862.01
3.	0.0297	388.002	404,308.0	-16,306.0	265,885,636.00
4.	0.0396	520.276	502,816.9	17,456,1	304,820,172.81
5.	0.0495	592.337	601,325.8	-8,988.8	80,798,525.44
	$\bar{x}$ = 0.0297				Σ = 983,409,853.90

$$S_{y/x} = \sqrt{\frac{\Sigma(y-\hat{y})^2}{n-2}} = 18{,}105.34 \quad (2)$$

$$\textit{Limit Of Detection (LOD)} = \frac{3Sy/x}{b} = \frac{3(18.105{,}34)}{9{,}950.4} = 0.005\%\ v/v \quad (3)$$

$$\textit{Limit Of Quantification (LOQ)} = \frac{10Sy/x}{b} = \frac{10(18{,}105.34)}{9{,}950.4} = 0.018\%\ v/v \quad (4)$$

Table 4. Data for calculating the LOD and LOQ of Acetic Acid

No.	Acetic Acid concentration (%-v/v) (x)	Area (y)	$\hat{y}$	$(y - \hat{y})$	$(y - \hat{y})^2$
1.	6.00	6,747,187	6,005,727,8	741,459.2	549,761,745,265
2.	7.00	12,215,981	13,518,045.0	-1,302,064.0	1,695,370,660,096
3.	8.00	21,145,238	21,030,362.2	114,875.8	13,196,449,426
4.	9.00	29,253,283	28,542,679.4	710,603.6	504,957,476,333
5.	10.00	35,790,122	36,054,996.6	-264,874.6	70,158,553,725
	$\bar{x}$ = 8.00				Σ = 2,833,444,884,844

$$S_{y/x} = \sqrt{\frac{\Sigma(Y-Yi)^2}{n-2}} = 971{,}844{,}45$$

$$\textit{Limit Of Detection (LOD)} = \frac{3\frac{Sy}{x}+2\,|a|}{b} \quad (5)$$

$$\textit{Limit Of Quantification (LOQ)} = \frac{10\frac{Sy}{x}+2\,|a|}{b} \quad (6)$$

Equation (5) is used to calculate the LOD of acetic acid instead of equation (3) as well for LOQ calculation due to the intercept of calibration of acetic acid has a negative value (Fig. 2B). Hence, the LOD for acetic acid analysis is 10.79% v/v. In comparison, its LOQ is 11.70% v/v.

Apple Vinegar Analysis

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Subsequently, the developed GC method analysis is applied to the apple vinegar samples such as XCJO, YSW, THT, NTF, and BST to analyze the ethanol and acetic acid content—the results data displayed in **Tables 5** and **6** for Ethanol and Acetic acid data.

Table 5. Data Analysis for Ethanol Content at XCJO and YSW samples

Samples	Replication	Retention time (min)	Area	Ethanol content (% v/v)
XCJO-bottle1	1	3.621	324,620	0.09%
	2	3.624	392,124	0.12%
	3	3.622	324,853	0.09%
XCJO-bottle2	1	3.627	377,181	0.11%
	2	3.628	352,748	0.10%
	3	3.620	408,062	0.13%
			Average of XCJO	$\bar{x}$ = 0.11%
YSW-bottle1	1	3.622	200,414	0.01%
	2	3.628	208,871	0.02%
	3	3.622	218,164	0.02%
YSW-bottle2	1	3.621	205,308	0.02%
	2	3.621	211,715	0.02%
	3	3.622	270,221	0.03%
			Average of YSW	$\bar{x}$ = 0.02%

Table 6. Data Analysis for Acetic acid Content at XCJO and YSW samples

Samples	Replication	Retention time (min)	Area	Acetic Acid content (% v/v)
XCJO-bottle1	1	4.050	9,114,912	17.82%
	2	4.053	9,192,028	17.84%
	3	4.049	6,770,132	16.95%
XCJO-bottle2	1	4.033	8,338,159	17.53%
	2	4.054	9,775,201	18.06%
	3	4.056	10,053,438	18.16%
			Average of XCJO	$\bar{x}$ = 17.73%
YSW-bottle1	1	4.058	13,268,879	11.61%
	2	4.066	11,582,551	11.24%
	3	4.057	12,566,925	11.46%
YSW-bottle2	1	4.063	12,609,043	11.47%
	2	4.065	12,765,836	11.49%
	3	4.055	12,390,346	11.42%
			Average of YSW	$\bar{x}$ = 11.45%

Furthermore, THT, NTF, and BST samples were also analyzed using a similar method and protocol as in Tables 5 and 6. The complete result for apple vinegar samples is in Table 7.

The samples contain 17.73%, 11.45%, 6.43%, 2.67%, and 1.49% v/v of acetic acid, respectively, for XCJO, YSW, THT, NTF, and BST. The acetic acid content of all brands of apple vinegar is consistent with BPOM Regulation No. 34 of 2019 about food categories; vinegar or cider apple content of acetic acid is not less than 4 g/100 mL.

At the same time, the ethanolic content is 0.11 and 0.02% v/v for XCJO and YSW are low. Meanwhile, the rest of the brands are 4.00%, 2.39%, and 3.21% v/v of ethanol for THT, NTF, and BST, respectively. The ethanol content of XCJO and YSW are low, below 0.5%, while others are higher >0.5%. Though THT, NTF, and BST contain more than >0.5% ethanol, all are halal due to the Fatwa MUI Number 10 of 2018.

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Table 7. Ethanol and Acetic acid in the various samples of apple vinegar

Samples	content (% v/v)	
	Ethanol	Acetic Acid
XCJO	0.11±0.015	17.73±0.439
YSW	0.02±0.004	11.45±0.121
THT	4.00±0.08	6.43±0.058
NTF	2.39±0.09	2.67±0.000
BST	3.21±0.07	1.49±0.000

Apple vinegar specification, or apple cider, varies from country to country. In Indonesia, as regulated in BPOM Regulation No 34 of 2019, about food categories, apple vinegar contains acetic acid not less than 4 g/100 mL. This requirement is also the same as SNI 01-4371-1996: vinegar should contain a minimum of 4 % w/w of acetic acid. While SNI 01-3711-1995 only explains tabel and kitchen vinegar. Table and kitchen vinegar, covered in the SNI 01-3711-1995, is a liquid product obtained by diluting acetic acid glacial (for food and pharmaceutical use) with drinking water. According to the acetic acid content, the vinegar is grouped into table and kitchen vinegar. When the concentration of acetic acid is between 4-12.5% v/v and higher, it is classified as table vinegar. Meanwhile, in the range >12.5%, it is classified as kitchen vinegar (SNI 01-3711-1995).

The ethanolic content in food and beverages is explicitly regulated with Fatwa MUI No. 10 of 2018 concerning food and beverage products containing alcohol/ethanol. Only ethanol derived from khamr cannot be used for halal products because it is haram. If it does not come from the Khamr industry, other types of ethanol may be used with the restrictions set out in the Fatwa, such as synthetic ethanol or non-khamr fermentation industrial products.

Fatwa MUI No. 10 of 2018 states, “All Muslim scholars agree that vinegar derived from naturally occurring khamr is holy and halal.” This statement is also analogous to Hadis Muslim, “The best side dish is vinegar; The best side dish is vinegar" (HR. Muslim, number 3824). Therefore, it is stated in Fatwa MUI No. 10 of 2018 that vinegar that comes from khamr, whether it occurs by itself or through engineering, is holy and halal because there is a fermentation process which changes the original nature of fruit juices into vinegar and is accompanied by the release of the original characteristics of the end products, acetic acid. In vinegar production, such as apple vinegar, ethanol is the intermediate product, which is later converted into acetic acid in the second fermentation stage, acetification (Fig. 1). The ethanol and acetic acid concentrations in apple vinegar vary due to the different types of apples used as raw materials (Alsaleem et al., 2022). Jamaludin et al. (2016) indicate that ethanol and acetic acid content, which are formed during fermentations, highly depend on the initial sugar content of the fruit juices as raw materials. Therefore, the sugar content, such as glucose, sucrose, and fructose, in the raw materials must be known.

At the same time, ethanol content in fruit juices should be less than 0.5% v/v, as emphasized in Fatwa MUI No. 10 of 2018. Jamaludin et al. (2016) examined that the ethanolic content in fruit juices is increased during 30 °C storage 5-day fermentation into 6.53, 7.42, and 6.79%, respectively, for apple, grape, and orange juices. However, the initial ethanol content in the fresh juices is only 0.13, 0.49, and 0,70% v/v (Jamaludin et al., 2016). Storing the fresh pineapple juice at a lower temperature, 4 °C, for ten days can delay the increase of the ethanolic content. It only rose from 0.48 to 1% v/v (Gunduz et al., 2013).

Those facts are closely related to an explanation from LPPOM MUI in the Joint Fatwa Commission and LPPOM Team meeting, as stated in Fatwa MUI No. 10 of 2018. When stored in a closed container at 29 °C for three days, fruit juices will have 0.76, 0.32, and 0.33% ethanol content, respectively, for grape, apple, and date palm juices (Fatwa MUI No. 10 of 2018). Therefore, from the referred research data, the Fatwa Commission concluded that the average alcohol/ethanol content in squeezed fruit juice for three days was 0.5%. In addition, Alsaleem et al. (2022) reported that when preservative fruit juice is stored at 4 °C in a dark room, there is no significant increase in the ethanol content. Apple juice contained a low ethanol content with a 0.006 to 0.0058% v/v within a 28-day storage interval. A freshly opened mix of grape and berry juice reported has the highest ethanol content, ca. 0.075 to 0.069% v/v within a 28-day interval. None of them contain ethanol higher than 0.5% v/v.

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Preservative addition, storage in low temperatures, and dark conditions may suppress the increase of ethanol in fruit juices (Alsaleem et al., 2022).

In other countries, the ethanol content in cider is regulated since the ethanolic drink, i.e., wine, is commonly produced from fermented fruit juices. Usually, the alcohol content in cider, the intermediate product of apple vinegar, is between 2.0-8.5% v/v. Spain is between 4.0-8.0%, at least 15% in apple juice in Sweden, and 0.15% in the US (Jamaludin et al., 2016). These differences should be known to Muslim customers in different countries while consuming the vinegar.

Possibility of Halal Certification of Apple Vinegar Products via Owner Statement Scheme

It is not the same as wine production; apple vinegar production is processed in two stages instead of one fermentation step (Fig. 1). Sugar fermentation is first followed by acetic acid fermentation. The first stage is also known as alcoholic fermentation. While the second is acetic acid fermentation. Fermented sugars into alcohol, i.e., ethanol, with cider as the product, need an anaerobic process, and the second is Acetic acid fermentation. It is an aerobic process converting ethanol into acetic acid. The apple vinegar or cider apple is produced at the end of the second stage.

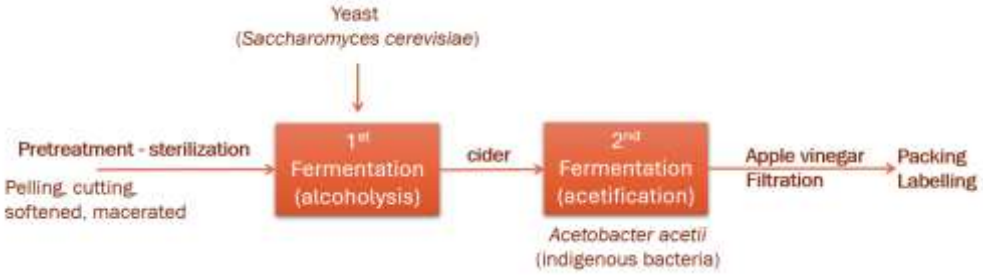

Figure 1. Block diagram of the Fermentation process for apple vinegar production

Even though the Fatwa MUI No. 10 of 2018 stated that vinegar from khamr, whether it occurs by itself or through engineering, is holy and halal, not all the commercial vinegar in the market is halal. However, we still need to consider the critical points of the vinegar production process carefully. It may come from the source of microbes and the fermentation media. Attention should be paid to the growth nutrients of microbes used in fermentation, which could come from meat extracts, meat hydrolysis peptone, and other materials (Yana, 2023). That material is a critical point in halal determination.

Moreover, ingredients such as preservative, flavoring, and colouring agents may contain fat derivatives from animals and vegetables; these also become a critical point. If it comes from animals, it must be ensured that it comes from halal animals that are slaughtered according to Islamic law. In addition, the possible use of the pectinase to clarify apple vinegar is also critical. This enzyme is mainly produced from fermentation, so the source of microbes and the fermentation media should be ensured that it is halal. If the enzyme is not used, then the filter specification should meet the halal requirements. Hence, Muslim customers are always advised to buy halal-certified apple vinegar in the market (Table 8) as comfort and assurance of the halalness of the product purchased.

Table 8. Additional specifications in the sample bottle

Samples	Halal certified	Product
XCJO	Not Certified	Import
YSW	Not Certified	Import
THT	MUI Halal Certified	Local
NTF	BPJPH Halal Certified	Local
BST	Not Certified*	Local

*not halal certified nor MUI or BPJPH.

Therefore, small-medium enterprises (SMEs) of apple vinegar production, especially in Indonesia, can take advantage of free halal facilitation or a halal certification from the owner statement, which the government has intensified. This programme is also known as self-declared halal certification. Halal certification based on owner statement or self-declared halal certification is regulated through a

Decree of the Head of the Agency Halal Product Guarantee Provider (BPJPH) No. 33 of 2022 must meet the following requirements:

1. The product is not risky or uses ingredients that have been confirmed to be halal;
2. The production process is guaranteed to be halal and straightforward;
3. Have a Business Identification Number (NIB);
4. Have a maximum annual sales result (turnover) of 500 million as proven by an independent statement;
5. Have a location, place and equipment for Halal Product Processing (PPH) that is separate from the location, place and equipment for product processing not Halal;
6. Has an outlet and or production facility in at most one location and or;
7. Has or does not have a distribution permit (PIRT/MD/UMOT/UKOT), Sanitation Hygiene Eligibility Certificate (SLHS) for food/beverage products with a shelf life of less than 7 (seven) days, or other industrial permits for such products generated from related departments/agencies;
8. Has been actively producing 1 (one) year before the application for halal certification;
9. The product produced is in the form of goods (not services or restaurant, canteen, catering, and shops/houses/food stalls) as well as details of product types;
10. The materials used have been confirmed to be halal, proven by a halal certificate or included in the list of materials under the KMA No. 1360 of 2021;
11. not use hazardous materials as regulated by the Food and Drug Supervisory Agency (BPOM);
12. It has been verified as halal by the halal product process assistant;
13. The type of product/product group that is certified as halal does not contain slaughtered materials unless it comes from producers or slaughterhouses/poultry slaughterhouses that are halal certified;
14. Using simple production equipment and technology or done manually and or semi-automatically (consider business home, not factory business);
15. The resulting product does not use irradiation techniques, genetic engineering, or the use of ozone (ozonization), and a combination of several preservation methods (hurdle technology);
16. Willing to complete the halal certification application documents using the online self-declaration mechanism via SIHALAL.

By fulfilling all the listed requirements, specifically the critical raw materials, the SMEs of apple vinegar production can be halal certified.

CONCLUSION

The observed vinegar samples contain 17.73%, 11.45%, 6.43%, 2.67%, and 1.49% v/v of acetic acid, respectively, for XCJO, YSW, THT, NTF, and BST. While 0.11, 0.02%, 4.00%, 2.39%, and 3.21% v/v, respectively, for ethanolic content of XCJO, YSW, THT, NTF, and BST. A consumer should be aware of dilution before consuming the XCJO apple vinegar. However, Fatwa MUI No. 10 of 2018 stated that vinegar from Khamr, whether it occurs by itself or through engineering, is holy and halal, but not all the commercial vinegar in the market is halal. Apple vinegar process production has several critical points in halal certification. Therefore, an assessment for halal certification is mandatory, giving comfort and assurance of the halalness of the consumed product.

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