

Islamic Conception in The Utilization of Cocoa Pulp Waste As Basic Ingredients of Vinegar

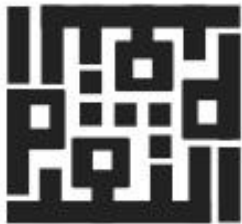
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ABSTRACT

Vinegar is a liquid containing acetic acid from fruits or other agricultural products through a multistage fermentation process. Cocoa pulp liquid waste with high sugar content can be used as raw material for various products such as vinegar through a biotechnology approach. This process is one of the efforts to utilize and at the same time overcome environmental pollution by utilizing the services of microbes that produce acetic acid. In the context of the use of natural resources, including the use of waste, this is relevant to Allah's command so that humans can make practical use of all His blessings as stated in the Qur'an. On the other hand, as a food ingredient, vinegar has a critical halal point that needs to be reviewed based on the process. This review describes the production process of vinegar produced through the processing of cocoa pulp waste and an Islamic review of the product to follow the concept of food safety in Islam, namely halal and thayyib.

Introduction

The development of science and technology, especially in its implementation in biotechnology, is expected to solve various problems related to human welfare. The definition of welfare is comprehensive; it can have a direct or indirect impact and is related to all living things. One thing that cannot be

denied is that economic factors are closely related to people's welfare. The economy is possible to be stimulated through the development of various biotechnology implementations.

The potential in the plantation sector is one area that needs to be explored considering the significant potential in this field, including cocoa plantations. Besides that, cocoa also plays a role in encouraging

regional development and agro-industry development (Statistik Perkebunan Indonesia, 2019). So it is natural that it requires more attention and constantly explores all the potential that can be developed from this sector, including by-products in the form of waste from the cocoa plantation itself, which has not been paid attention to. In fact, under certain conditions, it can become a problem in cocoa processing. In fact, with the use of biotechnology, it is hoped that the community can be more innovative and creative to realize mutual prosperity (Satapathy et al., 2021; Vásquez et al., 2019; Sriharti & Dyah, 2018).

Cocoa processing is essentially an effort to process cocoa pods into dry cocoa beans that meet quality standards and can bring out the distinctive characteristics of cocoa, namely taste. The processing stage that is considered the most dominant influencing the quality of dry cocoa beans is fermentation (Manalu, 2018). Cocoa bean fermentation aims to destroy the pulp and provide conditions for chemical and biochemical reactions in the bean chips that contribute to the formation of flavour and colour precursors of chocolate. The crushed pulp will easily be separated from the seeds, thus forming a liquid pulp that drips out of the pile of beans, and the cocoa beans become clean and dry quickly (Gonibala et al., 2013).

Cocoa bean pulp is a white, slimy membrane that covers cocoa beans, containing about 25-30% of the weight of the beans, of which contain relatively high levels of sugar, around 10-13% (Roini et al., 2019). During fermentation, 15-20% pulp liquid waste can be produced from the weight of fermented cocoa beans (Ganda-

Putra et al., 2019). As a waste by-product during cocoa bean fermentation, Pulp liquid contains acetic acid, lactic acid, and alcohol. These organic acids are formed from the fermentation of sugars contained in the pulp of cocoa beans. The production of these substances results from the metabolism of various types of microbes (Wijaya & Wiharto, 2019). This refers to the power of Allah SWT who give each role to His creatures.

Fermentation of fresh cocoa pulp with various fermentation bacteria can produce acetic acid (vinegar) compounds. Apart from being a food ingredient, it is known that vinegar also has a positive effect on health as long as it is used in moderate amounts. The wide use of vinegar, including that made from cocoa pulp, requires various reviews to review the Islamic concept of the product. In matters of food, including vinegar, Islam is very selective in determining the foods consumed (An-Najjar, 2011). Halal and tayyib, in the sense that they are not food obtained from efforts or methods that the Shari'a does not justify, order from Allah SWT conveyed through the Qur'an and confirmed through hadith.

Literature Review

Waste pulp, as a by-product during the fermentation process of cocoa beans contains acetic acid or vinegar acid, lactic acid and alcohol. These organic acids are formed from the fermentation of sugars contained in the pulp of cocoa beans. The pulp of cocoa beans is a white slimy membrane that wraps around cocoa beans, there are about 25-30% of the weight of the beans, among which they contain relatively high levels of sugar, about 10-

13%. During fermentation can be produced pulp liquid 15-20% by weight of fermented cocoa beans (Gandra-Putra, 2008).

The principle of making vinegar is the fermentation of acetic acid. This process involves the activity of acid-fermenting bacteria that convert alcohols of a certain level into a certain amount of acetic acid under aerobic conditions. The main parameter of vinegar quality is the content of acetic acid. Puspa et al. (2015) Finding the best ingredients of the process of making vinegar from acetic acid raw material sources from distilled pulp liquid by-product of fermentation of cocoa beans added yeast tape with the addition of 0.15% sugar and 0.20% salt. The resulting feeding vinegar showed a good level of acceptance by respondents. in different studies, Adrista et al (2016) has tried variations in yeast concentrations, long and fermentation temperature to produce vinegar with high acetic acid levels.

Through their research, Widjaya et al. (2018) produced fermentation products from pulp liquids by-products of fermented cocoa beans produced with variations in fermentation period and the addition of *Acetobacter aceti* inoculum with a general procedure of processing fermented vinegar and producing fruit vinegar containing high acetic acid.

Result and Discussion

Overview of Cocoa Pulp Liquid Waste as Basic Ingredients for Making Vinegar

According to the Directorate General of Plantations (2021), Indonesia's cocoa plantations have experienced rapid

development since the early 1980s. The area of Indonesian cocoa plantations is recorded at 1,658,421 ha (Table 1), of which the people manage most (87.4%). The remaining 6.0% are state plantations and 6,7% of large private plantations. The success of this area expansion has provided tangible results for increasing Indonesia's cocoa market share in the world cocoa scene. Indonesia has succeeded in positioning itself as the world's second-largest cocoa producer after Ivory Coast. With a production of around 450,000 tons per year, the cocoa plantation area has exceeded the government's target, which previously only targeted the plantation area to increase to 1.4 million ha with a production achievement of two million tons per year. Around 350,000 tons of the national cocoa production are South Sulawesi, West Sulawesi, Southeast Sulawesi, and Central Sulawesi. The cocoa in these four provinces is the result of smallholder plantations.

Table 1.

Potential Areas for Cocoa Cultivation Development by Province in Indonesia, 2019-2021

Province	Cocoa Area (Ha) in Year		
	2019	2020*)	2021**)
Aceh	99.267	99.498	96.874
Sumut	54.545	54.619	53.397
Sumbar	114.75	84.969	79.034
Riau	4.321	5.639	5.757
Kep. Riau	39	38	37
Jambi	2.681	2.702	2.929
Kep. Bangka Belitung	702	711	701
Bengkulu	7.637	7.231	7.032
Lampung	79.653	79.766	77.464

Jabar	9.811	9.74	9.031
Banten	8.194	8.028	7.888
Jawa Tengah	6.614	6.93	6.707
DIY	5.281	4.634	4.31
Jatim	48.686	48.967	47.685
Bali	13.91	13.882	13.501
NTB	7.996	7.932	7.727
NTT	61.8	61.8	66.077
Kalbar	11.366	10.403	10.841
Kalteng	2.838	2.853	3.174
Kalsel	697	671	706
Kaltim	7.328	7.508	7.399
Kalut	2.622	2.612	2.54
Sulut	17.247	17.469	16.681
Gorontalo	14.395	14.193	14.272
Sulteng	279.3	279.22	272.079
Sulsel	201.22	196.28	196.378
Sulbar	144.38	143.93	139.974
Sulteng	246.3	246.05	239.043
Maluku	26.105	26.106	24.989
Maluku Utara	23.513	23.515	23.828
Papua	34.004	34.104	33.053
Papua Barat	13.242	15.872	16.135

Source: Directorate General of Plantations

Note:

*) Temporary Figures

***) Estimated Figures

-) Data not available

The cocoa area spread in various provinces in Indonesia illustrates the very high potential of cocoa production (Directorate General of Plantations, 2021). So far, the results of cocoa plants in the form of cocoa beans are processed without fermentation, and some are through a fermentation process (Afoakwa, 2010, 2014). Because the selling price is not much different and the fermentation takes a long time, farmers are more likely to process the results into

dry bean products without being fermented (Gonibala et al., 2013). This cocoa management produces by-products. This by-product is not paid much attention to by the public and tends to be considered waste. There is an assumption by some people that waste is something that is no longer useful so that at the end of the fermentation process, this by-product is thrown away. One of the by-products obtained from the cocoa fermentation process is pulp liquid waste. This waste is generally discharged into the river without any prior treatment, thus polluting the river (Satapathy et al., 2021; Vásquez et al., 2019; Yuniarta, 2012).

Janairo & Amalin (2018) stated that what is meant by pulp is a layer of white or pale yellow mucus that covers the surface of the cocoa bean (Figure 1). The pulp is a thick layer of endosperm consisting of turbulent cells with large intercellular spaces. In unripe fruit, this layer swells, but this layer becomes soft and slimy (Towaha, 2013). According to Figueira et al. (1993), in general, the pulp occupies 40% of the wet weight of cocoa beans. It can vary depending on the variety, the location where it grows, the season when harvested, and the level of fruit maturity. The pulp is a thin, slimy tissue that is tightly attached to the cocoa bean. The pulp consists mainly of water and a small part of dissolved nutritional compounds, including sugars with a reasonably high content, carboxylic acids, proteins, vitamins and minerals (Lopes & Pires, 2014; Towaha, 2013).

Pulp mucus, especially the sugar it contains, plays an essential role in the fermentation process of cocoa beans (Afoakwa, 2014; Reshi, 2019). Afoakwa et

al. (2013) stated that when the cocoa pod is broken, the pulp will be contaminated by microbes. The pulp fermentation process occurs by utilizing the sugar contained as a metabolic substrate. This fermentation process causes two significant changes in the pulp, namely the conversion of sugar to alcohol by yeast and conversion of alcohol to acetic acid by acetic acid bacteria (Awidyanata et al., 2020; Purwanto et al., 2019; Vásquez et al., 2019; Putra et al., 2017; Puspa Aridona et al., 2015). Sugars contained in the pulp are: (1) reducing sugars, namely glucose ± 214.24 g/l and fructose as much as 10.70 g/l; and (2) non-reducing sugar, namely sucrose 107 g/l (Wijaya. M et al., 2018). Furthermore, Afoakwa et al. (2013) proved that mucilage pulp boiled for ten minutes has a sugar content equivalent to bee honey so that the pulp can be used as a source of sweetener like honey.

Figure 1.

Cross-section of a cocoa pod with a pulp-covered seed (Towaha, 2013)



Pulp liquid is a liquid obtained from the fermentation process of cocoa beans. This waste reaches about 10% of the wet weight of seeds and has an enormous enough potential to be utilized. This pulp waste can be a helpful product and has a high selling value (Satapathy et al., 2021; Vásquez et al.,

2019). One product that can be produced from this pulp waste is vinegar. Vinegar is one of the necessities needed in life, such as flavouring acids in food and the food industry. Vinegar can be used as a pH lowering agent. Vinegar, which has been known to the public, is obtained from fermented fruits and other ingredients. Pulp waste that the public has not noticed can be used as raw material to make alternative vinegar. In addition to abundant raw materials, it can also provide benefits for farmers and the community in terms of creating new jobs (Nurfaillah et al., 2018; Purwanto et al., 2019; Vásquez et al., 2019; Towaha, 2013; Gonibala et al., 2013; Yunianta, 2012).

Mechanism and Islamic Concepts in the Vinegar Acid Fermentation Process

Acetic acid (CH_3COOH) or ethanoic acid, commonly known as vinegar, is an organic acid chemical compound that gives a sour taste and aroma in food. In addition, acetic acid is used as a chemical reagent to produce various chemical compounds. As much as $\pm 45\%$ of world production of acetic acid is used as a material to produce vinyl acetate monomer, which is an intermediate compound for making polymers, coatings, paints, films, textiles and other products (Wijaya. M et al., 2018; Lopes & Pires, 2014).

Apart from being a natural flavour enhancer and flavour enhancer in cooking, acetic acid can also preserve foods, such as meat, vegetables, and pickles. For health, acetic acid from distilled vinegar with white vinegar products can help weight loss programs, relieve arthritis, lower harmful cholesterol levels, fight cancer, prevent

ageing, and various other benefits (An-Najjar, 2011; Ahmad et al., 2008).

In the context of the use of natural resources, including the use of waste as a primary ingredient for making vinegar, it is relevant to what is stated in the Qur'an so that humans can make practical use of all the blessings of Allah as stated in Q.S. al-Jatsiyah:13, which substantially states that Allah has made mercy upon humankind over the subjection of everything in the heavens and whatever is on the earth:

وَسَخَّرَ لَكُمْ مَافِي السَّمَاوَاتِ وَمَافِي الْأَرْضِ
جَمِيعًا إِنَّ فِي ذَلِكَ لَآيَاتٍ لِّقَوْمٍ يَتَفَكَّرُونَ

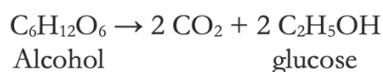
"And He has subjected to you all that is in the heavens and all that is in the earth, (as a mercy) from Him. Verily in that there are indeed signs (of Allah's power) for a people who think." (al-Jatsiyah: 13) (Departemen Agama RI, 2020).

Vinegar (Acetic Acid) results from a two-stage fermentation process where the first stage is the fermentation of sugar into ethanol by yeast. In contrast, the second stage is the oxidation of ethanol to acetic acid by acetic acid bacteria. Acetic acid (vinegar) is a compound that is quite important in food processing, both as a spice and as a preservative (Puspa Aridona et al., 2015; Putra et al., 2017; Towaha, 2013; Wijaya. M et al., 2018).

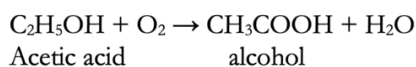
The process of making fermented vinegar is carried out by microbes, namely yeast and bacteria. At first, the alcoholic fermentation stage is carried out where the sugar is converted into ethanol using the yeast *Saccharomyces cerevisiae* under anaerobic conditions. Then in the acetate fermentation stage, ethanol will be converted into acetic acid under aerobic

conditions. The most commonly used bacteria are from the genus *Acetobacter* (family Pseudomonadaceae) and genus *Bacterium*. Some species of *Acetobacter* include *Acetobacter acetic*, *A. Francis*, *A. xylinum*. The bacteria found were *Bacterium schentzenbachii*, *B. curvum*, and *B. Orleanense* (Adrista et al., 2016; Awidyanata et al., 2020; Ganda-Putra et al., 2019; Martelli & Dittmar, 1961; Purwanto et al., 2019; Puspa Aridona et al., 2015; Vásquez et al., 2019; Wijaya & Wiharto, 2019).

In making vinegar, there are two kinds of biochemical changes: 1) Fermentation of sugar into ethyl alcohol and 2) Oxidation of alcohol to acetic acid. The first stage is an anaerobic process carried out by yeast and produces alcohol with the following reaction.



In this process, small amounts of other products are produced, such as glycerol and acetic acid. There are also small amounts of other substances produced from compounds other than sugars, including succinic acid and amyl alcohol. The alcohol produced in the first process is used as an energy source for the bacteria, oxidizing it to acetic acid. These bacteria use other substances in the fermented liquid as food. The reaction, which is an aerobic reaction, can be written as follows:



Acetaldehyde is the intermediate compound in this reaction. Among the final products are small amounts of aldehydes, esters, acetone, and so on. The

pleasant smell of vinegar comes from the presence of various esters such as ethyl acetate, alcohol, sugar, glycerin and volatile oil, which are produced in small quantities by microbial action. This odour can also come from the fermented cocoa cider, the essential ingredient for vinegar.

The vinegar method can be divided into slow methods such as those done at home, or the let alone method, the French or Orleans method, and fast methods, such as the general manufacturing process or the fogging procedure. In the slow method, the alcoholic liquid does not move during acetification, while in the fast method, the alcoholic liquid moves. The slow method uses fermented fruit juice or grain juice to produce acetic acid. In comparison, the fast method is mainly to produce vinegar from liquor (alcohol). Cocoa pod liquid is provided for bacterial vinegar nutrition. However, to maintain active vinegar bacteria in the fast method using alcohol, it is necessary to add food vinegar, a combination of organic and inorganic compounds. The percentage of vinegar is expressed in grains, which is ten times the number of grams of acetic acid per 100 ml of vinegar. So 40-grain vinegar contains 4 grams of acetic acid per 100 ml of vinegar at 20°C (Pujisiswanto, 2017; Putra et al., 2017; Rahmadani et al., 2020; Towaha, 2013).

Based on the findings of the method of making vinegar with the essential ingredients of cocoa pulp liquid waste, it proves that Allah SWT has created everything for the benefit of human life. The Qur'an at least reveals this statement 29 times with various editorials, including Q.S. al-Baqarah: 29 is stated as follows:

هُوَ الَّذِي خَلَقَ لَكُمْ مَافِي الْأَرْضِ جَمِيعًا

"He is Allah, Who made all that is on earth for you..." (Q.S. al-Baqarah: 29) (Departemen Agama RI, 2020).

Ahmad Mustafa AI-Maraghi and Muhammad Abduh, explained the meaning of the verse in more detail that this earth was created for human use in two ways:

1. We are utilizing the earth's products for physical life, for example, processing the products of the earth into food for sustaining life and human life.
2. It was making nature and its contents a vehicle or object of study to give birth to various science-related theories and concepts.

Observing these various views, it can be understood that the creation of this earth is to be managed and utilized by humans to fulfil the continuity and development of their life. Thus, the earth and all its contents are not intended to be owned by a particular people or nation but for all types of people. It can also be stated that in the Qur'an, there are not a few verses that talk about the favours of Allah SWT. These favours are subdued (taskhir) for humans to be used practically by humans in meeting physical and mental needs.

Vinegar is a *tayyib* (good) food. No evidence forbids vinegar, so that vinegar is considered lawful as it came from. (As long as the food is lawful, except for those that are forbidden). The evidence that supports vinegar is good food is the following hadith from 'Aisha, where the Prophet sallallaahu 'alaihi wa Sallam said.

الْأُدْمُ – الْإِدَامُ – الْخَلُّ

"The best seasoning and side dish is vinegar." (HR. Muslim no. 2051) (Ahmad

et al., 2008; An-Najjar, 2011; Wensink, 1936).

According to Imam An-Nawawi, al-Khathabi, and al-Qadhl 'Yadh, this hadith is interpreted as a suggestion to eat as is and to control one's desires from the pleasures of food. This hadith also contains praise for vinegar itself (Ahmad et al., 2008). Vinegar is known to be a complementary food ingredient that is also efficacious as a medicine for various health disorders (An-Najjar, 2011), so it is not surprising that the Prophet prioritized it.

The speciality of vinegar mentioned explicitly in the hadith has a side that needs special attention regarding the critical point of its halalness. The original vinegar or vinegar is considered halal. Allah Ta'ala said.

كُلُوا مِنْ طَيِّبَاتِ مَا رَزَقْنَاكُمْ

“Eat of the good food that We have given you” (QS. Al-Baqarah: 57) (Departemen Agama RI, 2020).

Several methods can produce vinegar. Some details of vinegar law and where vinegar comes from, and how it is made:

- If vinegar comes from khamr (everything that intoxicates), then it is processed by human hands into vinegar, then it is not halal. The hadiths that support this are:

عَنْ أَنَسِ بْنِ مَالِكٍ أَنَّ أَبَا طَلْحَةَ سَأَلَ النَّبِيَّ صَلَّى اللَّهُ عَلَيْهِ وَسَلَّمَ عَنْ أَيْتَامٍ وَرَثُوا خَمْرًا قَالَ «أَهْرِقْهَا» قَالَ أَفَلَا أُجْعَلُهَا خَلًّا قَالَ «لَا»

From Anas bin Malik, that Abu Tholhah once asked the Prophet sallallaahu 'alaihi wa Sallam about orphans inherited home. Then he said, "Destroy the khamr." Then

Abu Tholhah asked, "May I process it into vinegar?" The Prophet sallallaahu 'alaihi wa sallam replied, "No." In this case, Ibn al-Qayyim explained that this is an obvious explanation that if khamr is processed into vinegar (by human hands), then it is not permissible (haram). If this is allowed, then, of course, the property of orphans deserves to be treated like that because their property deserves to be guarded, developed and cared for.

- Suppose the khamr turns from vinegar on its own (the process occurs naturally). So this makes the original law of vinegar back as described, which is holy and lawful. Imam Malik (may Allah have mercy on him) even said, "I do not like a Muslim to bequeath khamr, and then the khamr is processed (by hand) and turned into vinegar. However, if the khamr turns into vinegar by itself, then it is okay to eat it."
- If the alcohol is not from home, then there is no problem. As we can see from the current process, vinegar (acetic acid) is produced not from khamr but from the fermentation process of molasses, which is processed into alcohol, then into aldehydes and then into acetic acid (Agusnan, 2017; Wensink, 1936).

In a review of the halalness of the resulting product in the form of vinegar made from cocoa pulp, it can be identified in the process and raw materials. The raw materials used are natural ingredients that are not included in unclean mutawassithah and unclean mughalladhah, namely cocoa pods. In addition, making cocoa pulp vinegar, as described previously, meets

industry standards for halal products as long as the entire process occurs naturally by microbes. Cocoa pulp is fermented by fermenter microbes that produce acetic acid (Emmanuel Ohene Afoakwa, 2014; Awidyanata et al., 2020; Effendi, 2002; Ganda-Putra et al., 2019; Rahmadani et al., 2020).

From Anas bin Malik, if khomr changes from vinegar by itself (the process occurs naturally). So this makes the original law of vinegar back as described, which is holy and lawful. Imam Malik (may Allah have mercy on him) even said, "I do not like a Muslim to bequeath khomr, and then the khomr is processed (by hand) and turned into vinegar. Nevertheless, if the khomr turns into vinegar by itself, then there is nothing wrong with eating it."

Production of cocoa pulp vinegar, as in the production process, vinegar (acetic acid) is produced not from home but from the fermentation process of the cocoa bean husk, which is then fermented into alcohol. Into aldehyde and then into acetic acid (Fatwa Al Lajnah Ad Daimah, 22:121 and Fatwa Al Islam Saul wal Answer no. 113941.), from here we can draw the conclusion, vinegar made from cereal grains and fruits is halal for consumption (Agusnan, 2017).

The phrase, also contained in several fragments of the previous verse, substantially states that Allah has made mercy for humans upon the subjugation of everything in the heavens and all that is on the earth. These are signs of Allah's power for people who think.

Group of Institution	2013	2014	2017
Education	11	12	13

Government	120	119	115
Corporate	23	22	21
Organization	163	163	167

Source: Indonesia Statistics 2013-2017, processed

Conclusion

The halal review of the cocoa pulp vinegar product disclosed reveals that the services of microbes cannot be ignored as creatures created by Allah SWT. These tiny creatures can pan for the foodstuffs needed by humans by utilizing the by-product of cocoa pods through the fermentation process. The phrase, which is also found in some of the previous verses, substantially states that Allah has given mercy to humans for the conquest of all that is in the heavens and what is on earth. These are the signs of Allah's power for those who think.

Recomendation

Cocoa pulp waste with high sugar content can be used as raw material for vinegar through a biotechnology approach as an effort to utilize and at the same time overcome environmental pollution by utilizing the services of acetic acid-producing microbes while still meeting the food safety aspects in Islam, namely halal and thayyib.

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