

## Spent brewer yeast status in halal food industry: an analysis from Shariah and science perspectives

Ramli, S.N.H., \*Jamaludin, M.A., Abdullah Sani, M.S. and Nordin, N.F.H.

*International Institute for Halal Research and Training (INHART), Level 3 KICT Building, International Islamic University Malaysia (IIUM), Jalan Gombak, 53100 Kuala Lumpur, Malaysia*

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### Abstract

The yeast, *Saccharomyces cerevisiae*, is the protagonist in brewing, while spent brewer yeast is a by-product of beer production. *Khamr* or intoxicant, and its by-product, are prohibited by Shariah, whereas yeast is used to produce alcoholic beverages. Generally, the yeast dies after alcohol fermentation, but some of them settle at the bottom of the fermentation tank. Concerns arise about whether post-purification of spent brewer yeast will take place as it is initially considered impure (*najs*) because alcoholic fermentation occurs in yeast cytosol. This study examined spent brewer yeast's halal status, investigated the formation of spent brewer yeast, and analyzed methods of legal ruling on spent brewer yeast according to Shariah and science perspectives. Qualitative approaches had been applied including library research, fiqh adaptation (*al-takyif al-fiqhi*), and content analysis. *Istihalah* (transformation), debittering, and decolourization have been proposed for purification. Study shows that spent brewer yeast colour changed from chocolate brown to cream-white after purification, but there is still no complete removal of bitterness from beer achieved. The study concludes that spent brewer yeast can be permissible (halal) for consumption if the colour, odour, and taste of the beer are completely purified from the spent brewer yeast.

## 1. Introduction

Alcohol by-products have been widely exposed to consumers, including Muslims, without reassuring the source of origin of the products (Riaz and Chaudry, 2004), including spent brewer yeast, as it is a low-cost, by-product of nutrient-rich composition (Marson *et al.*, 2020). Generally, brewer yeast cultures predominantly come from the genus *Saccharomyces* (Stewart, 2016), whereas spent brewer yeast is a by-product of beer production (Jaeger *et al.*, 2020). As yeast continues to grow and metabolize sugar, the accumulation of alcohol becomes toxic and eventually kills the yeast cells (Gray, 1941). Some yeasts will sediment at the base of the fermentation tank or float to the surface, creating spent brewer yeast (Ferreira *et al.*, 2010; Pinto *et al.*, 2015; Kumar and Chandrasekaran, 2016). Muslims refused food that were derived from pig, intoxicant, carcass, blood, and their by-products and derivatives because the consumption of these food and beverages contravenes Shariah law and principles (Jamaludin *et al.*, 2012). Moreover, a maximal bitterness reduction was acquired by washing spent brewer yeast with strong alkali in the debittering process (Simard and Bouksaim, 1998).

*Istihalah* (transformation), debittering, and decolourization have been proposed on spent brewer yeast as it is considered impure (*najs*) because spent brewer yeast is a by-product from beer production and alcoholic fermentation occurs in yeast cytosol. *Istihalah* literally means transformation, such as the transformation of impure (*najs*) materials into pure (*tahir*) (Wahbah al-Zuhaili, 1997), and it is a complete transformation of a product, physically and chemically (Jamaludin and Radzi, 2009). *Istihalah* is said to hold when a substance has undergone complete changes (Abu Jayyib, 1988). Basically, there are two categories of *Istihalah*, which are *Istihalah Tammah* (complete transformation) and *Istihalah Ghayr al-Tammah* (incomplete transformation), however, only *Istihalah Tammah* (complete transformation) is accepted by the majority of Islamic scholars. *Istihalah Tammah* (complete transformation) can also be referred to as *Istihalah Sahihah* (accepted transformation), while *Istihalah Ghayr al-Tammah* (incomplete transformation) can be referred to as *Istihalah Fasidah* (damaged transformation).

Thereby, in this paper, an integration of Shariah and

\*Corresponding author.

Email: [mohdaizat@iium.edu.my](mailto:mohdaizat@iium.edu.my)

science analyses is the main concept to uphold the objectives of the study, which are to examine spent brewer yeast's halal status, investigate the formation of spent brewer yeast, and analyze methods of legal ruling on spent brewer yeast according to Shariah and science perspectives. Qualitative approaches had been applied including library research, fiqh adaptation (*al-takyif al-fiqhi*), and content analysis. Study shows that spent brewer yeast colour changed from chocolate brown to cream-white after purification, but there is still no complete (100%) removal of bitterness from beer achieved. The study concludes that complete transformation of the impurity (*najs*) in spent brewer yeast is regarded as the colour, odour, and taste of the beer, and thus spent brewer yeast can be considered permissible (halal) for consumption if the colour, odour, and taste of the beer within the spent brewer yeast are completely purified.

## 2. Materials and methods

### 2.1 Library research

The data were collected using library research from both antecedent and contemporary evidence from the scientists, Muslim jurists, and some other researchers from Shariah and science backgrounds.

### 2.2 Fiqh adaptation (*al-takyif al-fiqhi*)

Fiqh adaptation (*al-takyif al-fiqhi*) method is used by Shariah scholars and researchers to determine the legal ruling on new issues and to link the laws that have been determined by previous scholars to be discussed in a similar scope, in which it has been applied in Islamic research methodology as an alternative to conventional literature review (Khairuldin *et al.*, 2020). In this qualitative study, the researchers adapted the previous legal ruling on wine to vinegar case (Ghananim, 2008; Jamaludin *et al.*, 2012) that used the same method of legal ruling as the spent brewer yeast case, which is *Istihalah* (transformation).

### 2.3 Content analysis

Content analysis is a research method for making valid deductions from texts or others (Krippendorff, 2004). The previous data of debittering and decolorization processes have been analysed to strengthen the legal ruling on spent brewer yeast. The results will then be displayed in figure models.

## 3. Results and discussion

### 3.1 Spent brewer yeast from the science perspective

#### 3.1.1 Formation of spent brewer yeast

Briefly, beer is a beverage made up of barley malt,

water, hops, and yeasts, and the brewing process comprises ten important steps (Marson *et al.*, 2020). Figure 1 indicates a scheme design of the brewing process. According to Marson *et al.* (2020), during milling, malt is ground to make its molecule reachable to water, whereas mashing and lautering are carried out when water is heated, activating endogenous malt enzymes, and these enzymes trigger the hydrolysis process. During the mashing stage, starch is transformed into smaller sugars that brewing yeast may ferment (Matthew and Roger, 2019). Besides, grain husks shape a natural filtration bed that assists in the segregation of wort from solids, and then the boiling stage starts, in which the wort is boiled, and the hops are added on (Marson *et al.*, 2020). Moreover, the hot water is assorted with the grist to permit a temperature range of 60 - 70°C (Matthew and Roger, 2019). In the *whirlpool* stage, some aggregated proteins, hops, and other solids are segregated, and the wort is then cooled down to avoid oxidation when the fermentation state is reached and the yeasts are added, which initiates the fermentation process (Marson *et al.*, 2020). Fermentation converts sugars into ethanol (ethyl alcohol) and carbon dioxide (Matthew and Roger, 2019). Some of the yeasts settle at the bottom of the fermentation vessel or float to the surface, forming the second-highest by-product produced in beer making, the spent brewer yeast (Ferreira *et al.*, 2010; Pinto *et al.*, 2015; Kumar and Chandrasekaran, 2016).

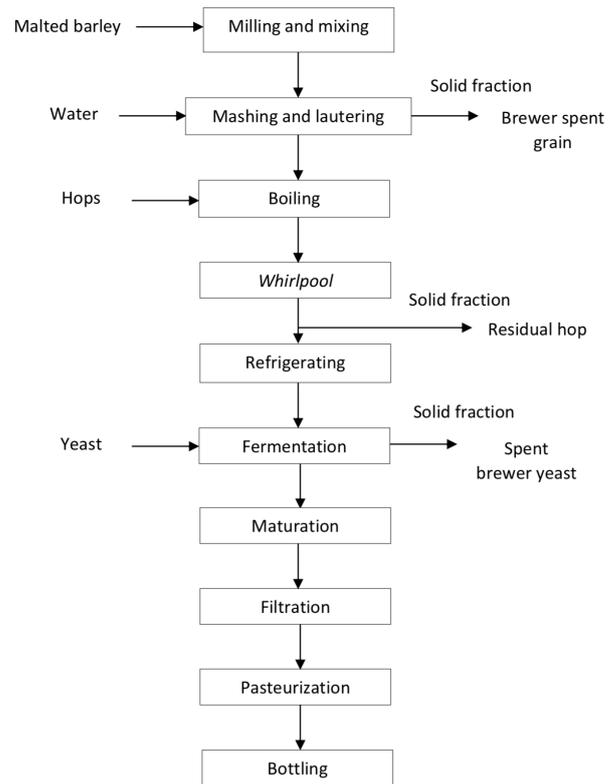


Figure 1. The brewing beer process and the steps in which the main by-products are formed (adapted from Marson *et al.*, 2020)

Additionally, some types of beer are bound to comprise a strong hoppy flavour and bitterness deriving from polyphenols in hops or barley, in which polyphenols give both bitterness and astringency, and the common hop, *Humulus lupulus*, provides beer with two major features, which are bitterness and aromas (Kristina et al., 2021). Besides, beer consists of tannins (Pizzi, 2019), which tannins are polyphenolic compounds naturally existing in plants (Fraga-Corral et al., 2020), and contributes to the organoleptically pleasing for the beverage (Pizzi, 2019).

### 3.1.2 Process for spent brewer yeast debittering

Normally, spent brewer yeast has a strong, bitter flavour affiliated with the brewery waste (Jaeger et al., 2020). Bitter materials arising from hops or known as iso- $\alpha$ -acids (for instance: humulones and iso humulones), tannins and resins, adsorb onto yeast cell walls during fermentation activity (Dwivedi and Gibson, 1970; Shotipruk et al., 2005). These components are eliminated by washing with alkaline or organic solvents prior to the extraction activity, but this technique is impractical, since it demands the cells to be washed with water, thus producing a huge amount of wastewater (Jaeger et al., 2020). Shotipruk et al. (2005) explored the alternate way of spent brewer yeast debittering, as such, he merged debittering process with cell debris segregation, and while the protein transmission and debittering efficiency were higher for homogenized autolysate, there was still a strong bitter taste contrary to cells cleaned with an alkaline solution (Jaeger et al., 2020). According to Simard and Bouksaim (1998), a bitterness reduction of 98% is attained, without influencing yeast viability or protein elements. Nand (1987) suggested washing only once with NaOH 2N and then twice in water, and he claimed the yeast's bitter flavour could be eliminated without any deleterious effect on its nutritive value (Simard and Bouksaim, 1998). A high pH (pH 10) in combination with a heat treatment, which is over 50°C, increased the solubilization of bitter materials as debittering is more profound at higher temperatures (Nand, 1987).

### 3.2 Application of *Istihalah* (transformation) on spent brewer yeast

In this study, *Istihalah* (transformation) has been proposed by the researchers to examine spent brewer yeast's halal status, and whether it is still considered impure (*najs*) after the purification process. *Istihalah* comes from the Arabic root word (ح و ل) which means "change" (Ibn Manzur, 1990; Wehr, 1974), and it is similar to the word (حال) or, (انقلب) and, (تغيير) which means "change" or "transformation" (Al-Razi, 1997). Literally, *Istihalah* means transformation and conversion, such as

the conversion of impure (*najs*) materials into pure (*tahir*) (Wahbah al-Zuhaili, 1997). Qal'ahji (1996) in his book, *Mu'jam Lughah al-Fuqaha'*, defined *Istihalah* as it is when a substance transforms from one form to another without the possibility to return to its original form. Besides, it is a complete transformation of a product, physically and chemically (Jamaludin and Radzi, 2009). Moreover, *Istihalah* is generally a transformation of impure (*najs*) materials into another material, such that changes include physical and characteristics, such as name, odour, taste, colour, and nature (Nazih, 2004). *Istihalah* (transformation) comprises three main elements, which are the raw material, the conversion agent, and the finished product, as shown in Figure 2. The finished product will be different, physically and chemically, from the original material after having undergone the conversion process, and the raw material is mixed with other substances to produce another new material (Jamaludin et al., 2012). Additionally, *Istihalah* can be applied to wine to vinegar cases as the process of conversion from wine to vinegar has undergone a complete transformation, both physically and chemically (Ghananim, 2008). Besides, *Istihalah* is applied when the ethanol has completely changed to acetic acid or vinegar, and thus the complete change from alcohol to vinegar in colour, odour, and taste, and also other chemical structures describes that the transformation process can occur (Jamaludin et al., 2012). In *Istihalah*, there are two main opinions in Islamic jurisprudence. Firstly, a wider scope in Hanafi, Maliki, and Zahiri schools of thought is that they accept all transformations of impure (*najs*) substance to pure (*tahir*) which occur either naturally or synthetically. Secondly, a limited scope in Shafi'i and a part of Hanbali schools of thought in which they hold that an impure (*najs*) substance cannot be transformed to pure (*tahir*), except in some cases such as the natural transformation of wine (or other intoxicants) to vinegar, or the skin of a dead animal (except dog and pig) will be pure after tanning, and the transformation that occurs naturally only, without any human intervention (Jamaludin, 2009).

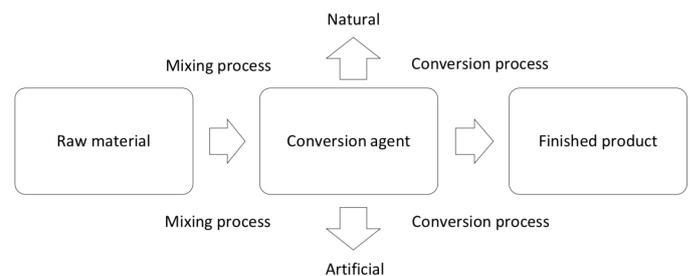


Figure 2. The three main components in the theory of *Istihalah* (transformation) (Jamaludin et al., 2012)

### 3.3 Fatwa on the usage of a by-product from alcoholic production

Generally, the Special Consensus (*Muzakarah*) of the National Council Fatwa Committee for Islamic Religious Affairs Malaysia had discussed the alcohol issues in food, drinks, fragrance, and medicines on the 14<sup>th</sup> to 16<sup>th</sup> of July 2011, and had agreed to decide that each alcoholic beverage contains alcohol, nonetheless not all alcohol is an alcoholic beverage, whereas alcohol obtained from the process of making alcoholic beverages is prohibited and impure (*najs*) (Mufti of Federal Territory, 2019).

Besides that, Fatwa, the Indonesian Ulama Council (MUI) (2011) had discussed the yeast obtained from the waste of beer processing is the yeast that is separated from beer liquid through the process of filtration and centrifugation. MUI had convened on the 3<sup>rd</sup> of March 2011, and had agreed that yeast obtained from waste of beer processing is considered *mutanajjis*, which is contaminated with filth, and thus can become clean and pure only after being washed or purified in a technique in conformity with Shariah, and the process of purification in Shariah in the matter of yeast obtained from waste of beer processing is one of the following techniques, which is either by pouring water over yeast until the smell, colour, and taste of beer are removed, or washing the yeast in a large amount of water until the smell, colour, and taste of beer are removed, nonetheless if after cleaning in a technique mentioned above is done at a maximum level, one of the smells or colour of the beer still exists because of the difficulty to remove it, thus the legal status of the yeast is clean and lawful for consumption (Fatwa, the Indonesian Ulama Council, 2011). On the other hand, in principle, if complete transformation occurs of the alcohol (beer) within the yeast (the spent brewer yeast), then it will be permissible (halal) for consumption, otherwise, it will not be permissible (halal) for one to consume due to the presence of alcohol (obtained from the beer processing) within the yeast (Mufti Ismail Desai, 2016), and as there are differences among the scholars, it is best to abstain from consuming such yeast (the spent brewer yeast) because it will fall under doubtful matters which the Prophet of Allah (peace be upon him) prohibited from (Mufti Mohammed Tosir Miah, 2018).

### 3.4 Purification of spent brewer yeast

The purification process of spent brewer yeast according to Shariah and science perspectives can be observed in Figure 3. Chan *et al.* (1991) explained the purification process of spent brewer yeast with the purpose of retrieving the largest amount of functional protein with the lowest contaminants (Ritchie, 2012).

Besides, Nand (1987) improved debittering process of spent brewer yeast by washing only once with NaOH 2N and then twice in water, determined the optimal pH as 10.00 and the optimal reaction temperature as 50°C, and he claimed a complete debittering of yeast without any deleterious impacts in its nutrients. It was also experimented with by Simard and Bouksaim (1998) at a pH ranging from 4.0 to 12.0 for *S. cerevisiae* with pH 10.0 resulting in a maximal value of 93% to 98% of bitterness removal, and the treatment did not affect yeast protein composition. The process described by Simard and Bouksaim (1998) is able to remove the bitter aroma in a percentage of 98% (Ionut and Sonia, 2021). Moreover, the debittering process does not appear to cause any significant compositional difference between raw and debittered spent brewer yeast (Nand, 1987). In addition to the sweet flavour attained after the treatment with polyoxyethylene sorbitan monooleate, the spent brewer yeast colour had changed from chocolate brown to cream-white (Simard and Bouksaim, 1998).

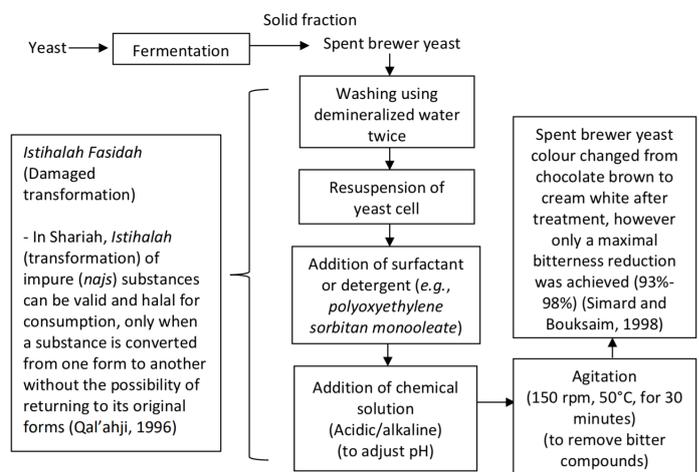


Figure 3. Spent brewer yeast purification from Shariah and science perspectives

### 3.5 Fiqh adaptation (*al-takyif al-fiqhi*) and Islamic legal ruling on spent brewer yeast

Indeed, *khamr* is a term deriving from the verb *khamara* which means “to shroud” or “to cloud” (Arshad and Mokhtar, 2018). Muslim jurists used the principle of analogy, and determined that *khamr* is that which clouds the mind or senses, and leads to intoxication (Musaev, 2017). Allah says: “O you who have believed, indeed, intoxicants, gambling, sacrificing on stone alters to other than Allah, and divining arrows are but defilement from the work of satan, so avoid it that you may be successful”, (Surah al-Maidah: 90). In fiqh (Islamic jurisprudence), *najs* or *najs al-‘ain* is an unclean thing that is judged *najs* (impure) on its substance, such as pigs, dogs, feces, urine, blood, wine (or other intoxicants), and their by-products and derivatives, whereas *mutanajjis*, is the thing that is originally clean but became defiled due to being exposed to *najs al-‘ain*

(Mahaiyadin *et al.*, 2020). In Shariah, the transformation of impure (*najs*) substances can be halal for consumption, only when a substance is converted from one form to another without the possibility of returning to its original form (Qal'ahji, 1996).

Moreover, in the production of spent brewer yeast, the primary fermentation is completed in seven to eight days, in which case the yeasts “break”, flocculate, and sediment to the bottom, and the beer is then transferred to huge clean tanks with a wort extract content of 12%, and 4% of ethanol is produced during fermentation (Hans-Dieter *et al.*, 2008). Beer comprises between 3% and 7% of ethanol and some compounds with antioxidants (Ghiselli *et al.*, 2000). In fact, yeast may grow aerobically or anaerobically, but only anaerobic fermentation is applicable in brewing, while yeast cells grow and multiply throughout fermentation, producing alcohol, carbon dioxide, and flavour elements (Lewis and Young, 1995). With that, when no oxygen is available, alcohol fermentation occurs in yeast cytosol (Sablayrolles, 2009).

In Shariah, if ethanol is produced by anaerobic fermentation and ethanol content is ranging between 1% and 15%, it is considered haram (unlawful) and cannot be used for consumption (Alzeer and Hadeed, 2016). A hadith narrated from ‘Abdullah Ibn ‘Umar that the Messenger of Allah (may peace be upon him) said: “*Whatever causes intoxication in large amounts, a small amount of it is (also) unlawful*” (Sunan Ibn Majah, Book 30, Hadith No. 3392). It means if the beverage consists of a percentage of ethanol intoxicates in large quantities, then it is also forbidden to consume any quantity of it, large or small (Fatawa of the Permanent Committee, 2015), and thus the usage of ethanol from *khamr* industry or its by-products and derivatives even in a small volume is forbidden (Arshad and Mokhtar, 2018). All impure (*najs*) substances must undergo a transformation process before it is considered pure (*tahir*). The complete transformation of the impurity (*najs*) in spent brewer yeast is regarded as the colour, odour, and taste of the beer, and thus spent brewer yeast can be considered permissible (halal) for consumption if the colour, odour, and taste of the beer within the spent brewer yeast are completely purified.

#### 4. Conclusion

In short, *Istihalah* (transformation) is one of the alternative verification methods of Shariah law in determining the legal ruling on some products. Initially, spent brewer yeast is considered impure (*najs*) because it is a by-product of beer production and alcoholic fermentation occurs in yeast cytosol. Study shows that

spent brewer yeast colour changed from chocolate brown to cream-white after purification, but there is still no complete (100%) removal of bitterness from beer achieved. The study concluded that complete transformation of the impurity (*najs*) in spent brewer yeast is regarded as the colour, odour, and taste of the beer, and thus, spent brewer yeast can be considered permissible (halal) for consumption if the colour, odour, and taste of the beer within the spent brewer yeast are completely purified. Laboratory works are important to establish a thorough clarification on specific issues. The theory of *Istihalah* (transformation) is relevant to overcome contemporary issues pertaining to the halal status of a product in accordance with the advancement of science and technology.

#### Conflict of interest

The authors declare no conflict of interest.

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