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Original article

Uniqueness of Ethiopian traditional alcoholic beverage of plant origin, *tella*

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ABSTRACT

There are many kinds of traditional fermented beverages in Ethiopia, not only of animal origin, but also of plant origin. In everyday life people enjoy fermented beverages and particularly when having guests, they like to treat them to traditional alcoholic beverages. *Tella*, *tej*, *areki*, *borde*, and *shamita* are drinks that each household brews to treat guests. Substrates for their production are from locally available raw materials. Therefore, the basic production method is the same, but the tastes may vary. One of the most consumed fermented alcoholic beverages is *tella*, which is made mostly with barley but wheat, maize, sorghum, and *teff* are utilized depending on the region. Its production process shows the similarity to beer: addition of malt and *gesho* which has the same function as hops in beer. The main fermentation yeast is *Saccharomyces cerevisiae* and saccharification of cereal starch seems to depend on malt. However, the degree of alcoholic fermentation is low and alcohol content varies between 2 and 6%. Lactic acid bacteria are very active in *tella* so pH ranges 4–5 give typical tastes such as sourness, sweetness, and bitterness. As the Ethiopian economy improves, more people drink western style beers. *Tella* has not been commercialized yet, so the process has not been standardized and modernized. Considering the case of Korean *makgeolli* and the Ethiopian creativity of utilizing *gesho* in *tella*, Ethiopia should pay more attention to *tella* for globalization.

1. Introduction

Alcoholic beverages are a part of human dietary culture and have an inseparable relationship with the life of mankind in history. The making and drinking of alcoholic beverages are ways of enhancing the nutritional significance as well as social relationships for human beings. Exactly when mankind started to produce and consume alcoholic beverages is not known but beer is known to have been produced by the Sumerians before 7,000 BC [1], while wine has an unequivocally recorded history stretching back nearly 6,000 years, with the earliest evidence dating between 5,400 and 5,000 BC [2].

Almost all countries and regions all over the world have traditional alcoholic beverages, which utilize indigenous agricultural produce. Alcoholic beverages of plant origin represent a vast diversity of products (Table 1) [3]. However, in general, alcoholic beverages can be classified into three main categories: wines, beers, and spirits [4]. This classification is based on production methods: (1) by mono-fermentation; (2) by malting and fermentation; and (3) by distillation after fermentation. Yeasts are able to produce ethanol primarily through metabolism of the low-molecular-weight sugars that can be transported into the cell cytoplasm. Thus, fruits with sugars can be utilized to produce alcoholic beverages such as wine and ciders by direct fermentation [5]. However, in production processes utilizing cereals or tubers, fermentations must be preceded by depolymerization of storage polysaccharides and proteins yielding the sugars and amino acids that can be utilized by the microorganisms [6]. This explains the process for producing beers. To produce spirits such as brandy, whiskey, and vodka, the alcoholic beverages are produced by either the mono-fermentation or fermentation after starch hydrolysis by amylolytic enzymes, and are distilled.

2. Ethiopian alcoholic beverages of plant origin and their production

In Ethiopia, very popular traditional fermented alcoholic drinks include *tella* [7], *tej* [8], *areki* [9], *borde* [10], and *shamita* [11]. *Tej* is mead which is prepared from honey, water, and leaves of *gesho*

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Table 1
Some of the traditional alcoholic beverages of plant origin in the world.

Country	Beverage	Substrate
Andes regions	*Chicha*	Maize
Bhutan	*Aarak*	Barley
China	*Tien-chiu-niang*	Rice
Egypt	*Bouza*	Wheat
Himalayan regions	*Raksi*	Cereals
India	*Aarak/Buza*	Barley
	Bhang-chyang	Maize
	Chulli	Apricot
	Duizou	Red rice
	Ennog/kiad lieh	Rice
	Kanji	Carrot
Japan	*Sake*	Rice
Korea	*Makgeolli*	Rice
Mexico	*Pulque*	Cactus
Mongolia	*Darassun*	Millet
Nepal	*Kodo ko jaanr*	Finger millet
Nigeria	*Pito*	Sorghum
Philippines	*Basi*	Sugar cane
Russia	*Bagni*	Millet
South Africa	*Bantu/kaffir*	Sorghum
Sudan	*Merrisa*	Millet
Tanzania	*Mbege*	Millet
Thailand	*Sato/krachae/nam khao*	Rice
Tibet	*Aarak/lugri*	Barley
Uganda	*Kwete*	Maize
Vietnam	*Ruou de/ruou nep*	Rice
Zimbabwe	*Mangisi*	Maize

Note. From "Fermented foods and beverages of the world", Tamang JP, 2010, p. 85–125. Copyright 2010, *CRC Press*. Adapted with permission.

(*Rhamnus prinoides*) [8]. Mix one part honey to three parts water, put in some stems and branches of *gesho*, and let it ferment for 5–6 weeks, removing the *gesho* after 2 weeks. *Areki* is a colorless distilled alcoholic beverage from fermentation products prepared in the same way as *tella*. The preparation of *borde* [12] is as follows: it is made from maize or wheat. A thick coarse paste of wheat or maize flour is roasted on a hot flat metal pan and cooled for 1 hour. Then it is thoroughly mixed with ground malt. The whole mixture is put into a jar and further blended with water and allowed to ferment at ambient temperature for 24 hours. *Shamita* is prepared as follows [11]: (1) dehulled barley is roasted on a flat metal pan until it turned light brown and ground finely; (2) barley flour, salt, ground linseed, and assorted spices are mixed together; (3) this mixture is mixed with water in a jar and then the jar is sealed tightly and allowed to ferment overnight at ambient temperature. Pepper is optionally added depending on the consumer's preference.

Borde and *shamita* are mainly consumed in central and southern parts of the country, while *tella* and *areki* are very popular in northern parts of Ethiopia. *Tej* is a honey wine and consumed in Ethiopia as well as Eritrea. However, *borde* and *shamita* are not exactly alcoholic beverages but fermented low alcoholic beverages with a thick consistency consumed as a meal replacement in some districts [9,13].

Among various Ethiopian fermented alcoholic beverages, *tella* has many varieties in the various regions and is made with diverse cereals such as barley, wheat, maize, millet, sorghum, and *teff*. It is, by far, the most commonly consumed alcoholic beverage in Ethiopia [13]. How the *tella* is produced differs among ethnic groups, and their tradition and economic situation affect the kind of cereals they utilize. The basic processing steps are similar.

How to prepare the barley *tella*: (1) a clay container (jar) is washed with water and cleaned with leaves of *grawa* (*Vernonia amygdalina*); (2) then the jar is fumigated by the smoke of burning chips of *weyra* (*Olea europea*) or *tinjute* (*Otostegia integrifolia*). This will eliminate some adverse microorganisms present in the inside of the jar and contribute to unique *tella* flavor; (3) malt (*bikil*) is prepared by grinding the dried germinated barley, maize, or wheat. For preparation of malt, cereals were moistened in a container and left to be germinated for about 3 days, and then sundried; (4) *gesho* plant (*Rhamnus prinoides*) is prepared to make a powder of leaves or shreds of stem. *Gesho* has some antibacterial effects against some groups of bacteria while imparting the typical bitter taste to *tella*; (5) flour of barley is made into dough and baked to make a unleavened bread (*kita*); (6) *kita* is broken into small pieces; (7) barley is ground to flour and roasted (*enkuro*). The extent of baking or roasting determines the color of *tella* to be from light yellow to dark brown.

The fermentation process has four phases [7]. At the first phase, dried *gesho* leaves (Fig. 1) are soaked in water for 4–5 d. The second stage starts by mixing malt (*bikil*) and unleavened bread pieces (*kita*) into the *gesho* leaf-soaked water with additional powders of *gesho* leaves and stem. In some areas, herbs are added at this stage. This is left to ferment for 2 days or more. At the third stage, powder of the *gesho* leaves and pounded stem and barley flour are mixed into a thick slurry and left to ferment for 2 days or more. At the final phase, the container is filled with water to the brim and the slurry is mixed thoroughly. The container is then sealed with mud to create an anaerobic condition and left for 2 days or more (Fig. 2). *Tella* is consumed directly or after filtration. To prepare *tella*, in general, 1 kg of *gesho*, 0.5 kg of malt (*bikil*), 5 kg of unleavened bread (*kita*), 10 kg of flour (*enkuro*), 30 L of water are needed. The final alcohol content of *tella* is 2–4%, while that of the filtered drink is 5–6% (Fig. 3 and 4).

3. Comparison of characteristics of Ethiopian *tella* with Western beer

Tella is called Ethiopian traditional beer. Its production process is similar to beer making in that the grain starch is converted into sugars by malting. However, there is no yeast inoculation stage for fermentation but it utilizes the natural yeast present on the cereals. The dominant microorganism after the end of the first stage until the completion of *tella* fermentation was reported to be *Saccharomyces cerevisiae* and *Lactobacillus pastorianumi* [7]. *Saccharomyces cerevisiae* is known to be the top fermentation yeast for ale production, while *S. pastorianus* or *S. carlsbergensis* are the bottom fermentation yeasts used for lager beer production [14]. Alcohol is a by-product of yeast metabolism and is toxic to the yeast; typical brewing yeast cannot survive at alcohol concentrations above 12%

Fig. 1. From the left, powdered leaves, leaves, and stem shreds of *gesho*.

Fig. 2. *Tella* made with toasted barley flour after 1 week of fermentation.

Fig. 3. Tej in the kettle and bottle.

Fig. 4. Commercial product of *areki*. (https://ethiopianfood.wordpress.com/2014/07/01/ethiopias-potent-potables/).

by volume [15]. Beer ranges from less than 3% alcohol by volume to around 14%. Tastes of *tella*, which the panel described were bitterness, sweet, and sour [9], are similar to the description of the typical beer taste. In order to control the formation of the very sour taste due to the succeeding bacteria during the *tella* fermentation, small parts of the *tella* are removed and are tasted. People add the ash of burnt wood to neutralize the excessive acid. The bitterness of *tella* is from *gesho*, while that of beer is from hops [15,16]. Hops are the female flowers of the hop plant *Humulus lupulus*. They are used primarily as a flavoring and stabilizing agent in beer, to which they impart a bitter, tangy flavor. Hops are also used for various purposes in other beverages and herbal medicine. Historically, traditional herb combinations for beers were believed to have been abandoned when beers made with hops were noticed to be less prone to spoilage [17]. Leaves of *gesho* are similar to hops in terms of its role in brewing; giving a bitter flavor and antibacterial effects for the shelf-life [16]. The origin of the usage of *gesho* in *tella* brewing in Ethiopia is lost in *history*. The mouth feel of beer is from the presence of protein, polyphenols, chloride, dextrins, and beta-glucan, etc. [18], which are mainly from malt and hops. The taste of *tella* is different depending on the different cereals in various regions of Ethiopia. The pH value of *tella* is in the range of 4.00–4.99, while that of the typical beer is 4.1–4.5. The pH and oxygen are usually considered as the main factors influencing the organoleptic stability of beer [19]. Off-tastes and odors in beer are produced most often by wild yeast and lactic acid bacteria (*Lactobacillus* and *Pediococcus*). The color of beer is derived from the color of the malt(s) used, while for *tella*, it is from that of toasted barley or cereals (Fig. 5 and 6).

4. Ethiopian *tella* versus Korean *makgeolli*

Tella is not on the market as a commercial product in Ethiopia but it is produced and sold domestically. Households with standing sticks with paper cups or bags in the front indicating they are selling their homemade *tella* is a common sight on countryside roads. *Tella* in Ethiopia is like cheese and fermented sausages in Europe and *kimchi* and *makgeolli* in Korea which are prepared by individual family recipes. In Korea, *makgeolli* is made with rice and *nuruk* which is a fermented whole wheat flour containing fungi, yeasts, and lactic acid bacteria. Considering the production process of Korean *makgeolli*, it is a beer-like Ethiopian *tella*, not a rice wine. The difference between *tella* and *makgeolli* is that *tella* uses mainly barley, while *makgeolli* uses rice. The taste of *makgeolli* is characterized by being sour, sweet, and astringent. The pH value and

Fig. 5. Distillation of *areki* (www.ethioabs.ca/local-drink/).

Fig. 6. *Borde* made of sorghum (https://baskettoethiopia.wordpress.com).

Fig. 7. *Shamita* in a glass and jug.

alcohol content were 3.4–4.5 and 15–18% after 6 days' fermentation [20,21]. The pH level around 3.4–4.0 is due to the production of organic acids, including succinic acid and lactic acid by the actions of the yeast and lactic acid bacteria. The main microorganisms for *makgeolli* fermentation include fungi such as *Aspergillus* sp., *Rhizopus* sp., and *Mucor* sp., yeasts such as *Saccharomyces cerevisiae* and *Pichia burtonii*, and bacteria such as *B. subtilis*, and various lactic acid bacteria [22–24]. It has been known that *A. oryzae* is the representative saccharifying fungi in the fermentation of *makgeolli*. The microbial flora of *tella* consists of fungi, *Lactobacillus* sp., and other bacteria at the early stage of the process. Later, the fermenting organisms are composed of *Saccharomyces* sp.(mainly *S. cerevisiae*) and *Lactobacillus* sp. (mostly *L. pastotianumi*) [7]. Yeast strains, appropriate for bottom-fermented beers (*Saccharomyces carlsbergensis*), are active below 5°C and they settle to the bottom of the fermenter after production of about 5% ethanol. Conversely, yeasts, typical for the production of top-fermented beers (*Saccharomyces cerevisiae*), operate at ambient temperatures and resist higher concentrations of ethanol up to 12% [15]. The major yeast of *tella* is *Saccharomyces cerevisiae*, but its alcohol content is the lowest among the three subjects. It remains to be studied why *tella* has a low alcoholic content after 10 days of fermentation, compared with beer and Korean *makgeolli*. Because of the action of lactic acid bacteria, *tella* has a pH of 4.00–4.99. In *tella*, malt is added for saccharification of starch, while in *makgeolli* fungi in *nuruk*. For both, there is no yeast inoculation step in contrast to the beer production process (Fig. 7).

5. Conclusion

Considering its production process using malt and *gesho*, *tella* seems more like beer rather than *makgeolli*. However, as far as the science of alcohol fermentation is concerned, the three are the same. The only difference among *tella*, beer, and *makgeolli*, is that *makgeolli* does not use pure malt for the conversion of starch into sugars for fermentation but *nuruk* which is a fermented whole wheat flour containing fungi and fermenting microorganisms. However, the difference between *tella* and beer is that there is no yeast inoculation step in *tella* production. Its production depends on the naturally present microflora in the substrates, utensils, and equipment used, and the environment of the households [25]. The use of *gesho* in *tella* production shows that Ethiopians are very scientific but they are so conservative that they have not shown any effort to modernize the process. Ethiopia is the only country in the African continent that has more than 3,000 years of history and has never been colonized. It has many endemic landraces of biological resources and for that the people are proud of it. Maybe for that reason, Ethiopians are very conservative, especially in food culture. In the case of Korean *makgeolli*, there has been a lot of effort to improve and modernize the process for consistent and better quality to find popularity. As for *tella*, if they do not pay attention to the improvement of the process and quality, there is a possibility that *tella* will die out and there will be no more *tella* in Ethiopia when the national economy improves.

Conflicts of interest

The authors have no conflicts of interest.

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