THE IMPORTANCE OF TRACEABILITY IN THE BEER BREWING PROCESS WITHIN THE BREWING MICROPRODUCTION WORKSHOP

Ionuț - Dumitru VELEȘCU[1], Georgiana GORESCU, Sandu TALPĂ[1], Roxana Nicoleta RAȚU[1], Vlad Nicolae ARSENOAIA[1], Alina Narcisa POSTOLACHE[2], Petru Marian CÂRLESCU[1]

e-mail i.velescu@yahoo.com

Abstract

Transparency in identifying the origin of food is a necessity. After a number of recalls and incidents related to food insecurity around the world, consumer awareness of food security issues has increased. In this scenario, food traceability appears as an important tool. The importance of the present paper derives from the approach to a highly current research area, namely the guarantee of food safety, food quality and the continuous concern of alcoholic beverage producers to obtain safe and healthy products. The main objectives and activities consist of: (1) making an exhaustive documentation of the national and international legislation (especially that of the EU) related to the topic addressed; (2) establishing the manufacturing recipe, the raw and auxiliary materials and the optimal technological parameters for beer manufacturing, the development of manufacturing technological norms for the companies in the field (internal quality standards); (3) planning and tracking the production process; (4) physico-chemical characterization of the raw and auxiliary materials that enter the manufacturing process of the analyzed products. This analysis can be useful for the creation and development of new guidelines to improve the production process of beer, aiming at a higher degree of satisfaction of breweries and increasing the degree of safety of foods in the brewery chain.

Key words: brewing, traceability, quality standards, food safety management system

Beer is an alcoholic beverage that is made from the fermentation of four main raw ingredients; malted barley, hops, yeast, and water. A liquid called wort is brewed from water, malt, and hops to form fermentable sugars for yeast to metabolize the carbohydrate energy source through alcoholic fermentation (Dabenne F. *et al*, 2014). During fermentation the sugar substrate is transformed into ethanol, carbon dioxide, and other flavor active chemical compounds. There are many examples of alcoholic beverages that require the fermentation of various sources of fermentable sugars (Mudura E., 2004). Examples of other sugar sources include fruits (grape, apple, pear), cereals (barley, wheat, millet, sorghum, rice, corn), and tubers (potato, sweet potato, cassava, sugar beet)(Mudura E. *et al*, 2008).

According to ”Codex Alimentarius”, product traceability is the ability to follow the path of the food product along the stages of production, processing and distribution (Mudura E. *el al*, 2005).

In 1987, the first international definition of traceability was given in the ISO 8402 standard as "the ability to trace the history, use or location of an entity by means of recorded identifications". Entity can indicate: an activity, a product, a process or a person (Pop C. *et al*, 2013; Popa M.E., 2015).

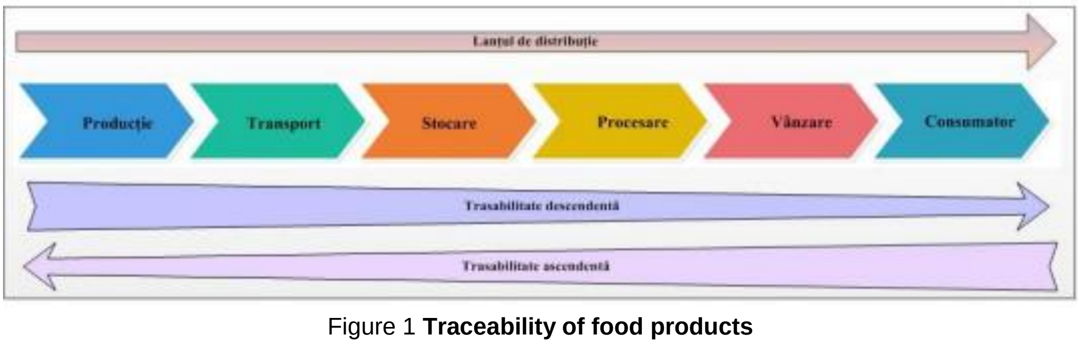

Figure 1 **Traceability of food products**

[1] Iasi University of Life Sciences, Romania
[2] Research and Development Station for Cattle Breeding Dancu, Romania

Traceability is a mandatory requirement for the agri-food sector in many countries, bringing many benefits such as increasing customer safety and thus their confidence and controlling the repercussions of product recalls (*figure 1*).

In the European Community Regulation no. 178/2002, the traceability of food products has a strictly regulated procedure (Luning P.A. *et al*, 2008). Businesses in the food sector should enable the exact identification of the origin of each food product through all stages of production and distribution (Tudora E., 2019).

Traceability in the agri-food sector refers to the acquisition, documentation, maintenance and application of information about all processes throughout the supply chain to provide consumers and other interested parties with information related to the origin, location and history of a product (Banu C. *et al*, 2009; ISO 22000:2018).

According Pop C., 2008 and Nour V., 2010 the traceability objectives are achieved if:

- supports food safety and/or quality objectives;
- fulfill the specification/s of the beneficiary
- establish the history or origin of the product;
- facilitates the withdrawal and/or recall of products;
- identify the responsible organizations in the food chain;
- facilitates the verification of specific information on the product;
- communicate relevant information to interested parties and consumers.

MATERIAL AND METHOD

Considering the diversified range of malt (resulted from the germination of barley and orzoaica, but also of other maltable grains), the multitude of hop varieties (bitter hops, respectively aroma), the parameters of the stages on the technological flow of beer production (flooding-saccharification, boiling, fermentation-maturation) it should be noted that a wide range of beer can be produced in the workshop.

The main objective was to design and produce a new product in the Beer Microproduction Workshop, the first beer recipe with coffee and chocolate flavor, along with conducting some technological tests in order to calibrate the installation.

In order to fulfill the objectives of this paper, research was carried out in the Beer Microproduction Workshop, within the "Ion Ionescu de la Brad" University of Life Sciences in Iași (*figure 2*). In the brewery, a closed work system is used, the machines being all made of stainless steel, in order to maintain food safety and perfect traceability throughout the production process. Also, all legislative provisions are respected regarding the circuit of the respective personnel and raw and auxiliary materials (ISO 22005:2007).

Beer is obtained from natural ingredients, barley malt, hops, water and yeast. Each of these contributes to the nutritional profile of the beer, depending on the quantity used and the technology adopted.

Traceability in the brewing technology of coffee and chocolate flavored beer refers to the raw materials used, the technology adopted to make the beer, the analytical methods of investigation, with the specification of each documentation.

Following the production of Stout beer with coffee and chocolate flavor, it was packaged in bottles with a capacity of 0.75 ml, and 6 experimental variants were organized, as follows (*figure 3*):

- V1 – coffee and chocolate flavored beer;
- V2 – beer with citric acid addition;
- V3 – beer with tartaric acid addition;
- V4 – coffee and chocolate flavored beer and carbonation pill;
- V5 – beer with added citric acid and carbonation tablet;
- V6 – beer with added tartaric acid and carbonation tablet.

Figure 2. **The beer microproduction workshop of IULS**

Figure 3. **Experimental variants**

The physico-chemical analyzes of the beer were carried out in the Oenology laboratory, the following determinations being made.

Determination of alcohol concentration

The alcohol concentration (alcoholmetric titre) represents the content in ethyl alcohol expressed in volume percentages (% vol.) at a temperature of 20°c or, more simply, it can be defined as the number of milliliters of pure ethyl alcohol in 100 ml of the product under analysis. The actual determination was made by simple distillation using the "Dujardin-Salleron" still, and the measurement was made using the alcohol meter, according to STAS 6182/6-70.

Determination of beer ph

The pH is measured using a glass electrode and a reference one. Calibrate the device, insert a magnetic bar into a 100ml berzelius glass, add 40 – 80 ml of beer, insert the sample electrode, read the results and express them with 2 decimal places (STAS 6182/14-72).

Beer foam check

A thin, colorless, well-washed and degreased glass of special shape and size is used to check the foam. Beer cooled to 10-12ºC is poured into the glass so that the jet falls on the axis of the glass, at a height of 30mm above the liquid in the glass. The foam is considered adequate if it has a height of 30 – 40 mm and its persistence time is 3 minutes.

Determination of density

Determination of density by the hydrometric method is based on Archimedes' law, according to which a body immersed in a liquid is pushed from the bottom up with a force proportional to the mass of the displaced liquid volume (STAS 6182/8-71).

RESULTS AND DISCUSSIONS

The technological process of obtaining Stout beer, with coffee and chocolate flavor, within the Beer Microproduction Workshop begins with the quantitative and qualitative reception stage of the malt. For this beer recipe, two types of malts were used in different proportions: blonde malt, respectively dark chocolate malt.

It should be mentioned that the dark chocolate malt was purchased commercially from a specialized store, the product being accompanied by a quality certificate. at the time of quality reception of the malt, it was assigned a new batch number specific to the brewery.

Also, a new batch number was assigned to the blond malt, in order to keep under control all the ingredients that go into the composition of the beer, respectively the traceability.

Grinding is the operation of crushing the outer shell of the grain, and the process of breaking the inner layer so that the saccharification liquid comes into contact with the grain. This is a very critical step in the process because an incorrect grind will affect the beer before the process starts (small particles that will not be filtered). The grinding of the malt (*figure 4*) is carried out with the help of the mill, the grinding reaching the flocculation and saccharification boiler where it will come into contact with the water (*figure 5*).

Figure 4. **Dark malt**

Figure 5. **Malt milling**

The saccharification process is followed with the help of a three-stage brewing diagram, for the beer obtained in order to carry out this work, we worked according to the following parameters: step I was carried out at 55ºC for a period of 55 minutes, step II was carried out at a temperature of 68ºC for 30 minutes and step III was carried out at a temperature of 75ºC for a period of 10 minutes (*figure 6*). all these data were recorded in the Technological Process Sheet. all this time, the process of saccharification was followed by checking the decomposition of starch with 0.1N iodine solution (*figure 7*).

When the flocculation and saccharification process is finished (starch splitting is complete), the product is transferred to the filter boiler, where it is subjected to a recirculation process until the moment of clarification (*figure 8*). This whole operation can take up to 2 hours. After filtering, the liquid is transferred to the boiler, and the obtained slurry will reach the farm to be used as animal feed.

Figure 6. **Immersing the malt grind in water**

Figure 7. **Control of starch cleavage**

Figure 8**. Disposal of slurry malt**

The boiling process lasts up to an hour and a half, being carried out at temperatures above 100ºC. During boiling, the hops are added, initially 15 minutes away from reaching the boiling temperature, bitter hops are added in the proportion of 80g/hl, and 15-20 minutes before the end of the process, the aroma hops are added in proportion to 50 g/hl, to avoid volatilization of hop aromas. The roles of the boiling process include removing a quantity of water from the product (about 10%), sterilizing the product, breaking down the hops, forming compounds from the hops, coagulation of proteins (*figure 9*). After boiling, the wort is transferred to the hydrodynamic separator (Rotapool installation) in order to remove coagulated proteins and solid particles from the hops (*figure 10*). This process helps to clarify the wort by removing the hot turbidity. The solid removed is called a trub.

After the separation of the two fractions (beer wort, wort), the wort is to be cooled, by passing it through a plate heat exchanger, to the fermentation / maturation tank.

Fig. 9. **Boilling process**

Fig. 10**. Rotapool and cooling system**

Fig. 11. **Beer**

Before entering the fermentation tanks, the wort is cooled to a temperature of 20°C so that when the yeasts (which are living organisms) are added to the wort, they are viable and produce the desired effects (*figure 11*). The yeasts added in the production process of coffee and chocolate flavored beer are top-fermenting Ale yeasts. They also received a batch number specific to the workshop.

Thus, a mixture of air and yeast is introduced into the cauldron to start the primary fermentation, which usually takes a few days (between five and ten, depending on the recipe). This wort fermentation process is exothermic and releases large amounts of heat, which means that these fermentation tanks must have a double cooling jacket to keep the temperature stable.

At the end of the primary fermentation process, the yeast is removed from the tank, and the secondary fermentation will then take place. Considering the fact that the workshop is not equipped with a CO_2 dosing system, the product remains in the same tank where the primary fermentation took place (so as not to lose the co2 obtained during the primary fermentation). Secondary fermentation is activated by gradually lowering the temperature inside the tank.

All the parameters of the primary fermentation - secondary fermentation / maturation processes are controlled daily, twice a day, being recorded in the *Fermentation Maturation Sheet of the product*.

The planning of the production process is carried out by the technological engineer, depending on the practice periods and the research programs, by drawing up the *Production schedule*.

The registration of the achieved production is done by the person in charge of the microsection, corresponding to the production phase, by completing the *Production Registers*. Following the analyzes carried out, a series of data was obtained, which are presented in table 1.

Table 1

The main compositional parameters of the beer obtained in the microbrewing workshop

Characteristics	Experimental variants					
	V_1	V_2	V_3	V_4	V_5	**V_6**
Density	1.0225	1.0312	1.0234	1.0295	1.0283	1.0302
pH	4.12	4.05	3.77	3.95	3.91	4.08
Total acidity (g/L malic acid)	1.22	1.45	1.35	1.39	1.42	1.48
Ascorbic acid (mg/L)	67	75	66	72	71	69
Malic acid (mg/L)	769	788	784	808	812	785
Lactic acid (mg/L)	132	136	144	154	148	142
Alcohol (% vol.)	6.12	6.05	5.83	5.85	5.96	6.04
Sugars (g/L)	0.5	0.3	0.3	0.4	0.6	0.4
SO_2 combined (mg/L)	16.12	15.98	16.03	16.04	15.94	15.89
SO_2 total (mg/L)	46.5	47.5	48.2	48.4	47.9	48.4
The height of the foam column (mm)	72	70	67	68	70	68

CONCLUSIONS

Traceability along the food chain is an important tool for guaranteeing food safety. European Union regulations oblige each actor involved in the food chain to be able to identify both the origin of the raw material used and the destination of its final products along the food chain. Also, the actor involved must be able to demonstrate which raw material it used and in the manufacture of which final products it was included. The European Union does not establish a specific system or program for traceability. Operators in the agri-food sector have the responsibility to develop and implement record-keeping and traceability systems, to meet the standards established in the European Community area.

Regarding the results obtained for the density and pH of the beer, values between 1.0225 (for V_1) and 1.0312 (for V_2), respectively 3.77 (for V_3) and 4.12 (for V_1).

Regarding the total acidity, minimum values were recorded for the experimental variant V_1 (1.22 g/L malic acid), and the maximum was 1.48 g/L malic acid (for the experimental variant V_6).

Regarding the content of ascorbic acid, the experimental version V_1 recorded values of 67 mg/L, and the experimental version in which ascorbic acid V_2 was added recorded values of 75 mg/L.

Regarding the alcohol content of the beer, the maximum alcohol values were registered by the experimental version V_1 (6.12% vol), while the minimum value was recorded by the experimental version V_3 (5.83% vol).

The maximum value of the height of the foam column was obtained for the experimental variant V_1 (72 mm), while the minimum value was obtained for the experimental variant V_4 (68 mm).

Schematically, the traceability assurance system within the food-related units is carried out in 4 stages:

Stage 1 – Identification of the product batches;

Stage 2 – Registration of information related to product identification on paper or electronic support;

Stage 3 - Establishing links between information - each economic operator in this chain must be able to justify through documents the link between batches of products, suppliers and customers;

Stage 4 - Communication - each economic operator in this chain communicates the identification elements of the lots to the next economic operator in order to allow the latter, in turn, to apply the principles of traceability.

To implement a traceability system for the unit's products it is necessary to follow a series of steps which are contained in a document called the Traceability Procedure.

It is essential to define the criteria that will be used to group products within the traceability plan and how this data will be recorded in the system:

Registration of food products in the unit:

A. The units in the food sector must have systems or procedures that allow the registration of the products entered into the unit (nature of the product, identification by lot, quantity, reception date, expiration date and the unit that supplies the products, etc.);

B. *Entry registration* can be done either through an electronic system or through a manual registration system (Data Register);

Registration of the storage of food products according to the batch

C. All units must store the quantities of products received/entered in the unit so as to allow the establishment of traceability (visible display of the lot number or internal labeling of the food lot);

Food processing registration

D. All units must maintain throughout the processing chain documents (production reports) by which it can be permanently identified:

- - lots of products used (raw meters, materials),
- - the batches of finished products obtained
- - the quantities of raw materials and incoming and unprocessed materials in stock (warehouse sheets);

Registration of food product exits from the unit:

A. The units must have systems or procedures that allow the registration of the products shipped / leaving the unit (nature of the product, identification by lot, quantity, date of delivery, unit where the products were shipped);

B. *The registration of exits* can be done either through an electronic system or through a manual registration system (*Delivery register*);

C. All products that are shipped from units must be identified according to the name of the assortment, type, as well as the code written on the labels/packaging that will make explicit clarifications to the additional information about the product and that will allow the identification of products of the same nature but with different antecedents.

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*****STAS 6182/6-70** – Alcoholic strength by volume.

*****STAS 6182/8-71** - Density at 20°C and relative density at 20°C.

*****STAS 6182/14-72** – pH.

*****EC Regulation no. 178/2002** on establishing the principles and general requirements of food legislation, establishing the European Food Safety Authority and establishing procedures in the field of food safety.