Productivity in the use of Beer Foam

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Abstract

The beer foam is one of the first elements that the consumer judges to determine the quality of a beer, so it is very important to the brewer as well. However, at the time of drinking, it is common to observe that the consumer discards foam, wasting an important percentage of the nutrients. This project presents a research on the nutritional content of beer foam through various laboratory tests, as well as proposals to make the foam more attractive to the consumer so that beer can be fully used, serving equally to divulge the benefits of beer. Through the tests, which are explained in detail in the document, the content of proteins, phenols, phosphates, vitamins, carbohydrates and minerals (which include potassium, phosphorus, calcium, silicon and magnesium) in the foam of a specific beer brand. In addition, the benefits of responsible beer consumption are described, which mainly are its diuretic effect (thanks to its potassium content), its ability to be metabolized, its vasodilator capacity and its antioxidant content. To know the consumption habits of beer foam, a survey was carried out, which helped to generate ideas for a better use of the beverage, by adding other nutrients and improving its quality.

Keywords
Beer Foam, Nutritional test, Health benefits, Productivity

1. Introduction

Beer is one of the oldest and most consumed alcoholic beverages in the world. Previous studies determined that several characteristics of beer such as taste, foam stability, foam formation and texture are related to the raw materials used (Asano et al., 1982). Among these traits, the stability of beer foam is a major concern of the brewer. The stability of the fine beer foam has been related to the consumer's visual preferences and thus to the quality of the beer (Bamforth 1985).

Foams can be defined as colloidal dispersions of gas within a continuous liquid phase at high fractions of gas volume. The generation of a foam results in a high increase in surface area and requires an input of energy in the system to overcome the force that counteracts the surface tension of the liquid bulk phase. This is achieved by mechanical work in the form of induced turbulence or spraying of the gas phase in the bulk liquid. Foaming increases the Gibbs free energy of the system. All the foams are therefore thermodynamically unstable and the initial state of the energy is restored by collapse of the foam. The thermodynamic instability can be partially improved by several physical and compositional factors (Dale, 1999).

The foam of the beer is unique compared to other characteristics of beer quality (clarity, color, taste and aroma) the foam is generated from the liquid immediately before consumption, and is extensively related to the stabilized protein system, in the which the main stabilization material of the foam is in the form of polypeptide material derived from the solubilization and proteolytic degradation of cereal proteins during malting and brewing processes (Dale, 1999).
The positively ionized proteins of the foam are polypeptides whose levels are predictive of the quality of the foam. This function can be mediated by the direct involvement in the structure of the foam and / or the indirect action that improves the quality of the foam (Evans et al., 1999).

There are many components that determine the quality of beer foam, including proteins, acids, polysaccharides and metal ions such as iron (Bamforth, 2004).

Protein Z (around 43 kDa) and lipid transfer proteins (LTP kDa) were the most abundant proteins in beer foam (NIU et al., 2018). The Z protein family includes the Z4, Z7 and ZX proteins, the Z4 protein was the predominant type since it represented over 80% of the total Z protein (Evans & Sheehan, 1999).

The main objective of our research is to scientifically prove that beer foam contains positive nutritional elements through various laboratory tests, as well as various proposals to make beer foam more attractive to the consumer, to disclose the benefits of the consumption of beer foam, benefits of responsible consumption of beer, which are mainly diuretics because its content is rich in potassium, where it has the ability to be metabolized by the body.

2. Theoretical Framework

Beer is the combination and fermentation of water, hops, barley, yeast and water. These ingredients are mixed in the amounts indicated by the brewer's recipe and put in a tank that carries an air outlet, but not inlet. In this tank the first fermentation takes place and once finished, the liquid is transported to another tank, leaving behind the sediments of the process. In this tank the second fermentation occurs and when this is finished, it is when the beer is bottled. Beer is the most consumed alcoholic beverage in the whole world and represents 78.2% of alcoholic beverages, having a much higher percentage in Mexico where beer represents 93.3% of the total consumption of alcoholic beverages. The beer has its origin in Mesopotamia, where evidence of its consumption has been found for more than 6000 years. The origin started in Egypt, a country where they acquired great importance and where it was also used in therapeutic treatments and in offerings. From Egypt it spread to Europe. Once spread throughout Europe, it reached practically every corner of the world with colonization.

The major component of beer is water, which represents around 92% of the final content. The yeasts, on the other hand, are unicellular fungi that are in charge of the fermentation process, where the result of the fermentation is ethanol and, to a lesser extent, carbon dioxide. Hops is a plant that takes advantage of the female cone of the flower, this ingredient is responsible for giving the beer the bitter taste and characteristic aroma. Finally, the barley or the particular grain used is subjected to a malting process, which consists of making them germinate in water to toast them later; it contains proteins, phenolic compounds, phosphates, vitamins and sugars (starch).

The fiber, dissolved in this drink, prevents constipation and contributes by decreasing the high cholesterol. The minerals found in this drink are mainly silicon, magnesium, potassium and to a lesser degree, sodium. Silicon as the main mineral helps the processes of obtaining calcium, and probably in the connective tissue. In turn, silicon increases bone density by helping in the formation of collagen.

One of the best known properties of beer is its diuretic effect, this means that it causes the elimination of water and electrolytes (including sodium) through the urine. This is due to the high content of potassium that contrasts with the low sodium content (about 15 times higher), it also stimulates liver function and reduces thirst. In addition to increasing blood flow, its composition makes it easy to metabolize, and by having folic acid, it can be used as a treatment for anemia. Likewise, its high content in phenols, acidic compounds that act as reducing agents, produces antioxidant properties which delays cellular aging and prevents cardiovascular problems.

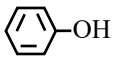

Figure 1. Fenol

The vitamins and minerals that are presented in beer make it a recommended food for cardiovascular diseases because it has a good relationship with the levels of "good" cholesterol, an antioxidant drink since it reduces oxidative agents, besides it is good for bones and for preventing osteoporosis by avoiding the loss of bone mass, it prevents diseases of the nervous system and neurodegenerative, and it is recommended in cases of anemia and menopausal symptoms to relieve their symptoms.

Regarding the protein content of beer, studies have been carried out on the role of beer, especially protein Z, on the stability of beer foam. In one of these studies, the results showed that both positive and negative proteins were

enriched with beer foam. Proteins with lower surface hydrophobicity were used for the stability of the beer foam. Among all proteins, protein Z was the most prevalent protein in beer foam and could be accurately measured using an enzyme-linked immunosorbent assay. It was found that the amount of protein Z correlated positively with the stability of the beer foam. The addition of purified protein Z from barley malt (Hordeum vulgare) in the finished beer could improve the stability of the beer foam. Therefore, proteins with lower surface hydrophobicity could be beneficial for the stability of beer foam, especially protein Z. Table 1 shows the approximate chemical composition of an average beer, note.

Table 1. Characterization of beer liquid

COMPOUND	CONTENT
Water	918/1000 g
Ethanol	51.5 ml/L
Carbohydrates	33.8 g/L
Carbon dioxide	5.15 g/Kg
Protein (amino acids)	4.2 g/L (1.2 g/L)
Glycerol, alcohols, esters, organic acids, aldehydes and ketones	2100 mg/L
Minerals	1300 mg/L
Hops derivatives	400 mg/L
Vitamins (vitamin B)	210 mg/L (42.5 mg/L)
Phenols	175 mg/L
Sulfur anhydride	5 mg/L
Calories	420 kcal/Kg

On the foam, it should be noted its importance, since it is one of the first elements that the consumer judges to determine the quality of a beer, so it is really important to the brewer. The quality of the foam is characterized by its stability, adherence to the cup and its texture; these are basically determined by the quality of the malted barley and hops used in brewing. In addition to the basic quality of the foam, fixed by the raw materials, it also influence: the brewing process, the use of additives to improve the foam, the packaging and the way to serve the beer. High levels of certain key proteins of the malt and hop acids improve the foam, while the inclusion of excessive levels of lipids, an excessive modification of the proteins and a high content of ethanol reduce the quality of the same.

The foam properties of the solutions in the bottles were evaluated using a pour type foam test. Using this foam test, a beer protein with excellent foam and physical stability was identified. This protein was identical to the barley lipid transfer protein (LTP-PAPI) when comparing its amino acid sequence. The complete amino acid sequence was determined by the molecular weights of the protein and individual peptides were analyzed by mass spectrometry. Melanoidins, on the other hand, have foam stabilizing properties, which are independent of other functions in helping the foam properties of beer proteins. The beer polysaccharides formed foam, but the stability of the foam was lower than the proteins and melanoidins.

This project presents a research in the nutritional content of beer foam through various laboratory tests, as well as proposals to make the foam more attractive to the consumer so that beer can be used in its entirety, serving equally as a means to divulge the benefits of beer. Through the tests, which are explained in detail in the document, the content of proteins, phenols, vitamins, carbohydrates and minerals (which include potassium, phosphorus, calcium, silicon and magnesium) in the foam of a particular beer brand was determined. In addition, the benefits of responsible beer consumption are described, mainly due to its diuretic effect (thanks to its potassium content), its ability to be metabolized, its vasodilator capacity and its antioxidant content. Looking to avoid the waste of a good percentage of beer, which occurs when the consumer discards the foam, relevant data about the beer are presented with emphasis on its content and properties, both generally and in the particular case of foam.

3. Method

The methodology to generate the foam and characterize it was through ultrasound as can be seen in figure 2. The foam that is generated with this device is collected in cans and introduced to a freezer with temperatures of up to 17

° C. The foam at this temperature appears in a semi-liquid form and when it returns to take the temperature above the freezing temperature it returns in liquid form; it is intended to analyze the changes in the concentration of the phenols each time foam is generated and it returns to form in liquid.

Figure 2. Ultrasound equipment to generate foam

The materials, reagents and equipment for the determination of the group of phenols is as follows: Preparation of various solutions of gallic acid. Subsequently, in order to extract the phenolic compounds from the sample of the beer foam, the appropriate amount of beer foam sample is added to a tube and methanol added in a 1:2 ratio. Sodium fluoride (2mM NaF) is also added to inhibit the polyphenol over and prevent the degradation of the polyphenols during the test. The contents of the tubes are homogenized in the vortex and centrifuged at approximately 10,000 rpm in a time of 20 minutes at a temperature of 10°C. To characterize the polyphenols in the beer sample and in the gallic acid standards that have been previously prepared, 250 µL of each gallic acid standard solution or supernatant that comes from the extraction of the polyphenolic compounds in the beer sample and place them in 25 mL volumetric flasks. To each test 15 mL of distilled water and 1.25 mL of Folin-Ciocalteau reagent are added. The contents of the flasks are homogenized and allowed to stand for 8 minutes in the dark. Once the 8 minutes have elapsed, 3.75 mL of the 7.5% sodium carbonate solution is added and it is lowered to a volume of 25 mL with distilled water. Again the flasks are homogenized and kept in the dark room temperature for 2 hours. Finally, the absorbance at 765 nm is measured.

Table 2. Equipment and reagents in liquid and beer foam

Equipment	Reagents
UV-Visible Spectrophotometer	Gallic acid
Analytical balance	Methanol
Centrifuge	Distilled water
Shake tubes (vortex)	Folin-Ciocalteau reagent
Volumetric flasks of 25 mL and 10 mL	Sodium carbonate 7.5%
50 mL beakers	Sodium fluoride
Pipettes of 1, 5 and 10 mL	
Test tubes with stopper	
Centrifuge tubes	
3 mL plastic cuvettes	

The determination of the total group of phenols is represented in table 3

Table 3. Phenols in liquid and beer foam

CONTENT OF PHENOLS IN BEER	CONTENT OF PHENOLS IN FOAM
175 mg/L	278 mg/L

4. Conclusion

In this work an investigation was carried out through a characterization of both the liquid and the foam of the beer. Normally it has been attributed to beer various health benefits derived from the content of phenols, responsible for improving the cardiovascular system of our body. However, which relation exists in the phenolic content between the liquid that we ingest from the beer against the foam that we usually throw for reasons of taste, aroma and ignorance of the diversity of benefits contained in it. The innovation in this work is to characterize the beer foam to determine its real benefits and promote its intake according to its potential benefits in consumption. It has been proved that the phenolic content in beer foam is actually greater than the phenolic content in the liquid. It has also been observed in this work that when the foam returns to its liquid state, the phenolic content does not decrease, which means, that it is not a reversible process. It can be determined and affirmed that effectively the consumption of beer foam provides greater benefits than the liquid itself.

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Biographies

Gerardo Espinosa-Garza obtained his Bachelor's in Chemical Engineering, his Master's in Environment Studies and Doctoral degree in engineering in Barcelona, Spain. He is the professor of engineering in the Tecnologico de Monterrey, Mexico. He has been the Construction Projects director for more than 20 years, with responsabilities ranging from management of institutional contracts to engineering, operations, maintenance and construction of instalations. From January 2015 to today, he has published 5 patents and created more than 20 prototypes and published a great number or articles. He belongs to the National System of Researchers of Mexico.