STUDY ON QUALITY OF DIFFERENT MALT TYPE USED IN BREWING INDUSTRY

Gh. MATEI[1], Ana Maria DODOCIOIU[2]

University of Craiova, Faculty of Agronomy

Corresponding author: anadodocioiu @gmail.com

Abstract. *Research has led to the conclusion that beer is the oldest drink produced by man. The first evidence about beer dates back 4,000 years. It is assumed that Mesopotamia is the land where this liquor has been produced for the first time. Her discovery was completely accidental: a harvest of barley bread-making, devastated by rain to germinate. Exposed to the sun, germinated barley is contaminated with yeasts naturally present in air and thus was born beer. The main raw materials used in brewing and malting industry are: barley, common hop, water and malt substitutes (Felicia Stoica, 2012). Malt is a product made from grains (mostly barley) sprouted, dried and milled, used in the manufacture of beer and spirits or fried for the preparation of a coffee substitute (Romanian DEX, ed.1998). It is the main raw material used in the manufacture of beer, it is a source of substances into the substrate and a source of hydrolytic enzymes which by their action on the substrate leads to the formation of the production of worth extract. In brewing, malt is analysed chemically and physically. It is estimated the appearance, size, uniformity of grain, colour, purity, smell, taste and resistance to crushing teeth. Malt grains must be as large and smooth. The main chemical constituent of the barley, the starch is in the form of granules located in the cells of the endosperm. The beads of different sizes have a structure midsole, semi-crystalline, consisting of concentric layers formed on a spot. The structure is broken when grain absorbs water, it swells and hot, its components gelatinizes chemicals. From the chemical point of view, the granule is composed of 17-24% amylose, 74-81% amylopectin and 2% of other substances (polar lipid, protein substances, and minerals). Nitrogenous substances can quantity vary greatly with variety and related to the pedo-climatic conditions. Thus, for malting barley, malt and especially for obtaining blonde beers, should contain dry substance from 9 to 11.5%. Although the amount of protein in a barley only 1/3 pass into beer, they have a great influence on beer quality, affecting the colour, fullness of taste, foaming characteristics, its colloidal stability of beer and flavour (Banu C., 2009).*

Key words: *malt types, quality of malt, grain uniformity, total protein content.*

INTRODUCTION

The malt is the product obtained by grinding barley grain (barley), sprouted (germinated) and dried used to make beer and spirits. Manufacture of malt covers the following main steps: soaking barley; germination of barley; drying of malt. (FELICIA STOICA, 2012).

Physical indices include determining hectolitre mass (ranging between 53-60 kg), the seed hardness, seed uniformity, plumule length and diving behaviour. Within malt chemical analysis to determine the humidity (the limit is 5%), the yield of malt extract, saccharification time, colour and other indices. Malt purchased from the factory is stored in silos at 10-15 ° C. Before use, malt must be cleaned of impurities by passing through a magnetic separator and vacuum tarar. Cleaned malt is weighed with scales automatically. A high water content is economically disadvantageous because it makes storage difficult.

[1] Faculty of Agronomy - Craiova

[2] Faculty of Horticulture - Craiova

Special malts are those that are used in a certain relation to brewing to improve the colour, taste and aroma, fullness, acidity and foaming beer. These malts ensures full taste of beer such as malt, caramel malts for dark malts for a flavour and malts that have a high content of reducing substances. Use the following types of special malts: caramel malt, colour malt, malt acid, melanoidin malt, malt "sharp" Vienna malt Stout malt, Munich malt, amber malt, chocolate malt, black malt and malt Roast.

Because these malts are destroyed enzymes cannot saccharify and they are used in mixtures with blond or brown malt no more than 20%. It prints great taste to the beer. The most used malt is a special one - malts caramel.

MATERIAL AND METHODS

The study conducted had as main objective to monitor the quality indices of the main raw material used in the manufacture of beer - malt - the qualitative determination of technological characteristics of batches introduced into the manufacturing flow.

Framing watched lots qualitative reporting results was done at both international standards and the internal standards of SC HEINEKEN Romania S.A. - Craiova factory.

Heineken's (www.heineken.com) quality policy for the use of raw materials is to only use ingredients that are safe for human consumption. The packaging materials and primary packaging must comply with all statutory guidelines and a good HACCP system is mandatory for all suppliers of these goods. In order to assure the quality of raw materials and packaging materials, all of its breweries have their own laboratories, in which entry checks are conducted in a systematic manner (CHARISIS G. VRELLAS AND GEORGE D. TSIOTRAS, 2013).

In flow *receive - processing - product* - have undergone quality control three types of malt:

- Malt type B – 10 batches;
- Malt type C – 10 batches;
- Malt type Caramel – 10 batches.

From each batch of malt that was to enter the production line were extracted samples (samples) were homogenized into a composite sample and reduced according to laboratory standards resulting homogeneous and representative samples.

Laboratory samples were extracted for analysis and this analyses were conducted in accordance with the operational procedures contained in the Quality Manual implemented in HEINKEN ROMANIA - Craiova factory.

At malts type B and C, whose percentage participation in manufacturing beer recipes is decisive, were determined:

- ✓ uniformity of grain> 2.5 mm;
- ✓ friability or a degree of fineness the grinding;
- ✓ moisture%;
- ✓ pH;
- ✓ vitreous of seed;
- ✓ Kolbah index;
- ✓ free nitrogen and total nitrogen;
- ✓ soluble protein;
- ✓ total protein;
- ✓ saccharification time;
- ✓ extract;
- ✓ final degree of fermentation;
- ✓ colour.

At Caramel malt type that use of user in a smaller scale and in particular to print a certain colour beers were made the following determinations:

- ✓ friability;
- ✓ moisture;
- ✓ pH;
- ✓ Husk index;
- ✓ total protein;
- ✓ extract;
- ✓ colour.

RESULTS AND DISCUSSION

Uniformity of grain (*ROB3 / 071GRDG*) - tables 1 - 3 and figure 1 in the composition of batches of malt used in the brewing industry seeds grading higher than 2.5 mm must be equals at least 70% for consignments from barley and at least 80% of consignments of barley for beer. Looking at this indicator, lots of malt B values recorded were between 92.20% in group B1 to 96.90% B9 group, with higher values minimum standards.

Loads malt-type C have a uniform grain that ranged from 93.6% in group C1 and 97.9% in group and C2, very good compared to standard values.

Lots of caramel malt were more homogeneous, with values ranging from 91% to lots CA8 and CA9 to 96.7% in group CA6

Table 1

Physical Indices on malt type B

LOT	ROB3/071-FRIA	ROB3/071-GRDG	ROB3/071-MOIS	ROB3/071-PH	ROB3/071-KOLB	ROB3/071-PUG
	071-Friability %	071-Grading, > 2.5 mm	071-Moisture %	071-pH	071-Kolbah index	071-PUG %
	Value	Value	Value	Value	Value	Value
B1	94,10	92,20	5,10	6,10	40,90	1,10
B2	95,20	95,00	4,00	6,06	40,20	0,50
B3	95,60	95,60	4,40	6,06	39,00	0,50
B4	95,10	93,30	4,50	6,08	42,40	0,90
B5	90,50	92,50	5,00	6,08	42,50	3,90
B6	93,50	95,00	4,10	6,09	44,10	1,60
B7	89,70	96,40	4,30	6,09	39,50	1,10
B8	89,50	96,70	4,40	6,08	37,80	1,20
B9	90,60	96,90	4,50	6.01	41,60	1,10
B10	92,60	96,50	4,50	6,07	44,30	1,00

In conclusion based on this index we can say that lots of malt monitored high values can be used in the production flow.

Table 2

Physical Indices on malt type C

LOT	ROB3/071-FRIA	ROB3/071-GRDG	ROB3/071-MOIS	ROB3/071-PH	ROB3/071-KOLB	ROB3/071-PUG
	071-Friability %	071-Grading, > 2.5 mm	071-Moisture %	071-pH	071-Kolbah index	071-PUG %
	Value	Value	Value	Value	Value	Value
C1	92,50	93,60	4,40	6,08	40,10	1,00
C2	98,10	97,90	5,20	6,14	41,90	0,40
C3	94,10	96,80	4,60	6,12	40,20	1,10
C4	94,40	96,20	4,00	6,12	38,30	0,90
C5	91,30	93,90	4,00	6,11	46,50	1,50
C6	92,40	96,10	4,10	6,10	42,10	1,00
C7	93,10	96,70	4,80	6,09	43,10	0,80
C8	95,10	96,00	4,30	6,10	40,10	0,70
C9	95,50	96,20	4,50	6,14	41,70	0,50
C10	91,60	94,90	4,10	6,10	44,10	0,80

Friability (*ROB3 / 071-Fria*) tables 1 and 2.

To ensure a fermentation process with a high yield of malt barley grains are milled. Grist quality directly influences: extraction and yield of the leaven extract, during brewing, filtering speed, clarity and stability worth. Regrind analysis is done using samples of 100-200 grams.

On lots of malt Type B values ranged between 89.5% in group B8 and 95.6% in group B3. It can be seen that in this case the values recorded in the analyses for this kind of malt are above the minimum of 85% mentioned in work standards.

At batches type C the friability values were higher than those found in malt type B, between 91.3% in C5 group and 97.9% tin C2 group.

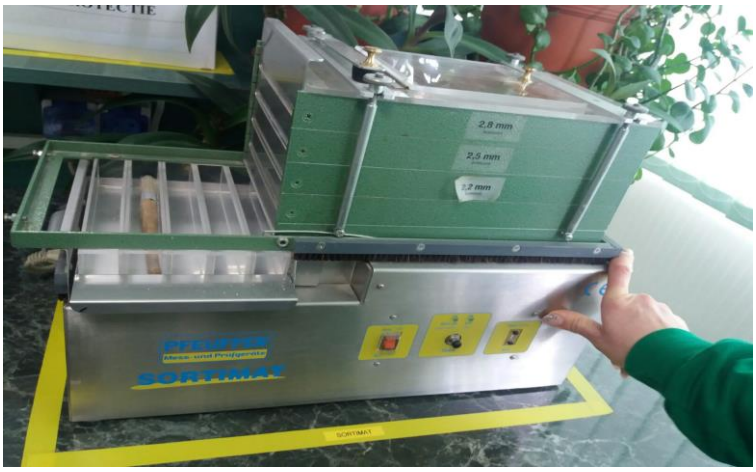

Figure 1 - Equipment used to determine the uniformity of grain

Table 3

Physical Indices on malt type Caramel

LOT	ROB3/071-GRDG	ROB3/071-MOIS	ROB3/071-PH	ROB3/071-PLVA
	071-Grading, > 2.5 mm	071-Moisture %	071-pH	071-Husk %
	Value	Value	Value	Value
CA1	94,10	2,30	6,02	1,40
CA2	92,40	3,00	6,28	3,60
CA3	96,20	2,43	6,32	1,20
CA4	93,90	1,98	6,10	1,30
CA5	96,10	3,20	6,18	1,10
CA6	96,70	1,70	6,24	0,70
CA7	92,00	2,00	6,19	1,20
CA8	91,00	5,24	6,15	1,20
CA9	91,00	2,60	6,17	1,10
CA10	92,00	2,70	6,11	1,20

Moisture (*ROB3 / 071-MOIS*) Tables 1 - 3.

It can be seen that lots of malt B and C humidity values ranged generally between 4% to lots C4, C5 and B2 and 5.2% in group and C2 (tables 1 and 2).

Caramel malt type had lower values (table 3), which ranged from 1.98% in group CA 4 and 5.24% in group CA8.

Vitreous of seed (*ROB3 / 071-PUG*) – on the lots of malt used in brewing we should have a value as small as there is an inverse relationship between the amount and nitrogen free extractives of barley grains.

Analysing this index has found that malt lots B and C which were determined values, they ranged between 0.4% in group C2 and 3.9% in group B5. Valuable from this point of view proved to be the batches of B2, B3, B10, C8 and C10 (tables 1 and 2).

PH (*ROB3 / 071-PH*) - Tables 1 – 3. The values determined in this index ranged from 6.01 batch of malt Type B - B9 and 6.24 batch of caramel CA6.

Kolbach index (*ROB3 / 071-KOLB*) Tables 1 - 2. - Is the ratio between the percentage of total soluble protein and the percentage of nitrogen. Kolbach index allows it to encode chemical disintegration of malt.

Appreciation is made using a scale of values which range between 29% and 45%:

- 45 excessive and could cause a disintegration of beer;
- 41 very good disintegration;
- 35 to 41 good disintegration;
- <35 poor disintegration.

For analysed lots it was found that all batches of malted B and C were employed with values in groups disintegrating good and very good, except batch of malt-type C - C5 in which the index was higher 45% (of 46.5%). This can cause disorders of worth in the manufacturing process.

Husk index (*ROB3 / 071-PLVA*).

The index represents the percentage of husk that contains malt sample after milling. It was determined only by caramel malt and ranged from 0.70% to 3.60% in group CA6 and CA2 (table 3).

Final Atenuation Limit (*ROB3 / 071-AEFA*) - Tables 4 and 5.

In fermentative industry food technologies the efficiency of the fermentation process is an index of performance and capacity of an engineer to conduct the process, he was influenced by several factors among which and quality of raw materials used - the type of malt and technological processing characteristics.

Lots of malt Type B degree of fermentation varied between 79.5% in group B8 and 83.40% in group B1. It can be noted that, in this kind of malt, with one exception, the degree of fermentation values are greater than 80%.

Batches of type C had a final degree of fermentation of between 80.20% in group C 5 and 83.20% in group C1 with smaller amplitudes compared to lots of malt type B. Uniformity largest of these groups of this view makes the process easier digestion and thus lead to higher quality finished product.

Table 4

Chemical Indices on malt type B

LOT	ROB3/071-AEFA	ROB3/071-COLR	ROB3/071-EXAS	ROB3/071-EXDM	ROB3/071-FAN	ROB3/071-SACC	ROB3/071-SPRO	ROB3/071-TN
	071-Final Atenuation Limit %	071 -Colour	071-Extract as is %	071-Extract, d.m. %	071-FAN units	071-Saccarafication time min	071-Soluble Protein mg/l	071-Total N2 %
	Value	Value	Value	Value	Value	Value	Value	Value
B1	83,40	3,70	77,90	82,10	167,00	15,00	711,00	1,74
B2	82,30	3,70	78,40	81,60	145,00	15,00	700,00	1,74
B3	82,30	3,70	77,80	81,40	151,00	15,00	687,00	1,76
B4	82,20	3,60	77,10	80,80	153,00	15,00	729,00	1,72

B5	80,90	3,80	77,20	81,30	143,00	15,00	730,00	1,72
B6	82,00	3,80	78,60	81,90	149,00	15,00	768,00	1,74
B7	80,10	3,50	79,50	83,10	141,00	15,00	616,00	1,56
B8	79,50	3,40	79,70	83,30	141,00	15,00	616,00	1,63
B9	81,30	3,40	79,80	83,50	145,00	15,00	695,00	1,65
B10	81,70	3,90	78,80	82,50	154,00	15,00	747,00	1,68

Colour (*ROB3 / 071-COLR*) - Tables 4 t- 6 - malts used in the brewing industry are appreciated due colour, this index influencing the characteristics of the finished product - beer. Malts type B and C had colour values - relating to the rating scale of 1 to 5 - between 3.40 (B8 and B9 lots) to 4.0 and the batch of malt-type C - C2.

Lots of Caramel malt, which is used to obtain varieties of beer brown or black, have a different level of appreciation and recorded high values between 323 units at CA 4 and 420 units and CA 7 batch.

Table 5

Chemical Indices on malt type C

LOT	ROB3/071-AEFA	ROB3/071-COLR	ROB3/071-EXAS	ROB3/071-EXDM	ROB3/071-FAN	ROB3/071-SACC	ROB3/071-SPRO	ROB3/071-TN
	071-Final Atenuation Limit %	071-Colour	071-Extract as is %	071-Extract, d.m. %	071-FAN units	071-Saccarafication time min	071-Soluble Protein mg/l	071-Total N2 %
	Value	Value	Value	Value	Value	Value	Value	Value
C1	83,20	3,50	77,60	81,20	147,00	15,00	690,00	1,72
C2	80,50	4,00	76,70	80,90	144,00	15,00	630,00	1,51
C3	81,30	3,80	76,90	80,60	145,00	15,00	656,00	1,63
C4	82,30	3,70	77,40	80,60	145,00	15,00	657,00	1,71
C5	80,20	3,60	75,80	79,00	141,00	15,00	771,00	1,66
C6	80,30	3,60	76,50	79,80	139,00	15,00	708,00	1,68
C7	82,90	3,60	78,20	82,20	123,00	15,00	714,00	1,66
C8	81,30	3,70	77,50	81,00	120,00	15,00	659,00	1,64
C9	81,30	3,80	76,20	79,80	132,00	15,00	713,00	1,71
C10	82,40	3,60	76,90	80,20	129,00	15,00	712,00	1,61

Extract - *Crude extract (ROB3 / 071-EXAS)* and on the *dried extract (ROB3 / 071-EXDM)* - Tables 4, 5 and 6 - were values that were within the technological parameters for the use of malts in the beer industry. Minimum limits for crude extract were 72.60% in group CA6 and 79.80% the group B9.

On the dried extract values of manufacturing increased from 73.90% in group CA6 and 83.50% on B9. With high values of this index fall and lots B7, B8, C7 and CA 10

Table 6

Chemical Indices on malt type Caramel

LOT	ROB3/071-COLR	ROB3/071-EXAS	ROB3/071-EXDM
	071-Colour	071-Extract as is %	071-Extract, d.m. %
	Value	Value	Value
CA1	375,00	76,50	78,30
CA2	351,00	75,30	77,60
CA3	372,00	76,80	78,70
CA4	323,00	75,60	77,10
CA5	355,00	76,00	78,50
CA6	399,00	72,60	73,90
CA7	420,00	74,50	74,10

CA8	370,00	75,80	75,10
CA9	361,00	74,40	75,20
CA10	386,00	73,50	75,30

Free nitrogen (*ROB3 / 071-FAN*) - Tables 4 and 5 - in accordance with the quality standards for raw material malt it must have values less than 160 units. The values determined in samples extracted for malt B1 were within this parameter, except that the lot B1 benchmark was exceeded by 7 units (167 units).

Free nitrogen level to lots of malt-type C was lower, between 120 units and 147 units in group 8 in group C1. From this point of view malt batches of type C have been found to be superior to the B type.

Saccharification time (*ROB3 / 071-SACC*) - Tables 4 and 5

After weighing, malt and malted grains are crushed us in special mills to enable the enzyme to act during operation and knead saccharification. Using water and under the action of enzymes in the malt is made from mash and insoluble macromolecular substances transformation saccharification of malt produced soluble low molecular weight and average that will make worth extract.

After saccharification the product is filtered to separate the worth parties will form insoluble malt mash. So first stum has a higher concentration. The main enzyme solubilisation process that occurs during the stum obtaining is the disintegration of starch. Besides this is registered decomposition of protein, hemicelluloses and some phosphates.

In groups with higher quality, during saccharification must be within 30 minutes. In this context, the evaluation malts B and C analysed revealed a saccharification 15 minutes in all groups, ranking them from this point of view the upper range of the raw materials used in the beer industry.

Soluble protein (*ROB3 / 071-SPRO*) - Tables 4 and 5.

Soluble protein content of consignments of malt Type B ranged from 616 mg/l on B8 and B9 lots and 768 mg/l in group B6.

Lots of malt-type C were recorded values of this index between 630 mg/l in group C2 and 771 mg/l in group C5.

In terms of qualitative parameters analysed all batches fulfil the standardized processing technology for beer varieties produced by HEINEKEN Romania S.A.

Total nitrogen (*ROB3 / 071-TN*) - Tables 4 and 5.

According to brewing standards, the total nitrogen amounts found in malts used, should be less than 2%. Lots of malt Type B recorded total nitrogen values of between 1.56% in group B7 and 1.76% in group B3. For lots of malt-type C values obtained from measurements ranged from 1.51% group C2 to 1.72% in and C1 group.

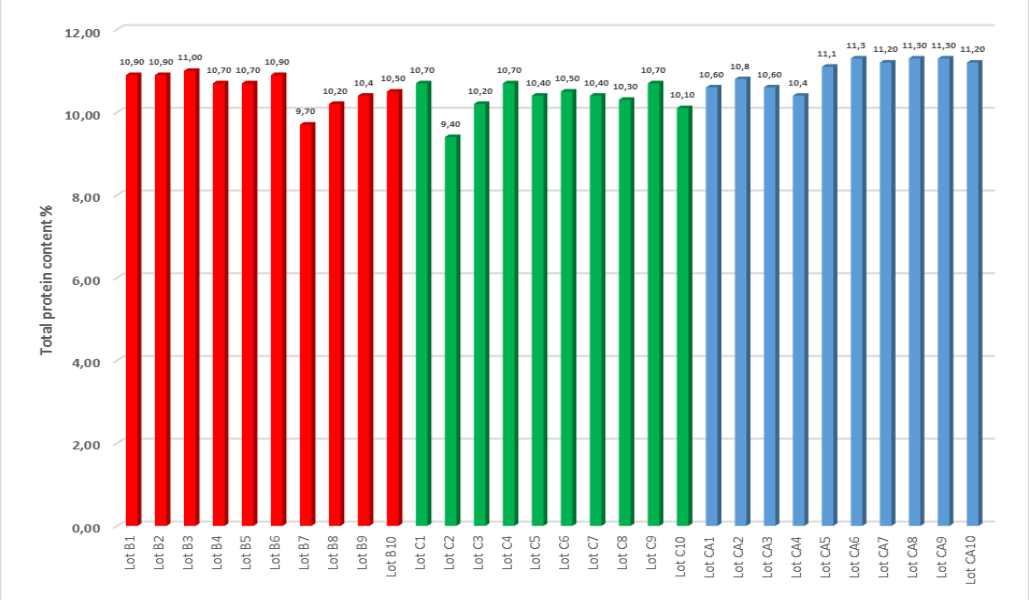

Figure 2 - Total protein content on studied batches of malt

Total protein content (*ROB3 / 071-Tpro*) - Figure 2.

Malts entering the brewing process must be as low as protein to not to impregnate one state worth cloudy feature, which makes it harder to settle.

Compared among the three types of malt analysed, we can say that on average, the highest values were found in malt caramel, with a maximum of 11.30 grams lots CA6, CA8 and CA9.

It can be observed that from this standpoint majority of the lots have metrics of quality class I (total protein content of between 9 and 11%), except lots CA5-CA10

CONCLUSIONS

If we taking in account that the HEINEKEN - Factory Craiova manufacturing activity is carried out after the implementation of quality standards found in the Quality Manual and the process is governed by procedures, we can say that this new production facility meets the highest standards covering all aspects of quality: quality of raw material, finished product quality, employee protection and respect for the environment.

Summarizing the data presented in this paper we may be mentioned that the most important, as follow:

- ✓ the qualities of the technological processing of malts B, C and caramel type are different, the proportion in which these types of malt are used in the process varies depending on this, and the recipe of the beers to be obtained and how the process is conducted;
- ✓ one of the most important clues mention physical quality: grain uniformity, friability, humidity vitreous of seeds, colour and index Husk;

- ✓ a specific physical parameters analysed in 30 batches of malt were within the standards of quality of the beer industry and the internal standards of Heineken Romania;
- ✓ one important role in obtaining quality of products belongs to the chemical indices of the raw materials: Kolbach index, extract, final atenuation limit, the free and total nitrogen, saccharification time and total soluble protein;
- ✓ qualitative parameters of chemical indices determined in groups monitored showed that they put the malt type analysed in first class quality raw materials, the result of this situation being in the quality of finished products obtained: a large assortment of blondes and black beer from the portfolio of Heineken Romania;
- ✓ from a qualitative point of view was a slight superiority of malts type C indexes physical and chemical values were significantly higher compared with malts type B;
- ✓ for malts type Caramel, whose shareholding in recipes is between 10 and 20%, the number of indicators determined was lower being monitored only that which are reflected directly on the quality of beer produced: colour friability, protein content, and the pH of the extract.

BIBLIOGRAPHY

1. BANU C., 2009 – Tratat de industrie alimentară.Tehnologii alimentare, vol.2, Editura ASAB, Bucureşti
2. BERZESCU P. ŞI COL., 1981 – Tehnologia berii şi malţului, Editura Ceres , Bucureşti
3. BRRIGS D.E., 1995 – Malting and brewing Science, vol. I, Editura Chapman et Hall, London
4. CHARISIS VRELLAS AND GEORGE TSIOTRAS, 2013 - Quality management in the global brewing industry - IJQRM 32,1, International Journal of Quality & Reliability Management Vol. 32 No. 1, 2015 pp. 42-52.
5. HOUDSON O.P. 1986 – Centenary review. Malting technology. Inst. Brew, nr. 92
6. HOUGH I. S. ŞI COL., 1995 – Malting and Brewing Science. vol. Ii, Ed. Chapman et Hall, London.
7. NARZISS, L. 1980Abriss der Bierbrauerei. Ferdinand Enke Verlag, Stuttgart.
8. NARZIS L., 1985 - Centenary review. Technological factors of flavor stability. Journal. Inst. Brew, nr. 92, pag. 346
9. PETERSEN, H. Brauerreianlagen Ed. Hans Cari Nurenberg (Brauwelt Verlag), 1986.
10. SOBERKA R. ŞI COL., 1989 – Pectinatus nouvelle bactérie pouvant affecter la stabilité biologique du mout et de la bière. Bios, bol. 20, nr. 1-2
11. SOBERKA R., WARZECHA A., 1986 – Influence de certains facteurs sur le taux d'oxygène dissous au cours de la fabrication de la bière. Bios, nr. 8-9.
12. STOICA FELICIA, 2007 – Tehnologii generale în industria alimentară fermentativă, Editura Sitech, Craiova
13. STOICA FELICIA, 2012 – Tehnologii generale in industria alimentara. Procese tehnologice si metode de analiza. Editura Sitech, Craiova.
14. *** **www.heineken.com**