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Study Of Β-Glucan Content Influence On Turbidity Beer Formation.

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ABSTRACT

The quality of beer is formed from grain and other plant materials used in the production technology. Its composition is a complex colloidal system. The beer durability is one of the important aspects that form the concept of finished drink quality. It causes the moving of biochemical processes in the production of beer, which are formed from the qualitative indicators of raw materials and compliance with technological parameters. This article reveals the need to study substances that effect on beer durability. It discusses the impact of the β-glucan level, extracted from malted and unmalted raw materials at the mashing stage, on the intensity of turbidity formation in beer, depending on the raw materials used in production.
Keywords: beer durability, accelerated aging, β-glucan, polyphenols, malt, barley

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INTRODUCTION

Beer is a complex colloidal system, its composition is determined by the components of plant raw materials used in beer technology: this is mainly barley brewing malt, unmalted raw materials and hops. During the storage of beer, the equilibrium conditions of the colloidal state can be violated, which leads to the turbidity formation. The compounds responsible for the formation of beer suspensions are most relevant to non-starch polyphenols and carbohydrates.

Therefore, it is important to monitor these indicators responsible for the formation of persistent turbidity during beer storage, in particular, the content of β-glucan.

During the study, it was necessary to solve the following tasks: to follow the path of formation and transformation of β-glucan at each of the stages of beer production, its dependence on the density of the initial wort; and the degree of influence on the formation of colloidal sediment.

LITERATURE REVIEW

Not only the glucan forms that appear during grain cytolysis in germination (so-called β-glucan) affect on the colloidal beer dregs formation, but also the forms that arise during saccharification of malt wort (so-called α-glucan) [1]. The last ones have α (1-4) and (1-6) bonds and include more than 26 glycosidic residues, non-hydrolyzed by malt enzymes during mashing - endo-β-glucanase, exo-β-glucanase and β-glucan solubilase. Mashing at a temperature of 45 to 47 ° C promotes hydrolysis of the non-starch polysaccharide under the action of endo-β-glucanase and exo-β-glucanase, then with increasing temperature to 60 ° C, this group of enzymes is completely inactivated, while β-glucan solubilase exhibits its optimal action at a temperature of 60-65 ° C, and its inactivation occurs at 70 ° C [3][1].

Scientists also note that the cause of the colloidal complexes formation by β-glucan molecules is the increased formation of hydrogen bonds during fermentation [4]. It is interesting that β-glucan molecules are associated with polysaccharides in the hopped wort, they are consumed by yeast during fermentation and are replaced by water molecules, which form hydrogen bridges between the β-1,4-cellotriose and cellotetraose sections. During fermentation glucan molecules can be enlarged due to the negative effects of aromatic substances, ethanol and the growing acidity of the environment.

MATERIALS AND METHODS

To assess the influence of β-glucan content on wort and beer quality, research methods were used: determination of β-glucan content – a photoelectrocolorimetric method of β-glucan content measuring [5]; determination of the volume fraction of alcohol - GOST 12787-81, the arbitration method, which is the separation of the alcohol fraction of a drink from extractive substances by distillation [6]; determination of polyphenols - EBC 9.11 [7]; determination of titratable acidity - GOST 12788-87, which is a method for the titration of the acid content by neutralizing them with a 0.1 sodium hydroxide solution [8]; determination of beer stability – measuring beer turbidity after holding at different temperatures (65°C and 0°C); determination of the mass concentration of sugars and glycerol - a method of high-performance liquid chromatography with a refractometric detector "Agilent Technologies 1200" ("Agilent", USA), equipped with an automatic system for collecting and processing information [9]; determination of mineral content – GOST 26929-94 with subsequent weighing [10].

The replication of experiments at all stages of the experiment - not less than 3. The results of experimental studies were processed by methods of mathematical statistics using Student's criterion.

In order to conduct a study on the production of beer, the following materials were used: barley malting brewing malt; barley; maltose syrup; dry brewing yeast S. cerevisiae.

The wort was prepared from cereal raw material with different bricks by infusion method.

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RESULTS

The substance of β-glucan was investigated in samples of wort (hopped and unhooked), young beer and finished beer. The finished data is presented in table 1.

Table 1: β-glucane content in wort and beer

Bricks of non-hopped wort (±2,0%), %	β-glucan content (±7,0%), mg/dм^3, in sample			
	wort		beer	
	non-hopped	hopped	after main brewing	finished
	Raw materials - 100,0 % malt			
10,0	558,5	381,0	279,0	200,0
14,0	930,0	479,5	465,0	260,0
18,0	1420,0	922,0	570,0	300,0
	Raw materials - 80% malt + 20% barley			
10,0	342,0	256,5	246,5	190,0
14,0	395,5	276,5	253,0	230,0
18,0	537,5	431,0	265,0	275,0
	Raw materials - 98% malt+2% maltose syrup			
10,0	412,0	380,0	255,0	180,0
14,0	888,5	459,5	425,0	210,0
18,0	1380,5	866,5	500,0	255,0

The data in table 1 showed that the content of β-glucan increases proportionally with increasing content of extractives in malt wort. Reducing the proportion of malt in the mash leads to a decrease in the amount of β-glucan. Thus, the introduction of 20% barley causes a significant reduction in the content of β-glucan - up to 2.6 times, and 2% maltose syrup - up to 2.3 times.

The hopping process makes changes in the amount of dissolved β-glucan — due to combination of glucan molecules with hop polyphenols and wort proteins, the β-glucan concentration decreases by an average of 30-50%.

During the process of fermentation and finished fermentation connected with the sedimentation of yeast molecules, polyphenols, proteins, etc. the content of β-glucan is also reduced by 5-35%.

In order to assess the degree of beer fermentation, the composition of the remaining dissolved carbohydrates of beer was determined and the data is presented in table 2.

Table 2: The fermentable carbohydrate composition of finished beer

Parameter (±)	Bricks of non-hopped wort (±2,0%), %		
	10,0	**14,0**	**18,0**
Raw materials - 100,0 % malt			
glucose	0,13	0,21	2,59
maltose	0,52	1,10	2,28
maltotriose	5,70	12,62	16,66
Total	6,35	13,93	21,53
Raw materials - 80% malt + 20% barley			
glucose	0,20	0,28	0,34
maltose	0,37	0,66	1,04
maltotriose	2,90	8,47	11,71
Total	3,47	9,41	13,09

Raw materials - 98% malt +2% maltose syrup			
glucose	0,13	0,23	0,24
maltose	0,63	1,83	2,46
maltotriose	5,54	11,78	15,34
Total	6,30	13,84	18,04

The data obtained in Table 2 shows that the fermentation processes were most fully carried out in a sample of beer, where 20% of unmalted barley was used. This is important results as it makes possible to evaluate the influence degree on the intensity of fermentation factors at the condition of β-glucan molecules, since there is a theory and it states the relationship between the depth of the fermentation process and the intensity of β-glucan formation of gel-like precipitates [3].

The finished beer was exposed to natural aging by the EMU method and the damaged indicators were measured, this data is presented in table 3.

The obtained data of table 3 showed an increase in the turbidity of the beer samples in all cases by 2 units. EMU, an increase in acidity of 1.1 - 1.5 times and a decrease in 2 times the amount of polyphenolic substances. Sediment formation was observed in all samples.

Table 3: Parameters beer subjected to accelerated aging

Bricks of non-hopped wort (±2,0%), %	Parameters in sample					
	beer before treatment			beer after treatment		
	hase, un. EBC, H_{90}/H_{25}, ±0.1	acidity, un.ac., ±0.2	polyphenol content, mg/dm^3, ±7,0%	hase, un. EBC, H_{90}/H_{25}, ±0.1	acidity, un.ac., ±0.2	polyphenol content, mg/dm^3, ±7,0%
	Raw materials - 100,0 % malt					
10,0	0.48/0.60	2.8	166.8	0.48/0.60	3.5	93.4
14,0	0.50/0.65	3.2	238.0	0.48/0.60	5.7	130.9
18,0	0.51/0.66	3.4	290.0	0.48/0.60	5.8	156.6
	Raw materials - 80% malt + 20% barley					
10,0	0.39/0.44	2.9	190.5	0.60/0.58	4.9	99.5
14,0	0.40/0.45	3.2	225.0	0.68/0.60	5.7	110.9
18,0	0.42/0.47	3.5	285.0	0.62/0.65	5.9	136.0
	Raw materials - 98% malt+2% maltose syrup					
10,0	0.31/0.20	3.0	215.0	0.50/0.40	3.5	105.4
14,0	0.35/0.30	3.3	236.0	0.55/0.50	5.9	122.5
18,0	0.41/0.31	3.5	285.0	0.61/0.59	6.2	145.4

In order to study the composition of the resulting turbidity, its composition was also studied, and the results are given in Table 4.

Table 4: The parameters of beer samples subjected to accelerated aging

Bricks of non-hopped wort (±2,0%), %	Parameters content of turbidity composition beer, %		
	polyphenol ±7,0%	β-glucan ±7,0%	minerals ±0,5%
	Raw materials - 100,0 % malt		
10,0	14.6	13.3	4.2
14,0	21.4	12.5	4.8
18,0	26.7	12.0	5.0
	Raw materials - 80% malt + 20% barley		
10,0	21.9	12.6	4.5

14,0	22.8	14.6	4.8
18,0	29.8	15.3	4.9
	Raw materials - 98% malt+2% maltose syrup		
10,0	18.2	12.0	4.0
14,0	22.7	13.2	4.6
18,0	27.9	12.6	4.3

The data obtained in Table 4 showed that β-glucan is most fully converted into the composition of beer sediment, picked up from malt and barley. It is also necessary to take into account that other substances that were not studied out during our investigation (for example, protein) were also part of beer cloudiness. The clear correlation between the content of β-glucan in the sediment and the solids content in the initial wort was not found.

DISCUSSION

The studies have shown that the content of β-glucan increases proportionally with an increase in the content of extractives in malt wort, and there is also a content dependence of this non-starch polysaccharide on the raw material is used. The insertion of barley in the form of unmalted grain decreases the level of β-glucan in wort. The explanation is that the proportion of soluble β-glucan is reduced and the wort becomes depleted.

The nature of the change in β-glucan throughout the brewing process was traced. Thus, the use of hopping significantly influenced the decrease in the level of β-glucan. The fact is that this non-starch polysaccharide is associated with protein molecules that are linked by hydrogen bonds. Therefore, these protein-tanning complexes which make up the sediment, lead to a decrease in the β-glucan content.

During fermentation, the polysaccharide was associated with protein molecules and polyphenolic substances, enlarged and, thus, precipitated and removed from beer during filtration, which affected the decrease in its level in beer.

The study confirmed that the most solid processes during fermentation contribute to the fullest participation of β-glucan molecules in the formation of beer cloudiness (data from table 4), which is confirmed by literary data [4].

However, a clear relationship between the content of β-glucan in the sediment and the solids content in the initial wort was not revealed.

CONCLUSION

According to dozens of studies of beer persistence, a number of substances are involved in the formation of irreversible turbidity, including β-glucan.

Its content clearly depends on the raw materials used in the brewing technology, as well as on the solids content of the initial wort.

Passing processes during beer mashing, hopping and fermentation affect on the changes in the level of this non-starch polysaccharide. It forms the composition of turbidity, that occurs in the beer during prolonged storage and during the tests on accelerated aging, and confirms its important role in assessing the quality of beer.

Therefore, the research and study of substances responsible for the formation of finished beer turbidity, and the processes affecting on the intensity of precipitation, still remains an urgent problem.

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REFERENCES

[1] Eliseev M.N., Alexeyeva O.M. Identification Of Soft Drinks And Kvass Fermentation Drinks. - Research Journal of Pharmaceutical, Biological and Chemical Sciences, May–June 2018 9(3), Page No. 697-701

[2] Dedegkaev A.T., Afonin D.A. Ways to improve the colloidal stability of beer. - 2013. - № 1. - p. 33 - 35

[3] Meledina T.V., Prokhorchik I.P., Kuznetsova L.I. Biochemical processes in the production of malt - SPb.: ITMO; IHiBT, 2013. - 89s.

[4] Merchant M., Poeler D., Fisher S., et al. The full range of β-glucans // Beer World - 2018 - No. 4 - pp. 157-160

[5] Methods for Measuring the Mass Concentration of β-Glucan in Brewing Product by Photoelectrocolorimetric method (Certificate of Measurement Method Attestation no. 205-21/RA.RU.311787-2016/2018)

[6] GOST 12787-81 Beer. Methods for Alcohol Determination, Actual Extract and Calculation of Dry Substances in the Initial Wort

[7] EBC 9.11 – Method for Measuring the Mass Concentration of polyphenols in Brewing Product by Photoelectrocolorimetric method

[8] GOST 12788-87 Beer. Methods for Acidity Determining

[9] Methods for Measuring the Mass Concentration of Sugars and Glycerin in Alcoholic and Non-Alcoholic Drinks by High Performance Liquid Chromatography (Certificate of Measurement Method Attestation no. 01.00225/205-54-12)

[10] GOST 26929-94 Raw material and food products. Samples prepearing. Mineralization for toxic elements determination