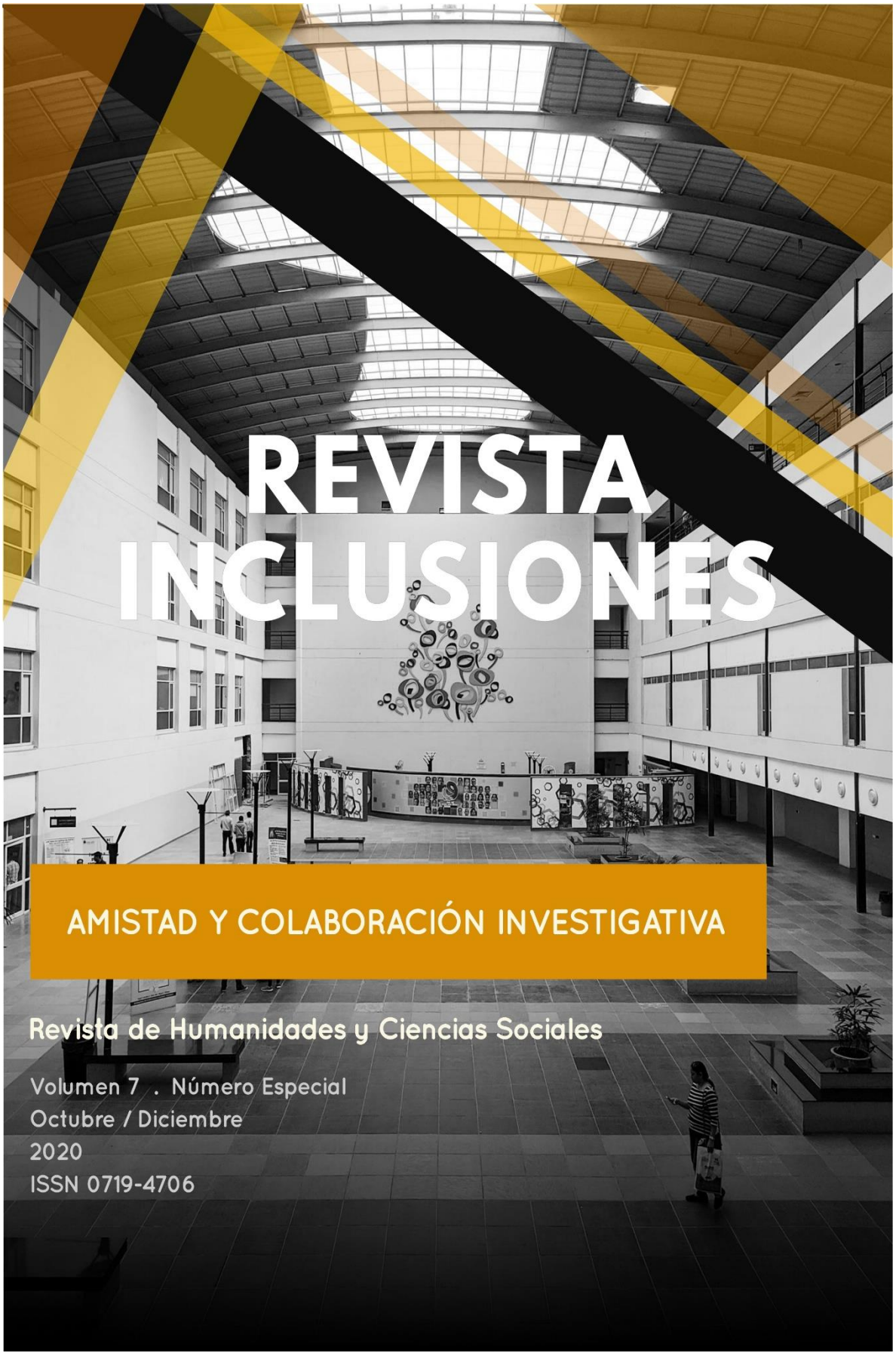


REVISTA INCLUSIONES

AMISTAD Y COLABORACIÓN INVESTIGATIVA

Revista de Humanidades y Ciencias Sociales

Volumen 7 . Número Especial
Octubre / Diciembre
2020
ISSN 0719-4706

REVISTA
INCLUSIONES M.R.
REVISTA DE HUMANIDADES
Y CIENCIAS SOCIALES

CUADERNOS DE SOFÍA
EDITORIAL

REVISTA
INCLUSIONES M.R.
REVISTA DE HUMANIDADES
Y CIENCIAS SOCIALES

CUADERNOS DE SOFÍA
EDITORIAL

REVISTA INCLUSIONES M.R.
REVISTA DE HUMANIDADES Y CIENCIAS SOCIALES

CUADERNOS DE SOFÍA EDITORIAL

REVISTA INCLUSIONES M.R.
REVISTA DE HUMANIDADES Y CIENCIAS SOCIALES

CUADERNOS DE SOFÍA EDITORIAL

Editorial Cuadernos de Sofía
Santiago – Chile
OBU – C HILE

Indización, Repositorios y Bases de Datos Académicas

Revista Inclusiones, se encuentra indizada en:

BIBLIOTECA UNIVERSIDAD DE CONCEPCIÓN

REVISTA INCLUSIONES M.R.
REVISTA DE HUMANIDADES Y CIENCIAS SOCIALES

CUADERNOS DE SOFÍA EDITORIAL

ISSN 0719-4706 - Volumen 7 / Número Especial / Octubre – Diciembre 2020 pp. 90-97

THE EFFECT OF TREATMENT OF UNMALTED BARLEY ON THE FRACTIONAL NITROGEN COMPOSITION OF BEER WORT

Dr. Madina Borisovna Khokonova
Kabardino-Balkarian State Agrarian University named after V.M. Kokov, Russia
ORCID: 0000-0003-2791-311X
khokonova.m.b@mail.ru
Dr. Aida Anatolyevna Adzhieva
Kabardino-Balkarian State Agrarian University named after V.M. Kokov, Russia
ORCID: 0000-0002-1047-8417
adzhieva.a.a@mail.ru

Fecha de Recepción: 11 de mayo de 2020 – **Fecha Revisión**: 13 de junio de 2020

Fecha de Aceptación: 26 de septiembre 2020 – **Fecha de Publicación**: 01 de octubre de 2020

Abstract

The correctness of breakdown of protein substances in raw materials during mashing is as important for the production of wort and beer of normal composition as that of starch. Abnormal breakdown of proteins leads to a sharp deterioration in the organoleptic characteristics of beer and a decrease in its stability. The study aims to determine the effect of pre-treatment of unmalted barley on the fractional nitrogen composition of the resulting wort. As a result of the studies, an increase in the content of total soluble nitrogen occurring evenly due to all fractions has been observed. However, it is noticeable that the higher the amount of unmalted barley in the mash, the greater the increase in total soluble nitrogen due to the high molecular weight nitrogenous substances of fraction A. Amine nitrogen content in the wort does change after the increase in the processing temperature of unmalted barley from 100 to 138°C, and it only slightly decreases with further increase in temperature, which occurs due to an increase in the reaction of melanoidins formation. The ratio of A and B soluble nitrogen fractions in the wort slightly increase depending on the processing temperature of unmalted barley and its proportion in the mash. The exception is the case with 40% content of unmalted barley.

Keywords

Unmalted barley – Beer wort – Heat treatment – Nitrogenous substances – Mashing

Para Citar este Artículo:

Khokonova, Madina Borisovna y Adzhieva, Aisa Anatolyevna. The effect of treatment of unmalted barley on the fractional nitrogen composition of beer wort. Revista Inclusiones Vol: 7 num Especial (2020): 90-97.

Introduction

The correctness of breakdown of protein substances in raw materials during mashing is as important for the production of wort and beer of normal composition as that of starch. Abnormal breakdown of proteins leads to a sharp deterioration in the organoleptic characteristics of beer and a decrease in its stability. In addition, products of protein breakdown are necessary for yeast nutrition[1].

Protein breakdown products – albumoses, peptones, polypeptides, and amino acids – make up the so-called group of "persistently soluble proteins", which, in contrast to real proteins, cannot be isolated from the solution.

Low molecular weight protein breakdown products are necessary for the nutrition of yeast, medium molecular weight products determine the palate fullness and foam resistance of beer, and high molecular weight products play a role in foaming, however, high content of them can cause clouding of beer[2].

Therefore, to obtain high-quality beer, it is necessary to achieve a certain ratio between high, medium, and low molecular weight nitrogen compounds in the wort[3]. It was found that preliminary heat treatment of unmalted barley at elevated temperatures is a more effective method for more complete hydrolytic decomposition of starch in unmalted raw materials than boiling unmalted mash at atmospheric pressure[4]. This study aimed to determine the effect of pre-treatment of unmalted barley on the fractional nitrogen composition of the resulting wort.

Scientific novelty of research

A comprehensive assessment of unmalted barley after various types of temperature treatment and its effect on the quality indicators of wort was performed. The effect of the temperature of treatment of unmalted barley on proteolysis during mashing processes was studied. For the first time in the Kabardino-Balkarian Republic, the ratios of soluble nitrogen fractions in the wort were studied depending on the temperature of treatment of unmalted barley and its proportion in the mash.

Materials and Methods

Our research was conducted in 2016-2018 at the Halva Factory "Nalchiksky" OJSC and the Department of Technology of Production and Processing of Agricultural Products of the Kabardino-Balkarian State Agrarian University.

---

[1] G. I. Kosminskii, Tekhnologiya soloda, piva i bezalkogolnykh napitkov: laboratornyi praktikum po tekhnokhimicheskomu kontrolyu proizvodstva (Minsk: Design PRO, 2001) y M. B. Khokonova y A. A. Adzieva, "Photosyntetic activity of spring barley plants depending on moisture provision", Amazonija Investiga Vol: 8 num 23 (2019): 96-100.

[2] V. Kuntse, Tekhnologiya soloda i piva (Sankt-Peterburg: Profession, 2009) y L. N. Tretyak, Tekhnologiya proizvodstva piva s zadannymi svoistvami: monografiya (Sankt-Peterburg: Profession, 2012).

[3] L. Nartsiss, Pivovarenie. Tekhnologiya solodorashcheniya (Sankt-Peterburg: Profession, 2007).

[4] V. A. Fedotov; S. V. Goncharov y A. N. Rubtsov, Pivovarennyi yachmen Rossii (Moscow: Agroliga of Russia LLC, 2006); O. S. Grujic; J. Pejin y N. M. Przulj, "The effects of winter barley variety and technological factors during malting of malt guality", Acta periodica technologica Vol: 36 (2005): 33-41 y M.J. Troughton, Canadian Agriculture (Budapest: Akademiai kiado, 1982).

The objects of research were brewing malt, unmalted barley, and laboratory brewing wort.

Beer wort samples were prepared using unmalted barley in the amounts of 20%, 30%, and 40% of the total amount of mashed grain products. Mash using unmalted barley was prepared according to the conventional method with two decoctions.

The effect of the temperature of heat treatment of unmalted barley mash on the duration of saccharification and filtration of the total mash, the yield of the extract and the physicochemical parameters of the wort was studied at temperatures of 100, 110, 120, 127, 133, 138, and 143°C. The duration of the heat treatment was 30 minutes.

In all wort samples, total nitrogen content was determined according to Kjeldahl's method, nitrogen fractions content was determined according to Lundin's method, and amine nitrogen content was determined using the method of determination of copper compounds of amino acids.

Results and Discussion

Our studies allowed us to determine the effect of heat treatment on the amount of nitrogenous substances of unmalted barley (Table 1).

Nitrogen forms, mg/100 cm^3		Nitrogenous substances content, mg/100 cm^3 after heat treatment of unmalted barley with a temperature, °C						
		100	110	120	127	133	138	143
Total		36.5	37.9	39.9	40.8	42.7	44.8	46.9
Fractions (Lundin)	A	17.2	18.0	19.8	20.3	21.7	23.4	24.9
	B	3.6	4.0	4.3	4.6	5.0	5.4	6.0
	C	15.7	15.9	15.9	15.9	16.0	16.0	16.0
Amine		3.4	3.4	3.4	3.3	3.3	3.2	3.0

Table 1
Differences in the fractional composition of nitrogenous substances in unmalted barley after heat treatment

According to the data in the table, an increase in the temperature of heat treatment of unmalted barley led to an increase in the content of total soluble nitrogen. At 143°C, more than 46% of nitrogenous substances passed into the soluble form, which was 10.4% more than at 100°C. The increase in total soluble nitrogen occurred mainly due to the increase in the content of fraction A – high molecular weight nitrogenous substances, associated with the phenomenon of protein peptization. The level of amine nitrogen (fraction C) – low molecular weight nitrogenous substances – after the heat treatment of unmalted barley at 100°C and above was similar, which implies that hydrolytic decomposition of protein molecules to low molecular forms did not occur during heat treatment[5].

[5] M. B. Khokonova; A. A. Adzieva y A. S. Karashaeva, "Barleycorn Productivity and Quality in Relation to the Surface Slope", International Journal of Advanced Biotechnology and Research Vol: 8 num 4 (2017): 884-889.

Quantitative changes in the soluble fractions of nitrogenous substances in the wort samples depending on the temperature of the heat treatment of unmalted barley with different proportions of barley in the mash are presented in Table 2.

Proportion of unmalted barley in mash, %	Mash treatment temperature, °C	Total nitrogen, mg/100 cm^3	Amine nitrogen, mg/100 cm^3	Nitrogen fractions according to Lundin, mg/100 cm^3		
				A	B	C
20	100	76.3	18.2	15.7	10.5	50.1
	110	76.7	18.2	15.7	10.6	50.4
	120	77.0	18.3	15.9	10.6	50.5
	127	78.0	18.2	16.2	10.9	50.9
	133	79.1	18.3	16.4	11.0	51.7
	138	80.0	18.2	16.5	11.1	52.4
	143	80.5	18.0	16.7	11.6	52.2
30	100	74.9	16.8	16.3	10.0	48.6
	110	75.6	16.9	16.5	10.1	49.0
	120	75.6	16.8	16.6	10.0	49.1
	127	76.0	16.8	16.7	9.7	49.6
	133	77.7	16.7	16.9	10.5	50.3
	138	79.0	16.9	17.2	11.2	50.6
	143	79.0	16.7	17.4	10.9	50.7
40	100	59.5	15.4	13.8	7.8	37.9
	110	60.2	15.5	14.0	7.9	38.3
	120	60.9	15.5	14.3	7.8	38.8
	127	62.3	15.7	14.7	8.1	39.5
	133	63.7	15.6	14.9	8.4	40.4
	138	65.1	15.2	15.1	8.8	41.2
	143	66.5	14.7	15.4	9.2	41.9

Table 2
The effect of the processing temperature of unmalted barley on the fractional nitrogen composition of the wort with different proportions of unmalted barley in the mash

It can be seen from the data that an increase in the temperature of mash heat treatment higher than 100°C led to an increase in the content of total soluble nitrogen in the wort when a portion of the malt was substituted by unmalted barley in a proportion of up to 40% of the weight of mashed raw materials: the higher the proportion of unmalted barley in the mash, the higher the content of total soluble nitrogen[6]. With 20% and 30% of unmalted barley in the mash, the increase was higher than 4.0% and with 40% of unmalted barley, it was 7.0%. The increase in the total soluble nitrogen content occurred uniformly due to the increase in the content of all fractions. However, it should be noted that the higher the proportion of unmalted barley in the mash, the greater the contribution of the increase in the content of high molecular weight nitrogenous substances (fraction A) to the increase of the total soluble nitrogen content. Amine nitrogen content in the wort did not change after the increase in the processing temperature of unmalted barley from 100 to 138°C. It only slightly decreased with further increase in temperature, which occurred due to an increase in the reaction of melanoidins formation[7].

[6] M. B. Khokonova; A. A. Adzieva y A. S. Karashaeva, “Barleycorn Productivity…

[7] M. B. Khokonova; A. A. Adzieva; M. V. Kashukoev y A. S. Karashaeva, “Optimization of barley cultivation technology, providing improving the quality of grain for brewing”, Journal of Pharmaceutical Sciences and Research Vol: 10 num 7 (2018): 1688-1690.

As already noted, it is necessary to achieve a certain ratio between high, medium, and low molecular nitrogen compounds in the wort to obtain high-quality beer.

In this regard, we studied the proportion of soluble nitrogen fractions in the total soluble nitrogen content in the wort with various temperatures of unmalted barley heat treatment (Table 3).

Proportion of unmalted barley in mash, %	Temperature of mash heat treatment, °C	Total nitrogen, mg/100 cm^3	Amine nitrogen, % of total	Nitrogen fractions according to Lundin, % of total		
				A	B	C
20	100	76.3	23.80	20.60	13.76	65.64
	110	76.7	23.80	20.52	13.78	65.70
	120	77.0	23.70	20.65	13.78	65.57
	127	78.0	23.40	20.73	13.96	65.31
	133	79.1	23.20	20.69	13.91	65.40
	138	80.0	22.80	20.63	13.84	65.53
	143	80.5	22.30	20.80	14.31	64.89
30	100	74.9	22.40	21.75	13.37	64.88
	110	75.6	22.40	21.83	13.38	64.79
	120	75.6	22.20	21.96	13.07	64.97
	127	76.0	22.10	21.97	12.71	65.32
	133	77.7	21.50	21.76	13.53	64.71
	138	79.0	21.40	21.80	14.08	64.12
	143	79.0	21.20	22.00	13.82	64.18
40	100	59.5	25.80	23.28	12.96	63.76
	110	60.2	25.70	23.26	13.10	63.64
	120	60.9	25.50	23.56	12.63	63.81
	127	62.3	25.20	23.67	12.92	63.41
	133	63.7	24.40	23.36	13.14	63.50
	138	65.1	23.30	23.20	13.53	63.26
	143	66.5	22.10	23.10	13.78	63.12

Table 3

The proportion of soluble nitrogen fractions in the wort depending on the processing temperature of unmalted barley and its proportion in the mash

The data in the table show that the total nitrogen content was higher with higher proportions of unmalted barley. The amine nitrogen content, on the contrary, decreased with an increase in the amount of unmalted barley and was 3.7% with 40% of unmalted barley in the mash.

The proportions of soluble A and B nitrogen fractions in the wort, depending on the processing temperature of unmalted barley and its proportion in the mash, increased slightly, except for the case with 40% of unmalted barley. Fraction C decreased slightly in all variants of the experiment.

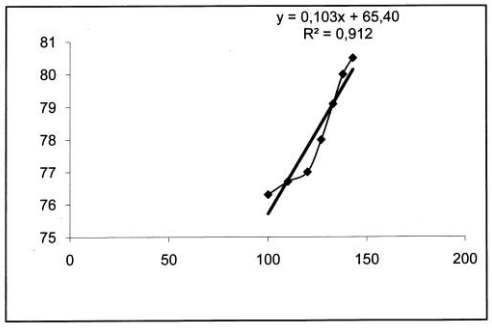
To determine the effect of the temperature of heat treatment of unmalted barley on proteolysis, we compared the amount of soluble nitrogenous substances that passed into the wort from unmalted barley after heat treatment at various temperatures with the total content of soluble nitrogenous substances formed in the wort during mashing (Table 4).

Temperature of heat treatment of unmalted barley, °C	Proportion of unmalted barley in mash, %								
	20			30			40		
	Total nitrogen in wort, mg/100 cm^3	Passed from unmalted barley, mg/100 cm^3	Formed from malt with enzymes, mg/100 cm^3	Total nitrogen in wort, mg/100 cm^3	Passed from unmalted barley, mg/100 cm^3	Formed from malt with enzymes, mg/100 cm^3	Total nitrogen in wort, mg/100 cm^3	Passed from unmalted barley, mg/100 cm^3	Formed from malt with enzymes, mg/100 cm^3
100	76.3	7.3	69.0	74.9	10.9	64.0	59.5	14.6	44.9
110	76.7	7.6	69.1	75.6	11.4	64.2	60.2	15.2	45.0
120	77.0	8.0	69.0	75.6	12.0	63.6	60.9	16.0	44.9
127	78.0	8.2	69.8	76.0	12.4	63.8	60.9	16.0	44.0
133	79.1	8.5	69.8	77.7	12.8	64.9	63.7	17.1	46.6
138	80.0	9.0	71.0	79.0	13.4	65.6	65.1	17.9	47.2
143	80.5	9.4	71.1	79.0	14.1	64.9	66.5	18.8	47.7

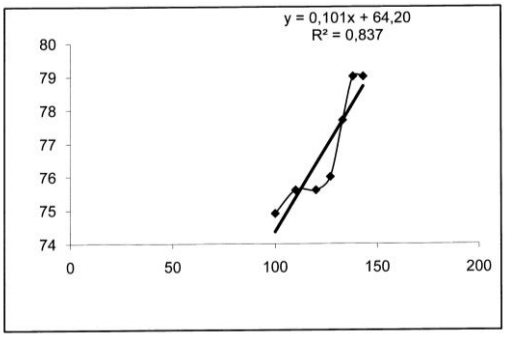
Table 4

The effect of processing temperature of unmalted barley on proteolysis during mashing

As can be seen from the data obtained, an increase in all indicators with an increase in the processing temperature was observed. A tendency was found: the amount of total nitrogen decreased with an increase in the proportion of unmalted barley[8] [2]. An increase in the temperature of the heat treatment of unmalted barley above 100°C slightly enhanced the susceptibility of unmalted barley proteins by malt enzymes. Using the results of the wort nitrogenous composition study, we performed a correlation and regression analysis for the temperature of the heat treatment of unmalted barley and the total nitrogen content in the wort when the content of unmalted barley in the mash was 20%, 30%, and 40% (Figure 1).

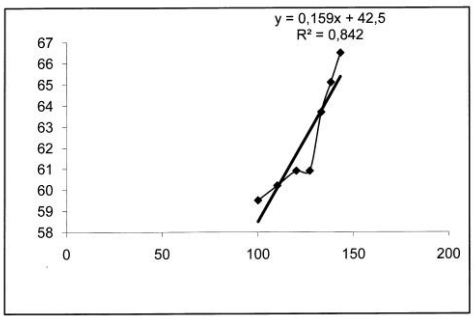


A



B

[8] M. B. Khokonova y A. A. Adzieva, “Photosyntetic activity…



C

Figure 1

The correlation and regression dependence between the temperature of the heat treatment of unmalted barley and the total nitrogen content in the wort when the content of unmalted barley in the mash is 20% (A), 30% (B), and 40% (C)

A strong direct correlation between the temperature of the heat treatment of unmalted barley and the total nitrogen content in the wort.

Conclusion

The study showed an increase in total soluble nitrogen due to the increase in the content of fraction A – high molecular weight nitrogenous substances, associated with the phenomenon of protein peptization. The increase in the total soluble nitrogen content occurred uniformly due to the increase in the content of all fractions. However, it should be noted that the higher the proportion of unmalted barley in the mash, the greater the contribution of the increase in the content of high molecular weight nitrogenous substances (fraction A) to the increase of the total soluble nitrogen content. Amine nitrogen content in the wort did not change after the increase in the processing temperature of unmalted barley from 100 to 138°C. It only slightly decreased with further increase in temperature, which occurred due to an increase in the reaction of melanoidins formation. The proportions of soluble A and B nitrogen fractions in the wort, depending on the processing temperature of unmalted barley and its proportion in the mash, increased slightly, except for the case with 40% of unmalted barley.

Therefore, heat treatment at elevated temperatures, effective for the hydrolytic degradation of starch in unmalted raw materials, affects the nitrogenous composition of beer wort. For the preparation of mash using unmalted barley, it is more important to use malt with high proteolytic activity and a high degree of dissolution and to carry out proteolysis of unmalted barley proteins in the first stage before the heat treatment of the unmalted part of the mash.

References

Fedotov, V. A.; Goncharov, S. V. y Rubtsov, A. N. Pivovarennyi yachmen Rossii. Moscow: Agroliga of Russia LLC. 2006.

Grujic, O. S.; Pejin, J. y Przulj, N. M. “The effects of winter barley variety and technological factors during malting of malt guality”. Acta periodica technologica Vol: 36 (2005): 33-41.

Khokonova, M. B. y Adzieva, A. A. “Photosyntetic activity of spring barley plants depending on moisture provision”. Amazonija Investiga Vol: 8 num 23 (2019): 96-100.

Khokonova, M. B.; Adzieva, A. A. y Karashaeva, A. S. “Barleycorn Productivity and Quality in Relation to the Surface Slope”. International Journal of Advanced Biotechnology and Research Vol: 8 num 4 (2017): 884-889.

Khokonova, M. B.; Adzieva, A. A.; Kashukoev, M. V. y Karashaeva, A. S. “Optimization of barley cultivation technology, providing improving the quality of grain for brewing”. Journal of Pharmaceutical Sciences and Research Vol: 10 num 7 (2018): 1688-1690.

Kosminskii, G. I. Tekhnologiya soloda, piva i bezalkogolnykh napitkov: laboratornyi praktikum po tekhnokhimicheskomu kontrolyu proizvodstva. Minsk: Design PRO. 2001.

Kuntse, V. Tekhnologiya soloda i piva. Sankt-Peterburg: Profession. 2009.

Nartsiss, L. Pivovarenie. Tekhnologiya solodorashcheniya. Sankt-Peterburg: Profession. 2007.

Tretyak, L. N. Tekhnologiya proizvodstva piva s zadannymi svoistvami: monografiya. Sankt-Peterburg: Profession. 2012.

Troughton, M. J. Canadian Agriculture. Budapest: Akademiai kiado. 1982.

REVISTA INCLUSIONES M.R.
REVISTA DE HUMANIDADES Y CIENCIAS SOCIALES

CUADERNOS DE SOFÍA EDITORIAL