

## DEVELOPMENT OF A BREWING TECHNOLOGY WITH USE OF HOP OF THE UKRAINIAN SELECTION

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**Abstract:** Results of a research of influence of hop of the Ukrainian selection on indicators of finished beer are given in work. The main physico-chemical parameters of the Ukrainian hop are defined, the brewing technology with its use is developed. For obtaining the comparative characteristic as an example of comparison the light and dark beer made by classical technology was used. Physico-chemical parameters are defined and the organoleptic assessment of all samples of the finished beer, which comparative characteristic indicates an optimality and expediency of use of hop of the Ukrainian producers in technology of beer, is carried out.

**Keywords:** beer, hops, physicochemical parameters, organoleptic evaluation.

### Introduction

In recent years, despite difficult economic conditions, in Ukraine a number of branches of the food industry, including production of beer and soft drinks, develops very dynamically.

Hop – one of the main and irreplaceable types of raw materials for production of beer. Thanks to existence of specific substances which aren't present in any other plant, it impacts to beer pleasant bitter relish and hop aroma, promotes removal of unstable fractions of albumens from a beer mash, improves foaming and firmness of foam of drink and, possessing antiseptic properties, increases its biological stability [1, 2].

According to botanical characteristics hop is long-term dioecious plant from family Cannabaceae. Only female unfertilized inflorescences – hop cones are used in brewing. Seeds reduce quality of hop cones and, besides, according to some researchers, they contain volatile alkaloid, which is close to morphine by physiological action on a human body. Amount of alkaloid is insignificant – to 0,3 % of dry mass of seeds [3, 4].

The major groups of hop substances for brewing are bitter acids, polyphenol compounds and essential oils.

Hop resins are the main and from the technological point of view of the most important component part of substances of hop. From hop resins the bitter substances, which are present in beer, are received. Hop resins classify as follows: soft resins - alpha-acids (humulones), beta-acids (lupulones); nonspecific soft resins (resupones); firm resins –  $\gamma$ -resins (insoluble in water),  $\delta$ -resins (soluble in water).

Among polyphenols by quantity and the importance the major are anthocyanogens, which make about 80% of polyphenols of hop.

Hop essential oil gives to hop characteristic aroma, which passes into beer in insignificant quantity. From this point of view hop essential oil has minor technological value, but plays large role at a trade assessment of hop [1].

### Problem statement and relevance of the research

Profitability of the enterprises of brewing in many respects depends on many factors and the main one is the raw materials and existence of direct access to it.

Today large breweries use import hop, that is considerably reflected in profitability of production and selling price. Domestic hop is not in demand for the Ukrainian brewers, lack of a sales market – a serious problem of Ukrainian hop growers while production of hop in Ukraine is promoted by climatic, social and economic conditions.

Formerly developed branch of the Ukrainian hop-growing is today in decline for many reasons. Now hop of the Ukrainian selection is bought only by "The Lvov brewery" and the private breweries, which segment in total quantity of the brewing enterprises makes 6%. Some grades of hop selected in Ukraine, don't concede in quality to the European classical grades. At the same time, they are much cheaper. Therefore, introduction of the Ukrainian hop in production will allow to reduce prime cost of finished beer, having domestic hop-growing supported [5].

### Major part

For carrying out of the research the classical Czech grade of Zatec hop was used. The Ukrainian grade Clone-18 was chosen as its analog according to the content of alpha acids (tab. 1).

**Table 1.** The content of alpha acids in grades of Zatec and Clone-18, %

Years	Clone-18	Zatec
2009	3,4	3,7
2010	2,2	3,2
2011	2,4	2,1
2012	3,7	3,9
2013	2,1	2,5
average	2,8	3,1

The technological scheme of brewing beer samples is submitted in figure 1.

Dosage of introduction of hop is defined taking into account norms of bitter substances (for a hot mash of  $H_m = 0,73$  g/dal). Application rate of the granulated hop ( $H$ ) of a hot mash counted on a formula (1):

$$H = \frac{\Gamma_c \times 10^4 \times 0,9}{(\lambda + 1) \times (100 - \omega)} \quad (1)$$

where  $\lambda$  – mass fraction of alpha-acids in hops, %

$\omega$  – humidity of hops, %

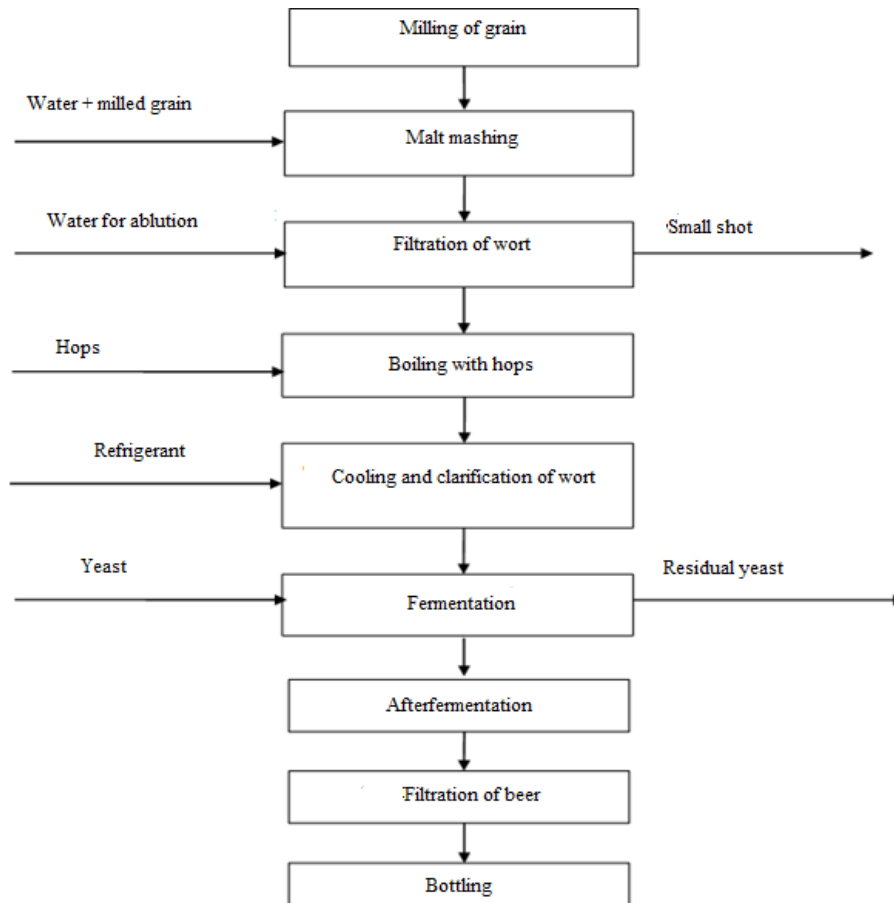
0,9 – coefficient, that consider decrease in a consumption rate of hop due to fuller use of bitter substances.

Technological modes of introduction of hop (100 %) in a mash corresponded to the following parameters:

– The first portion of hop of a grade of "Magnum" (100 %) was brought after 10 minutes of boiling of a mash;

– The second portion of hop of a grade "Clone-18" (4 0%) – in 50 minutes;

– The last portion of "Clone-18" (60%) – on the 65th minute of boiling.  
Duration of boiling of a mash with hop made 75-90 minutes.



*Fig. 1.* Technological scheme of brewing beer

The main physico-chemical parameters of ready samples of beer are presented in table 2. For obtaining the comparative characteristic samples of light and dark beer of restaurant-brewery "Lyustdorf" were analyzed. The main physico-chemical parameters are provided in table 3.

**Table 2.** Physico-chemical parameters of ready beer

Parameter	Light beer	Dark beer
Density, %	11,18	11,89
Alcohol by mass, %	3,67	3,75
Alcohol by volume, %	4,69	4,79
Apparent extract, %	2,32	2,88
True extract, %	4,03	4,62
Color, EBC	7,1	99,6
pH	4,63	4,44
Bitterness BU	25,8	26,9
Acetaldehyde, mg/dm <sup>3</sup>	8,2	4
DMS, mg/dm <sup>3</sup>	131	42,1
Ethylacetate, mg/dm <sup>3</sup>	16,8	7,2
n-propanol, mg/dm <sup>3</sup>	20	36,9
Isobutanol, mg/dm <sup>3</sup>	8,5	30,3
Isoamylacetate, mg/dm <sup>3</sup>	1,2	0,15
Isoamylalcohol, mg/dm <sup>3</sup>	72,2	54,6
Diacetyl free, mg/dm <sup>3</sup>	36	71
Diacetyl total, mg/dm <sup>3</sup>	50	121
2,3-pentandione free, mg/dm <sup>3</sup>	16	3
2,3-pentandione total, mg/dm <sup>3</sup>	20,5	7

**Table 3.** Physico-chemical parameters of ready beer of restaurant-brewery "Lyustdorf"

Parameter	Светлое пиво	Темное пиво
Density, %	12,27	14,53
Alcohol by mass, %	4	4,73
Alcohol by volume, %	5,11	6,06
Apparent extract, %	2,68	3,35
True extract, %	4,52	5,5
Color, EBC	12,7	56,8
pH	4,73	5,06
Bitterness BU	20,7	16,5
Acetaldehyde, mg/dm <sup>3</sup>	10,6	3,72
DMS, mg/dm <sup>3</sup>	24,2	19,3
Ethylacetate, mg/dm <sup>3</sup>	17,6	24
n-propanol, mg/dm <sup>3</sup>	16,2	13,2
Isobutanol, mg/dm <sup>3</sup>	2,1	10,4
Isoamylacetate, mg/dm <sup>3</sup>	1,5	2,15
Isoamylalcohol, mg/dm <sup>3</sup>	68,5	62,1
Diacetyl free, mg/dm <sup>3</sup>	79,8	96,3
Diacetyl total, mg/dm <sup>3</sup>	129	99,5
2,3-pentandione free, mg/dm <sup>3</sup>	28	64
2,3-pentandione total, mg/dm <sup>3</sup>	49	65

Data of tables 2 and 3 prove that the beer made with use of hop of the Ukrainian selection in a compounding, doesn't concede on the main physical and chemical indicators of beer of the restaurant-brewery "Lyustdorf". It is possible to draw a conclusion on expediency of use of hop of the Ukrainian origin in the classical technology of brewing.

The organoleptic assessment of beer was carried out on a 25-mark scale. Profile record of a tasting assessment is presented in figure 2.

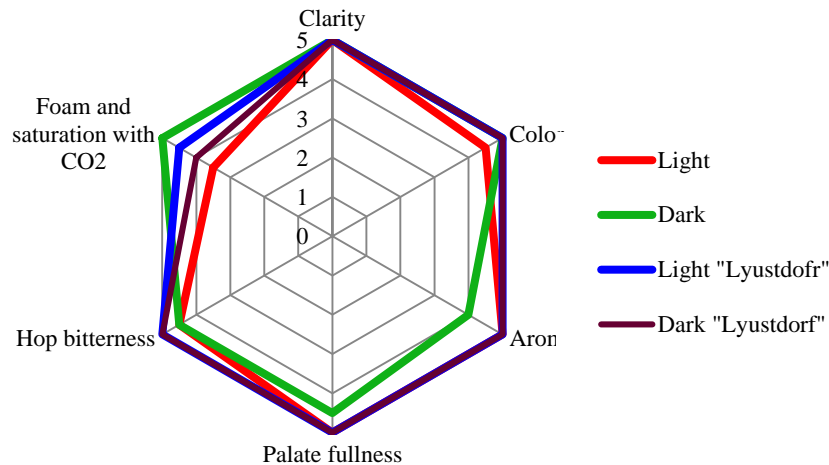


Fig. 2. Profile record of a tasting assessment

### Conclusion

The analysis of physico-chemical parameters and the carried-out organoleptic assessment of beer allow to draw a conclusion on expediency of use of the Ukrainian grade of the hop Clone-18 in technology of beer brewing. Ready samples of the beer made with use of the Ukrainian hop, don't concede on quality to the samples made with use of foreign hop.

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