

# Comparative analysis of quality cones and bitter acids in *Humulus lupulus* L. Lithuanian varieties

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Hops have been cultivated in Lithuania since ancient times, most often in farmsteads brought from natural habitats. Hop varieties introduced from West and Central Europe started to be cultivated and researched in 1926 at Kaunas Botanical Garden of Vytautas Magnus University. Dr. S. Gudavicius has raised 5 Lithuanian varieties peculiar for good economical characteristics while crossing male local plants with foreign species. After innovation of hop research in 1991 fertility (crop production power), the quality of cones of Lithuanian varieties has been researched; their dependence upon genotype and meteorological conditions has been determined. Within research period in 1997-2000 the medium late varieties have distinguished themselves by fertility - 'Fredos taurieji' (average fertility within the period of 4 years – 1083 kg/ha). The amount of alpha acid in cones fluctuated depending upon climatic conditions. 'Kauno grazieji' sorts has cumulated alpha acid from 3.3 to 6.3 %, 'Fredos taurieji' - from 3.9 to 5.8 %.

**Key words.** cones, varieties, technological ripeness, aerial dry yield of cones.

## INTRODUCTION

The hop cones is by nothing replaceable raw material in beer brewing, besides, more and more of them are used in pharmacy, perfumery, food and cosmetics industry. The raw material of hop cones for beer brewing industry of Lithuania (partly for pharmacy, too-partly from local raw material) is imported. It was indicated in 'Uzsienio prekyba' (Foreign Trade) publication that 63.1 t (for the sum of 170.5 thousand Lithuanian Lt) of unprocessed cones, 123.9 t of granules and powder for the cum of 2366.6 thousand Lithuanian Lt extract – 20.2 t (for the sum of 1424.3 thousand

Lithuanian Lt) was imported to Lithuania in 1999. While it has been proved by tests carried on in Lithuania since 1926 that the climatic conditions of Lithuania are suitable for cultivation of hops.

*Humulus lupulus* L. is naturally growing throughout the territory of Lithuania, the wild, fertile forms of it have been cultivated at farmsteads since ancient times. After foundation of the Department of Technical plants in at the Kaunas Botanical Garden of Vytautas Magnus University in 1926 – prof. K. Grybauskas started gathering and research of Western and Central Europe varieties. In 1939 there were about 30 species in the collection, though only small part alpha acid it met the requirements for the yield and cones quality. Having completed a detailed research of 18 varieties within the period of 1950-1955 (10 of the of German origin) dr. S. Gudavicius has determined that the major part of them isn't suitable due to small fertility or low cones fertility. When crossing the local male hop individuals with German and English varieties within the period of 1952-1970 at the Kaunas Botanical Garden of VMU dr. S. Gudavicius has raised 5 new sorts even exceeding other European sorts by quantity and quality factors [1]. Currently the genetic and selection specialists all over the world have raised hundreds of varieties famous for different peculiarities. Everybody knows that the fertility of the hop and cones quality directly depends upon climatic conditions and the peculiarities of a sorts. Attempts have been made to by researches determine the fertility and cones quality of sorts raised in Lithuania.

## METHODS

The 5 Lithuanian hop varieties have been researched in the research area of 10 shrubs of different species, 3 repeats. The aerial dry yield, by grams/shrub of technologically ripen hop coned has been determined and recalculated for kg /ha. The amount of alpha acid in cones has been determined using the thin layer chromatography method [2, 3]. The mathematical statistical reliability of data has been calculated by method of analysis of variance.

## RESULTS AND THEIR DISCUSSION

Technologically ripened hop cones are used in beer brewing and in other branches of industry. The term “technologically ripen” expresses not the biological ripeness of cones, but their development degree, when the maximum amounts of active substances are cumulated in cones. The in-

tensivity of biosynthesis of active substances is influenced by the genotype, meteorological conditions, harvesting time etc. [3,4]. Fertility also depends upon the peculiarities of varieties, soil, cultivation agrotechnics, fertilizing and meteorological conditions.

Immense correlation between the air temperature during the time of vegetation and fertility has been determined by the scientists of Ukraine, smaller, but also significant between the amount of precipitation during the vegetation period and fertility [5]. According to the results of research in Ukraine the optimal air temperature for growing a good yield of hops is +15-17°C within the first half of vegetation, while up to 20 within the flowering – technological ripeness of cones time. The temperature exceeding +20°C and small amount of precipitation the fertility. The meteorological conditions were rather different during the research years. Having analysed the average values of temperature within a day and the amount of precipitation within the periods – from the beginning of vegetation to flowering and from flowering to the technological ripeness of cones it has become clear that the climatic conditions near to the optimal ones were in 2000 - there were no great fluctuation of temperature within different stages of development, the distribution of precipitation was also favorable for ripening of good yield (Table 1). While in 1999 the temperature was high in July – August – within the period of buttonization, flowering and formation of cones. Besides precipitation was distributed very unequally: the was not enough of it within the period of flowering and formation of cones. Thus the maximum fertility was noted in 2000. 'Fredos Taurieji' - 2088 kg/ha, 'Fredos Derlingieji' - 1514.8 kg/ha, i.e. much large than many years averages (Table 2). The 4 years average fertility of these sorts exceeds 1000 kg/ha i.e. a high index under Lithuanian climate conditions. The other Lithuanian sorts aren't significant by such fertility. Meteorological conditions greatly influence the intensivity of biosynthesis of bitter substances, especially alpha acid. It has been determined by the research that within the year when the average a day hours temperature exceeds 18 °C, while the precipitation amount is less than 300 mm cones cumulate a rather smaller amount of alpha acid [6, 7,8].

All the researched Lithuanian sorts don't distinguish themselves by the large amount of alpha acid. The cones of 'Kauno Grazieji' and 'Fredos Taurieji' varieties respectively 6.3 and 5.8 % cumulate the greatest amount of alpha acid, when the year is favorable (Table 2). The amount of alpha acid of 'Fredos Taurieji' and 'Fredos Derlingieji' varieties fluctuate from 3.6 to 4.0 % even under unfavorable meteorological conditions, possible that it is the advantage of the genotype.

## CONCLUSIONS

1. The climatic conditions of Lithuania (the amount of precipitation and the average day temperature during the vegetation period) are favorable for growing a large and quality yield of hops.

2. 'Fredos Taurieji' (1680.4 kg/ha) and 'Fredos Derlingieji' (1083 kg/ha) varieties have distinguished themselves among the researched sorts by the fertility. It is expedient to cultivate such sorts on an industrial basis.

3. A sufficient amount of alpha acid has been accumulated in the cones of 'Fredos Taurieji', 'Fredos Derlingieji' and 'Kauno Grazieji' varieties of Kaunas Botanical Garden of VMU selection, so their raw material may be recommended for the needs not only pharmacy, but for beer brewing, too.

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**PALYGINAMOJI ŽALIAVOS IR KARČIŪJŲ RŪGŠČIŲ  
KIEKIO ANALIZĖ *HUMULUS LUPULUS* L. LIETUVOS  
VEISLĖSE**

**S a n t r a u k a**

Tyrimai atlikti 1997–2000 metais Vytauto Didžiojo universiteto Kauno botanikos sode. Tyrimo objektas paprastojo apynio veislės: vidutinio ankstyvumo – ‘Kauno Gražieji’, ‘Kauno Ankstyvieji’; vidutinio vėlyvumo – ‘Fredos Derlingieji’, ‘Fredos Taurieji’ ir ‘Raudoniai’ – sukurtos 1952–1975 metais hibridizacijos metodu Kaune, Vidurio Lietuvoje. Introdukuojamos ir tiriamos apynio veislės paveldėjo vietinio–laukinio apynio adaptacinės savybės, pereina visą vegetaciją iki pilnos spurgų brandos respublikos klimatinėmis sąlygomis. Straipsnyje pateikta palyginamoji vaistinės augalinės žaliavos – spurgų ir jose esančių karčiųjų rūgščių kiekio palyginamoji analizė.

**Table 1. Meteorological conditions within the research period (1997-2000)  
(The data of Kaunas meteorological center)**

Development period	Amount of precipitation, mm				Average values of day temperatures, C			
	1997	1998	1999	2000	1997	1998	1999	2000
The beginning of vegetation-the beginning of flowering	186,1	161,7	145,3	132,5	15,1	15,1	14,3	14,1
Flowering –technological ripeness of cones	90,6	131,5	88,3	132,6	18,5	14,9	17,8	16,4
Within the vegetation period	276,7	293,2	233,6	267,1	16,3	15,3	15,2	15

**Table 2. Aerial yield (kg/ha) and amount of alpha acid (%) of hops cones  
(Kaunas Botanical Garden of Vytautas Magnus University)**

Nr.	The name of the sorts	1997	1998	1999	2000	Average yield	Amount of alpha acid
1	Fredos Derlingieji	948,6	921,9	946,6	1514,8	1083	3,6-5
2	Fredos Taurieji	1754,5	1540,8	1337,5	2088,8	1680,4	3,9-5,8
3	Kauno Gražieji	703,6	897,9	833,2	1016,6	862,8	3,3-6,3
4	Kauno Ankstyvieji	777,6	679,3	695,3	849,9	750,5	2,3-3
5	Raudoniai	673,6	628,6	610,9	999,9	728,2	1-4,6