ОДЕСЬКА НАЦІОНАЛЬНА АКАДЕМІЯ
ХАРЧОВИХ ТЕХНОЛОГІЙ

ЗБІРНИК НАУКОВИХ ПРАЦЬ

МОЛОДИХ УЧЕНИХ, АСПІРАНТІВ ТА СТУДЕНТІВ

NATURA INCIPIT SCIENTIA DIRIGIT USUS PERFICIT

ОДЕСА
2016

ББК 36.81 + 36.82
УДК 663 / 664

Одеська національна академія харчових технологій
Збірник наукових праць молодих учених, аспірантів та студентів
Міністерство освіти і науки України. – Одеса: 2016. – 408 с.

Збірник опубліковано за рішенням вченої ради від 01.07.2016 р., протокол № 12
За достовірність інформації відповідає автор публікації

ISBN 966-571-063-х

РОЗДІЛ 2

ХІМІЧНІ, ФІЗИЧНІ ТА МАТЕМАТИЧНІ МЕТОДИ ДОСЛІДЖЕННЯ ПРОЦЕСІВ ТА АПАРАТІВ

INFLUENCE OF YEAST STRAINS AND YAN-LEVELS ON FERMENTATION KINETICS OF GRAPE MUST

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Nitrogen is an important macronutrient that plays a major role in many of biological functions and processes of grapevine and fermentative microorganisms.

Under nitrogen deficiency conditions in the must the use of nitrogen supplements eliminates the possibility of incomplete fermentations, enhances wine flavour, accelerates the process of fermentation, promotes yeast adaptation to environmental conditions [1].

Currently, the most common method of solving problems with nitrogen deficiency is addition of nitrogen as ammonium salts. Inorganic nitrogen, being added at different stages during the yeast growth phase, contributes to increase the population size and leads to reduction of the fermentation time [1].

Organic nitrogen sources or preparations, which comprise inactivated yeast or yeast products, amino acids, peptides, lipids and sometimes other nutrients have became commercially available recently. Preparations, based on inactivated yeast cells provide not only the need for nitrogen, but also contain cell walls, which is beneficial for yeast during fermentation. Cell wall fraction contains sterols and lipids, which are factors contributing to the maintenance of cell membrane permeability and helps avoid alcohol intoxication. Ultimately, the yeast cell walls may act as supporting components in suspension to avoid settling yeasts on the tank bottom [1].

Adding a small amount of oxygen at the end of the growth phase of the yeast is also effective, allowing biosyntheses of sterols and also can reduce the oxidation-reduction processes [1].

Another solution of the problem of nitrogen deficiency is the selection of natural strains with low nitrogen demand [1].

In many cases, winemakers use different types of nitrogen additives without the control of the initial content of this macro element in grape berry. The exclusive addition of ammonium imbalances the natural ratio of inorganic/organic nitrogen and affects the amino acid uptake pattern. Ammonium is a preferable yeast nitrogen source and, when plentiful, it represses the expression of catabolic pathways which use other nitrogen compounds. These changes in the consumption of nitrogen promote the formation of undesirable aroma compounds (in particular, hydrogen sulfide) and urea, which is the main precursor of carcinogen – ethylcarbamate [1].

Excessive addition of mineral nitrogen in the form of diammonium phosphate results in extremely low values of must pH and the formation of acetate esters, in particular ethyl acetate, which enhances perception of volatile acidity, suppresses varietal aroma characteristics. Moreover, excessive addition may result in formation of residual amounts of the nitrogen at the end of fermentation, causing microbial instability during storage of wine [1].

Thus, it should be a differentiated approach to the problem of nitrogen deficiency, based on the initial content of macronutrients in grape must and the need for a specific yeast strain to avoid negative effects of both the deficit and the excess of nitrogen compounds.

Aim. Estimation of the effect of yeast strains and YAN-levels on fermentation kinetics of grape must.

Objects: must, obtained from Zagrey and Aromatnyi, white grape varieties, selected by NSC “Institute of viticulture and winemaking named after V. Ye. Tairov”; commercial active wine dry yeasts (Martin Vialatte Vitilevure Quartz); yeast strain Tairovskaya 86-10 K from the collection of NSC "IVW named after V. Ye. Tairov"; endogenous yeasts.

As additional sources of nitrogen nutrition supplements we used – Actiferm 1 and 2, commercial preparations, manufactured by Martin Vialatte. Actiferm 1 and 2 were added for each scheme in dosages of 20 g/ hl at the beginning of fermentation and after 1/3 consumption of sugars by yeasts. The controls were fermented by the same yeast strains but without any supplementation.

Data of the dynamics of physical, chemical and microbiological parameters during fermentation of the samples was obtained with assessment of density, amino nitrogen, total number of yeast cells, which was carried out on a daily basis.

The change over time of the cell number was analyzed using a standard logistic model within the *Statistica* software (version 7.0), which describes exponential growth followed by a stationary phase based on the following equation [2]:

$$X_t = (X_0 \times Pop_m \times e^{t-rx_{max}})/(Pop_m + X_0 \times (e^{t-rx_{max}} - 1)), \qquad (1)$$

X_t — population size, cells/ml, at time t, days; Pop_m– maximum population size, cells/ml; X_0- initial population size, cells/ml; rx_{max} – maximum rate of increase of the population, per day).

This model was fit to 15 experimental data points, allowing the parameters rx_{max} and Pop_m to be estimated.

The dynamics of nitrogen consumption during fermentation were fit by using exponential decay function within the *Statistica* software (version 7.0) with the following equation [2]:

$$N_t = N_{min} + \Delta N \times e^{-r_n \times t}, \qquad (2)$$

N_t — concentration of nitrogen, still present in must, mg/l; N_{min}– lowest residual nitrogen concentration when t tends to infinity (t→∞), mg/l; ΔN – difference between the upper and lower residual nitrogen concentrations, mg/l; r_n — rate of nitrogen consumption, mg/day.

For each replicate about 10 experimental data points were used to estimate three parameters. The equations obtained were then used to calculate the time necessary to consume 5, 50 % of the initial nitrogen source present in must – T_5, T_{50} and the maximum rate of nitrogen consumption – r_{nmax}.

Obtained results show, that both the growth characteristics and the parameters of nitrogen consumption and differed considerably between grape varieties, strains and variants with Pop_m varying from 41, 6 to 61×10^6 cells/ml, T_{50} varying between 2,9 and 7,0 days and r_{nmax} varying between 26,8 and 203 mg/day.

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Наукове видання

Збірник наукових праць молодих учених, аспірантів та студентів

Підписано до друку 2016 р. Формат 60×84/8. Папір офсетний.
Ум. друк. арк. 47,4. Тираж 30 прим. Замовлення