The influence of cultivation conditions and strain of yeast on the mannan polysaccharide content in cells

R.Harbah[1,*], T.Meledina[1],D.Manshin[1], A.Morozov[1].

[1]Saint-Petersburg State University of Information Technologies, Mechanics and Optics (ITMO University), Faculty of Food Biotechnology and Engineering, Kronversky pr., 49, St Petersburg, 197101, Russia

*Correspondence: razan.harbah@mail.ru

INTRODUCTION

Mannan is a polysaccharide widely distributed in nature, which consists of mannose residues linked by β (1-4) bonds. It is obtained from various sources, such as plants, bacteria, fungi, and yeast [1]. The **mannan polysaccharide** has attractive **biological properties**, which has expanded its application in many sectors, especially in the field of nutrition and medicine .Recently, there is an increasing focus on **yeast cell wall** as a source of mannan since it is a cheap by-product that is produced in large amounts in breweries[2,3] . The mannan content in yeast cells varies depending on many factors, including the physiological state of the yeast, **the yeast strain**, and the **cultivation conditions.**

In context, the purpose of this study was to investigate the influence of cultivation conditions and the role of the yeast strains on the content of mannan in yeast cells

THE MAIN MATERIALS AND METHODS

Research objects were dry yeast ***S. cerevisiae Californian Lager* (M54)** (Mangrove Jacks, New Zealand) and ***S. cerevisiae Belgian Wit* (M21)** (Mangrove Jacks, New Zealand).

Spraymalt light barley wort extract (Muntons, England) was used to prepare the medium.

The process of cultivation was carried out in incubator (TC-1/80 CPU, Russia) using two methods:

1. Cultivation according to the principle of batch culture without forced aeration.
2. Cultivation on Petri plates using synthetic medium.

Extraction and estimation of crude mannan: We extracted mannan from 2 g of dry yeast extraction with 1% NaOH (50 mL) at 100°C for 2 hours, cooling and neutralizing to pH 7 with dilute HCl solution .Deprotienization carried out using the TCA (trichloroacetic acid) method .The quantitative estimation of mannan was determined by the phenol-sulfuric acid method using glucose as standard [4].

The accumulation of yeast biomass: We determined it by the weight method after drying the suspension of washed yeast to constant weight at 105°C for 24 h in cabinet dryer ES-4610 (Reaktivsnab, Shymkent, Kazakhstan).

TABLE I. The results of yeasts cultivation grown according to the principle of batch culture at temperature 28℃

Period of cultivation, (h)	S. cerevisiae Californian Lager(M54)				S. cerevisiae Belgian Wit (M21)			
	Dry matter (g/ 100 cm^3)	Absolute dry biomass (g/100 cm^3)	Y (%)	Substrate consumption rate (h^{-1})	Dry matter (g/ 100 cm^3)	Absolute dry biomass (g/100 cm^3)	Y (%)	Substrate consumption rate (h^{-1})
0	8.6	0.22±0.009	-		8,6	0.31±0.007		-
3	8.3	0.24±0.007	6.66	0.1	8.3	0.33±0.008	6.66	0.10
6	7.9	0.27±0.005	7.14	0.12	7.2	0.53±0.006	15.71	0.23
9	5.5	0.56±0.006	**10.96**	**0.34**	5.6	0.81±0.009	**16.66**	**0.33**
24	4.6	0.65±0.004	10.75	0.16	4.3	0.80±0.005	11.40	0.18
29	4.4	0.54±0.002	7.61	0.14	4.1	0.71±0.004	8.88	0.15

TABLE II. Change in the yield of biomass and mannan content in the yeast grown according to the principle of batch culture at temperature 24 ℃

Period of cultivation (h)	S. cerevisiae Belgian Wit (M21)				
	Dry matter (%)	ΔS (g/100 cm^3)	Dry biomass (g/100ml)	ΔX (g/100 cm^3)	Yield of biomass (%)
0	8.6	-	0.32±0.004	-	-
3	8.1	0.5	0.42±0.003	0.10	20
6	7.2	1.4	0.61±0.008	0.29	20.7
9	6.6	2.0	0.75±0.007	0.43	21.5
15	6.2	2.4	0.87±0.003	0.55	**22.9**
24	4.6	4.0	0.83±0.004	0.51	12.75
29	4.4	4.2	0.79 ±0.004	0.47	11.9

RESULTS

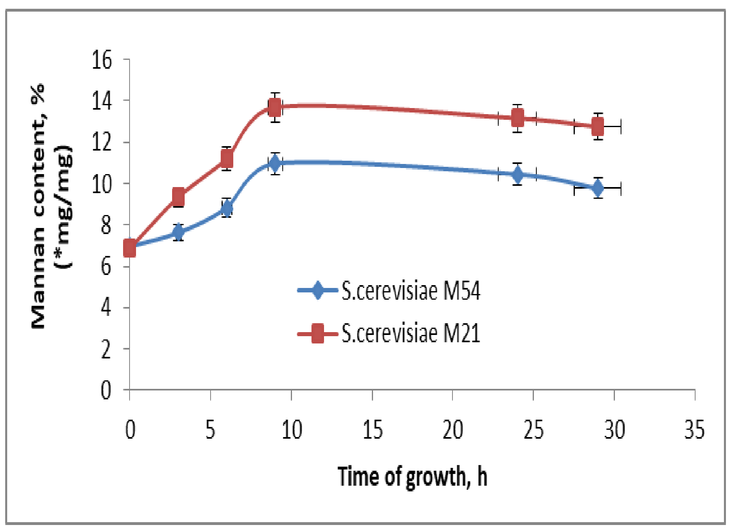

FIGURE 1. Mannan content in the yeast cells, which grew according to the principle of batch culture at a temperature of 28 ℃.

* **mg mannan/mg dry cell weight**

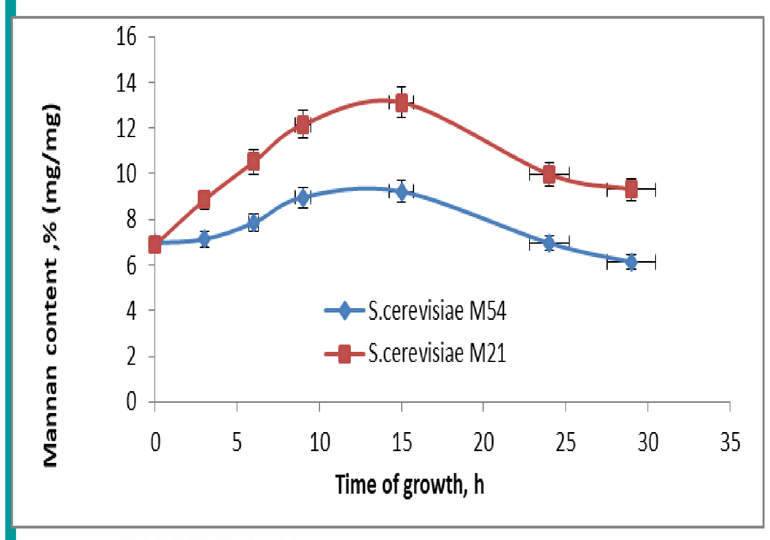

FIGURE 2. Mannan content in the yeast cells, which grew on Petri plates at 28 ℃

DISCUSSION AND CONCLUSION

The results showed that, **the highest mannan content** was found in yeast *S. cerevisiae Belgian Wit* M21 (top-fermenting), which grew in **the batch culture** at a temperature of **28 ℃ after 9 hours** of cultivation, where its content increased by 98.98%. Whereas its content in the cells grown in the batch culture at 24 ℃ and the cells grown on Petri plates at temperature 28 ℃ was maximum after 15 hours of cultivation.

In yeast *S. cerevisiae Californian Lager* M54, which was grown in the batch culture at a temperature of 28 ℃, the highest amount of mannan in the cells was after 9 hours, where its content increased by 57.61%.

According to the obtained results, we conclude that **the mannan content** in the yeast cells varies **depending on** the cultivation conditions, including the **method of cultivation, nutrition medium, and temperature.** As well as its content in the cells relates to t**he yeast strain**, where its content was in **top-fermenting** yeast was higher than its content in other yeast. The accumulation of mannan in cells was associated with **the good physiological state** of cells, represented by an **increase in yeast biomass yield**, which was higher in the top-fermenting yeast grew according to the principle of batch culture.

REFERENCES

1 . L. R. Moreira and E. X. Filho, “An overview of mannan structure and mannan-degrading enzyme systems,” Appl. Microbiol. Biotechnol. 79, 165–78 (2008).

2. E. K Dunn, D. A. Shoue and X. Huang, “Spectroscopic and Biochemical Analysis of Regions of the Cell Wall of the Unicellular ‘ Mannan Weed,’ Acetabularia acetabulum,” Plant Cell Physiol. 48(1), 122–133 (2007).

3. G. Huang, Q. Yang and Z. B. Wang, “Extraction and deproteinization of mannan oligosaccharide,” Z. Naturforsch C. 65 (5-6), 387–390 (2010).

4. 11. V. Maru, S. Hewale, H. Mantri and V. Ranade, “Partial Purification and Characterization of Mannan Oligosaccharides from Cell Wall of Saccharomyces cerevisiae,” Int. J. Curr. Microbiol. Appl. Sci. 4(12), 705–711 (2015).