Spring 2-2-2020

Growing Torula Yeast (Candida utilis) For Food Grade Fatty Acids

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Abstract

The focus of this article is the cultivation of a food grade yeast for the production of fatty acids without the restrictions of climate or growing season. Torula yeast (Candida utilis) was selected since it can grow on a wide variety of culture media and has over 60 years of use in the food industry. The fatty acid composition of Candida utilis grown on two different media are presented in this article; the first example using completely synthetic media and another using distiller's vinasse. Also, the effect of different culturing conditions on the percentage of various fatty acids will be covered.

Introduction

Nearly all the oil producing plants need a long period of time for maturation before the first harvest can be done. Plants that produce high amounts of oil such as avocado and palm kernel need a tropical or subtropical environment to reach their maximum potential. Yeast can be grown quickly enough to have several harvests per year in contrast to oil seed plants that have one large harvest at the end of the season.

Torula yeast (Candidia utilis) was chosen because it can be grown on a variety of substrates from glucose to more exotic sugars such as hexose and pentose. This yeast can also grow on organic acids, aldehydes and alcohols.[4]

Candida utilis has been in use for more than 60 years as a food additive.

Traditionally Torula is grown in a mixture of sugars and minerals such as molasses, spruce waste, or brewing by-products. The resulting biomass is then harvested, washed, thermolyzed and dried. The end product is highly digestible with 50% protein and a variety of B vitamins.[1]

The focus of this article is cultivation of a food grade yeast for the production of fatty acids without the restrictions of climate or growing season.[1]

The Use of Synthetic Media

The total saponifiable fatty acids of candida utilis (VTT-C-84147) ranged from 6.0 and 7.1% of cell dry weight when grown within the temperature range of 10 to 40 degrees Centigrade. The material primarily consisted of palmitic, plamitoleic, stearic, oleic, linoleic and linolenic fatty acids.[5]

The organism used in this study is Candida Utilis NCYC 321. The media contains [2]:

- KH_2PO_4 1.0 gram
- $MgSO_4 * 7H_20$ 1.0 gram
- D-biotin 0.195 pico gram
- Glucose 2 grams
- $(NH_4)_2SO_4$ at either 1 gram or 0.25 gram

Equipment Used

The yeast was grown in a glass chemostat vessel with stirring that had a 2 liter volume. The chemostat was fitted with a device to control the level of dissolved oxygen tension. Cultures were stirred at 1,400 revolutions per minute without baffles.[2]

The culture vessel was heated or cooled with circulating water from a refrigerated water bath through a stainless steel hollow coil immersed in the culture. A resistance thermometer immersed within the culture took temperature readings for the study and was recorded with a

Fielden Bikini indicator.[2]

The culture was kept at a constant pH of 4.5 + or - 0.1 with a automatic 0.1 mole NaOH dispenser connected to a pH meter / controller.[2]

The air that entered the culture vessel was passed through a fiberglass filter to keep the inside of the vessel sanitary.[2]

During the study a flow of new media entered the chamber consistent with continuous culture procedures.[2]

All parts that had contact with the culture was autoclaved for sterilization before use.[2]

Yeast was harvested from the chemostat in collection tubes which were placed in an ice water bath. The yeast cells were separated from the media using a centrifuge set at 2000 X g.[2]

Altering the environmental conditions and nutrients available will change the composition of the fatty acids within Candida utilis. With this knowledge the grower has better control over the final product than traditional oil seeds. While under glucose limitation, as dissolved oxygen decreases the level of plamitic acid (C16:0) increases from 12.3% to 16.5% of the total fatty acids when the dissolved oxygen tension decreases from 75 mmhg to less than 1 mmhg. During these conditions stearic acid C18:0 also increases rom 1.0% to 2.5%. However, these effects are not as pronounced under ammonium limitation.[2]

Some of the common fatty acids that are listed below are [3]:

Lauric (dodecanoic acid): C12:0

Myristic (tetradecanoic acid): C14:0

Palmitic (hexadecanoic acid): C16:0

Stearic (octadecanoic acid): C18:0

Arachidic (eicosanoic acid): C20:0

Behenic (docosanoic acid): C22:0

Distiller's Stillage as a Substrate Material

Using a aerobic process Rodriguez et al. grew candidia utilis on distiller vinasse. Vinasse is the remaining material after the main fermentation products such as ethanol are removed.[4]

The composition of the fatty acids recovered from Candida utilis are [4]:

- Saturated fatty acids (35.24%): palmitic acid (C16:0) was the highest at a level of 21% all fatty acids.
- Monounsaturated (29.68%): Oleic acid (C18:1n9) was the highest monounsaturated fatty acid at 22% of all fatty acids.
- Polyunsaturated (35.08%): linoleic acid (C18:2n6) was the highest polyunsaturated fatty acid at a level of 31% within all fatty acids.

Table 1. Profile of fatty acids of a sample of torula yeast grown on distiller's vinasse

Fatty acid	mg/100g	Fatty acid	mg/100g
C12:0	4.63	C16:1n9	0.62
C13:0	39.44	C17:1	45.42
C14:0	15.53	C18:1n9	512.70
C15:0	19.47	C18:1n7	26.55
C16:0	485.04	C20:1	2.89
C17:0	94.11	C22:1n9	1.76
C18:0	151.40	C18:2n6	729.41
C20:0	5.72	C18:3n3	90.74
C21:0	0.93	C18:3n6	2.23
C22:0	4.80	C18:4n3	0.30
C23:0	2.05	C20:3n6	3.99
C24:0	10.82	C20:4n6	0.60
C14:1	8.98	C20:5n3	2.17
C15:1	28.96	C22:6n3	0.84
C16:1n7	74.37		
Total fatty acids (mg/100g			2366.47

For comparison cottonseed oil has a fatty acid profile similar to this. 100 grams of cottonseed meal contains[6]:

- 25.9 grams saturated fatty acids
- 17.8 grams monounsaturated fatty acids

- 51.9 grams of polyunsaturated fatty acid

However, the cotton plant contains toxic gossypol which has to be removed before human consumption.

Conclusion

The potential of Torula yeast (candida utilis) as a source of food grade oil has excellent possibilities. Torula yeast can be grown in culture all year regardless of temperature or length of growing season. A second advantage is the capability of this yeast to grow on a wide variety of nutrients besides sugar. Lastly, Torula yeast contains a high level of saturated fat that is comparable to cottonseed oil and peanut oil. This distribution of the different types of fatty acids makes it suitable to be used in a wide range of products.

References

1. Bekatorou, Argyro, Costas Psarianos, and Athanasios A. Koutinas. "Production of Food Grade Yeasts." Food Technology & Biotechnology 44.3 (2006). https://www.semanticscholar.org/paper/Production-of-Food-Grade-Yeasts-Bekatorou-Psarianos/3cbaa5360ff334e7d14be6eab1c7477e7314dbdd

2. Brown, C. M., and A. H. Rose. "Fatty-Acid Composition of Candida utilis as Affected by Growth Temperature and Dissolved-Oxygen Tension." Journal of Bacteriology 99.2 (1969): 371-378. https://jb.asm.org/content/99/2/371

3. McGill School of Computer Science. “Fatty Acid.” https://www.cs.mcgill.ca/~rwest/wikispeedia/wpcd/wp/f/Fatty_acid.htm

4. Rodríguez, Bárbara, et al. "Profile of Fatty Acids from Torula Yeast (Candida utilis) Grown on Distiller’s vinasse. Technical note" Cuban Journal of Agricultural Science 46.2 (2012). https://pdfs.semanticscholar.org/2b9b/793e38ba640dd26fa536750da8b95bf2eb17.pdf

5. Suutari, Merja, Antti Rintamäki, and Simo Laakso. "Membrane Phospholipids in Temperature Adaptation of Candida utilis: Alterations in Fatty Acid Chain Length and Unsaturation." Journal of Lipid Research 38.4 (1997): 790-794. https://www.jlr.org/content/38/4/790.full.pdf

6. U.S. Department of Agriculture Agricultural Research Service FoodData

Central. “Oil, cottonseed, salad or cooking.” https://fdc.nal.usda.gov/fdc-app.html#/?query=ndbNumber:4502