Production of industrial organic acid from cassava using fungi

S. Anbuselvi*, L. Jeyanthi Rebecca

ABSTRACT

Objective: Citric acid an industrial organic acid produced by Aspergillus niger from Manihot esculenta peels with different carbon and nitrogen sources. Glucose-enriched medium showed maximum yield of citric acid. Ammonium chloride and ammonium persulfate reduced the formation of citric acid. The high amount of citric acid was observed in ammonium dihydrogen phosphate-enriched source. Results and Discussion: The optimum yield of organic acid from cassava pulp in the presence of fungi was found in 20 days of fermentation with pH3 and room temperature.

KEY WORDS: Citric acid, Cassava, Fungi

INTRODUCTION

Citric acid is an industrial organic acid which found in many citrus fruits. It is a natural occurring caking preservative. It also gives sour taste to foods and soft drinks. It is important intermediate in the tricarboxylic acid cycle of all living things. It also serves as a bleaching agent and acts as an antioxidant. It is a white crystalline powder which can exist either in anhydrous form or monohydrate. Citric acid can generate heat in an alkaline state.

Citric acid is used in animal feed formulations to form soluble and rapid digestible with essential metal nutrients. It enhances best flavor to increase food uptake by animals. It also helps to control gastric pH and maintain the efficiency status of the feed. Sodium citrate is used as a buffer in detergent making. Citric acid is produced from Aspergillus niger by utilizing starchy and sugar sources.

Organic acid is also mixed to cosmetic formulations to adjust the pH, act as an ion stabilizer, and cleave metal ions to prevent discoloration and decomposition. It is used in fruit flavors and to impart a better taste. It helps to maintain stability of the active ingredients in food products.

The marketing use of citric acid in syrups, elixirs, oral suspensions, and solutions is good industrial applications. The citric acid used in pharmaceutical industry, especially in antacid production. The amount of starch was found in cassava pulp 31.6%. Therefore, cassava is used as best substrate for ethanol and citric acid production. It is recognized as safe for applicable use in food industry which is readily metabolized and eliminated from the body. The main objective of this study was to produce industrial organic acid from cassava pulp in fungal medium and its yield was analyzed.

MATERIALS AND METHODS

A. niger was extracted from onion and cultured in a nutrient of potato dextrose agar media. Cassava pulp was washed, sliced, and dried in a hot air oven at 60°C. This dried sample was powdered and subjected into acid hydrolysis and autoclaved for 20 min. The hydrolyzed materials were subjected to fermentation medium.

The fermentation media were enriched with cassava powder. Its approximate composition was determined. Different carbon sources of sucrose, glucose, and maltose and nitrogen sources of ammonium chloride, potassium dihydrogen phosphate, ammonium persulfate, and ammonium nitrate were used for its optimization. The fermentation process was carried out at 300°C for 20 days.
Different carbon and nitrogen-enriched media were carried out after 3 days of incubation. These were filtered into a clean beaker with the help of Whatman no.1 filter paper. 1 M NaOH was prepared and taken in burette. The filtrate was titrated against NaOH with phenolphthalein as indicator till pink color appears. The readings were noted, and amount of citric acid produced was calculated.

RESULTS AND DISCUSSION

The cassava pulp powder was used as a nutrient source for the growth of fungi to produce citric acid. r and its maximum yield through optimization parameters. Pandey et al. showed that cassava pulp and waste disposal in the environment can cause serious environmental pollution due to its high organic material and biodegradable. For optimum with pH, media with different pH were titrated, and the optimum pH range was found to be within 1-3 where the amount of organic acid produced was estimated to be <1%. The yield of citric acid was observed in glucose-enriched medium. Hussein et al. reported that 15% of sucrose-enriched medium showed high yield n of citric acid. Suitable carbon source was shown to be as glucose as the best yield of citric acid [Table 1].

In case of nitrogen source, NH₄Cl was found to be showed lower contribution for the citric acid which produced was estimated to be 0.058%. The medium contained ammonium nitrate and sodium nitrate did not show any change in citric acid production, but ammonium dihydrogen phosphate yields more amount of citric acid [Table 2]. Many of them explained that ammonium ions play a significant role in the regulation of citric acid cycle.

Art (1987) stated that the higher concentration of ammonium constituents within cells could lead to prevent the citrate activity through PFK inhibitor. The substrates of urea, yeast, and ammonium dihydrogen phosphate also showed high yield of citric acid (Xie and West). The greater concentration of phosphate led to decline in fixation of carbon dioxide with certain amount of sugars and acids.[13]

In case of temperature, the amount of citric acid produced was maximum (0.064%) at room temperature. The maximum yield of 0.1152% was obtained in optimized media after incubating for 6 days at room temperature.

CONCLUSION

The A. niger strain was grown on nutrient media and was used for the greater yield of citric acid. The optimization of culture and nutritional conditions were done for high and consistent yield of citric acid. Rapid amount of citric acid yield was observed in optimized media when compared with normal medium.

REFERENCES

1. Ali HK, Daud MZ, Azzuair AL. Economic benefit from the optimization of citric acid production from rice straw. Turk J Eng Sci 2011;35:1-13.
2. Haq H, Ashraf S, Ali WA, Butt K, Shafiq S, Qadeer MA, et al. Effect of mineral nutrients on biosynthesis of citric acid from Aspergillus niger using sucrose salt media. Pak J Bot 2001;33:535-40.
3. Da Silva LV, Taveres CB, Amaral PF, Coelho MA. Production of organic acids by solid state fermentation-SSF in different crude glycerol concentrations and different nitrogen sources. Chem Eng Trans 2012;27:199-204.
4. Pandey A. Solid state fermentation. Biochem Eng J 2003;13:81-4.
5. Ikram-ul H, Ali S, Qadeer MA, Iqbal J. Citric acid production by selected mutant of Aspergillus niger from cane molasses. Bioresour Technol 2004;93:125-30.
6. Pandey A, Soccol CR, Rodriguez-Leon JA, Nigam P. Production of organic acids by solid state fermentation-SSF in biotechnology. In: Fundamentals and Applications. New Delhi: Asia Tech Publishers; 2001. p. 113-26.
7. Balamurugan T, Anbuselvi S. Physicochemical constituents of cassava pulp and waste. J Chem Pharm Res 2013;5:258-60.
8. El Holi MA, Delaimy SA. Citric acid production from whey sugars. Afr J Biotechnol 2003;2:356-9.
9. Parad FC, Vanderberghe LP, Soccol CR. Citric acid production by SSF on a semi pilot scale using different percentage of...
treated cassava bagasse. Braz J Chem Eng 2005;22:356-60.
10. Lotfy WA, Ghanem KN, El Helow ER. Citric acid production by novel from *Aspergillus niger* isolate induced mutagenesis and cost reduction studies. Bioresour Technol 2007;98:3464-9.
11. Husseiny FA, Younis NA, Farag SS. Selection of *Aspergillus niger* isolates growing on different carbon sources by products for citric acid production. J Am Sci 2010;6:1222-9.
12. Arts E, Kubicek CP, Rohr M. Regulation of phosphofructokinase from *Aspergillus niger*. J Gen Microbiol 1987;133:1195-200.
13. Xie G, West TP. Citric acid production by *Aspergillus niger* from a treated ethanol fermented product using solid state fermentation. Lett Appl Microbiol 2009;48:634-44.

Source of support: Nil; Conflict of interest: None Declared