# IMPROVEMENT OF ELECTRIC PROCESS OF LACTIC ACID PRODUCTION

**Vutcariova I.**
Bologa M., Solonari S.

Institute of Applied Physics, Academy of Sciences of Moldova
**Vutcariova I., e–mail: irinavutkareva@yahoo.com**

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Industrial technologies of lactic acid production from lactic whey are based on the processes of fermentation of lactose contained in it and separation of the final product in the form of lactates. The necessity of neutralization of the forming lactic acid in medium being fermented as well as the following crystallization of lactates with the recurring dissolving and release of the acid makes this technology power–consuming and long.

Working out the direction, combining fermentation of the lactic whey and electrophoretic removing of the formed acid, ensuring a high degree of lactose utilization and pure lactic acid production, seems to be expedient. However application of electrodialysis process has it own limits, caused by the presence in the medium of the substances (proteins, mineral salts), inhibiting the membranes.

The complex method of the electrophysical treatment of lactic whey envisages solution of these problems mainly as a result of electrolysis–reagent separation of protein and mineral fractions of lactic whey. The obtained degree of deproteinization and demineralization (75 and 80 %, correspondingly) permits the following usage of membrane technology.

The scheme of the treated whey lactose fermentation by L.acidophilus thermoresistant lactic acid bacteria using lactic acid fermentation activator was worked out. The increasing of ferment quantity, introducing into whey, promotes also the acid storage process intensification, permitting to decrease fermentation time to 24–36 hours at constant temperature 37°C.

The further production of lactic acid takes place in the diaphragm electrolyzer chamber. lionitic membrane is used as a diaphragm. The upper limit of pH value at which the electrodialysis release of lactic acid compound being optimal is revealed. So at current low density, permitting to maintain the necessary temperature electrodialysis process duration, we have favourable conditions for the further production of lactic acid preparation. During the given period (1 hour) lactic acid preparation, which main physical and chemical properties correspond to the accepted standards, is accumulated in the interelectrode space.

So this improvement of lactic acid production technology permits to quicken fermentation processes and to obtain a higher degree of lactose hydrolysis comparing with traditional technologies of calcium lactate production with the following filtration, concentration and treatment by sulphuric acid. The method of fermentative hydrolysis and electrophysical release of lactic acid is perspective to solve the problems of utilization of lactose and ecology.

## Introduction

The ways of usage of lactic whey valuable components, creation of little and no–waste technologies on the basis of membrane methods, based on electrodialysis process, are outlined lately. During electrodialysus process other components, particularly lactic acid, which molecules acquire negative charge due to the chip off of hidrogen atoms, are removed as well as mineral salts. The curd whey being processed complexly it is expendient to utilize lactic acid and protein–whey concentrate, extracted from the whey with the help of electrodialysis, for increasing the process ecological safeness.

To obtain the preparation with needed content of lactic acid (10%) the deep fermenting of whey before electrodialysis salt elimination, permitting to increase the lactic acid level in the concentrate, is proposed. The devices for obtaining acid from salts–lactates solution have been worked out but the necessity of neutralization of the forming lactic acid in medium being fermented as well as the following crystallization of the lactates with the recurring disolving and release of the acid makes this technology power – consuming and long [1]. Working out the direction, combining fermentantion of the lactic whey and electrophoretic removing of the formed acid, ensuring a high degree of lactose utilization and pure lactic and production, seems to be expendient [2].

## Materials and methods

But application of electrodialysis method to obtain lactic acid in pure form is limited by substanced and process of membrane cupping by protein substances. Intensification of protein compound coagulation process allows to recommend a method of β–lactoglobuline separation by increasing the initial calcium hydrophosphate concentration for 10–15 mmol/l, i.e. protein separation with the preliminary precipitation of mineralized and the following coagulation of whey proteins in diaphragm electrolyzer. The whey was treated by the calcium phosphate acid salt $CaHPO_4x2H_2O$ and $CaCl_2$. Protein separation process using calcium hydrophosphate reaches saturation at pH – 6,6.

So it is necessary to neutralize the whey after additions of salts from pH – 3,8 till pH – 6,6 (taking into account the development limit of the used in future for fermentation L.acidophilus to be pH – 6,6).

The experiments on removing proteins by thermal precipitation were conducted simultaneously. According to the obtained data it is known that the method of protein precipitation doesn't influence the degree of lactic acid concentration, i.e. the preliminary deproteinization doesn't effect the further process. The obtained of deproteinizetion and demineralization (75 and 80 %, correspondingly) permit the following usage of membrane technology. The effeciency of protein substances separation permits to us this method as a preliminary stage of lactic whey fermentation was conducted according to the worked out scheme. Partly deproteinized whey containing 3,2% of lactose and the ferment of thermoresistant lactic acid bacteria L.acidophilus, characterized by a high enough productivity (in average 0,55 kg/($m^3$·h) of lactic acid) and resistance to the medium acidity, were used for fermentation. The limit of acid formation in the whey is always substantially lower, than in milk for the same kinds of microorganisms as testifies the necessity of choosing the lactic acid fermentation activators.

The introducing into the whey of the activator – citric acid Na in the amount of 1,0; 1,5; 2,5% promotes to the intensification of the acid storage process in the whey. The whey with acidity 200–220°T could be obtained during 36, 24, 20 hours the corresponding activator being introduced against 72 hours at the ordinary fermentation. If the acidity is high and prevents from the development of lactic acid bacteria, it is eliminated by neutralization of the formed lactic acid.

## Results and Discussion

Side by side with the improving of ferment preparing method, we looked for the ways to increase the amount of lactic acid bacteria. This aim could be reached by increasing the ferment amount till 10%, that promotes also the acid storage process intensification, permitting to decrease fermentation time to 24–36 hours at constant temperature 37°C. During fermentation process the titrated whey acidity changes from 70–75°T in the initial whey till 200–220°T during the above mentioned time interval.

The further production of lactic acid takes place in the diaphragm electrolyzer chamber. The electrolyzer with plate vertical electrodes, the anode chamber of which was filled with weak solution of electrolite, is used. Ionitic membrane is used as a diaphragm. The device cathode chamber was filled with the fermented whey (according to the offered scheme with the ferment content10%) till pH 3,8; in the comparison test the whey, fermented with the traditional ferment content 5% during the same period the time (36 hours) till pH level 3,9. Current intensity – 20 mA/cm$^2$ and voltage 30 V were kept constant in both cases. Change of active acidity in both chambers is presented in Fig. 1; 2.

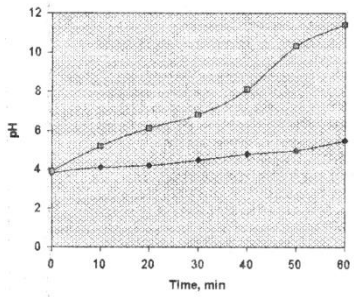


***Fig. 1.*** Change of the active acidity pH in the cathode chamber:
♦ – more fermented whey; ■ – fermented whey.

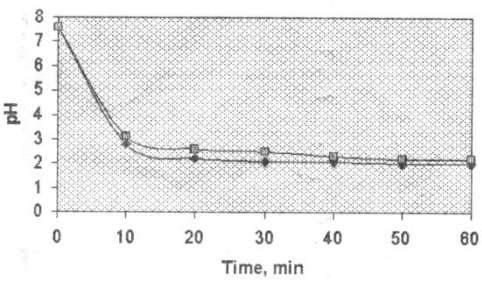

Fig. 2. Change of the active acidity pH in the interelectrode chamber:
♦ – more fermented whey; ■ – fermented whey.

So at current low density, permitting to maintain the necessary temperature electrolisis process duration, we have favorable conditions for the further production of lactic acid preparation.

After electric treatment during 60 min in the near–electrode (cathode) working chambers we can observe the differences in the composition of nitrogen–containing fractions. That could be explained by removing low–molecular nitride compounds, dissociating in aqueous solutions.

Lactic acid preparation which main physical and chemical properties correspond to the accepted standards is accumulated in the interelectrode space (Table 1).

***Table 1.*** Physical and chemical properties of lactic acid

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|---|---|
| Mass portion of directly titrated lactic acid, % | 37 |
| Chromacity, degrees | 4,8 |
| Ash mass portion, % | 0,215 |
| Content (in ash) mg/kg: | |
| • Potassium (K) | 616,4 |
| • Sodium (Na) | 303,0 |
| • Calcium (Ca) | 394,4 |
| • Magnesium (Mg) | 69,4 |
| • Manganese (Mn) | 0,11 |
| • Copper (Cu) | 0,41 |
| • Zine (Zn) | 0,77 |
| • Iron (Fe) | 10,60 |

## Conclusion

So according to the lactic acid quality indexes it may be concluded that the lactic acid preparation obtained by electrocontact method has good quality. The preliminary deproteinization degreases the economic expenditures owing to combining the stages of coagulation and concentrating. The method of fermentative hidrolysis and electrophysical release of lactic acid is perspective for solving the problems of utilization of lactose and ecology. Improvement of lactic acid production technology permits to quicken fermentation processes.

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