BEHAVIOR OF THE DETRIMENTAL MICROORGANISMS FOR THE SOLAR SALT PRODUCTION IN THE PRESENCE OF A HEALTHFUL POPULATION OF BRINE SHRIMP IN THE ISYSA SOLAR SALTWORKS

Sergio Manuel Ortiz Milán, M.Sc[1]

Joseph Steven Davis, PhD[2]

Industria Salinera de Yucatán S.A. of H.P., Mérida, Yucatán, México, 97128

Department of Botany, University of Florida, Gainesville, Florida, the USA 32611

sortiz@isysa.com.mx

Abstract

One of the main characteristics of the brines that feed the solar salt production system in the facilities on ISYSA is the brine that comes from the Rio Lagartos Estuary, where the high productivity is one of the inherent characteristics of this type of coastal ecosystems. The development and interrelation of these microorganisms comprise the beginning of our production system and give to sustenance to majors organisms as fish and coastal birds in the first stages of brine evaporation. The diversity of microorganisms is very interesting at the beginning of the system where the brine concentration initiates the differentiation and selection of resistant organisms to these particular conditions.

In the system two great groups of microorganisms are developed, one of them in the column of brine (plankton) and another one in the floors or bottoms of pools (benthos). Both groups interrelate giving as a result the different conditions of health of the salt ponds.

Many of these microorganisms play an important role in the system, modifying the structure of nutrients that is in suspension in the brine, because are organisms that "catch" the nutrients that favor the growth of some others that by his metabolic characteristics detriment the quality of the production brine.

The Aphanotehce halophytica microalgae is an indicating organism of the quality of the brines and that in favorable conditions of growth forms mucilage that aggravates the optimal conditions for the salt production.

Another one of the organisms most common in salt ponds that regulates the development of many microorganisms is the Brine Shrimp or Artemia. The Artemia is a little crustacean whose maximum development occurs in hyper-salinity systems, and in favorable conditions it reproduces continuously and constantly feeds on small organic and inorganic particles that are suspended in the brine column, basically microalgae's.

In the particular case of ISYSA, the adverse meteorological conditions (hurricanes) have caused the total losses of the populations of Artemia in the salt ponds, which has taken to ISYSA to reproduce this organism at laboratory level for its inoculation directly in the ponds and restoration of the biological saline system.

The Artemia in all the worldwide Saltworks has an excellent importance like fundamental part in the balance of the saline ecosystem. The populations of this small organism can be affected themselves by diverse variations in the conditions where it is developed and that can be from an increase in the salinity, the depredation by major organisms (fishes fundamentally), an excess of microorganisms that competes by the little quantities of dissolved oxygen in the brine, etc. Another important factor in the population movements of Artemia is the flow of brines towards the crystallizers ponds, losing an important amount of artemias mainly during the salt harvest season.

By this, the Artemia production in the ISYSA´s laboratory, is inoculate continuously in evaporation ponds where the physical conditions (salinity and temperature) are optimal for the good development and reproduction.

The weekly monitoring of the salt ponds to evaluate the behavior of Aphanothece halophytica and other important microorganisms as Aphanocapsia and Dactiloccocopsis allows defining the actions for the inoculations of Artemia. The populations of Artemia stay always constant by means of the inoculation program that occupies practically all the year.

The behavior of the populations of Aphanothece halophytica has been modified in the diminution of organisms (# org. X 106/ml) mainly in the central area of the salt production system, where the populations of Artemia maintain a healthful level with an average of 50 organisms per liter.

As a result of this natural control, the brines that reach the crystallizers has a good quality with a minimum of organic matter.

Introduction

In all production of solar salt by evaporation system an interesting amount of microorganisms exists that are adapted to the strict conditions that an atmosphere of high salinity generates.

Micro and macro organisms that coexist in this characteristic ecosystem as Saltworks play an important role in the development and control of the quality of the brine for the production of salt with good quality.

The main group of microorganisms can be divided in two sub groups denominated commonly like "good organisms" and the "bad

organisms". The good organisms are those that do not create a negative change in the raw material (brine), and contribute with their metabolic activity to improve the productivity of saltwork. In the case of the bad organisms, these take advantage of the conditions of the habitat to be increased in number and compete by the space, oxygen and nutrients suspended in the brines.

The bad organisms are located in all the solar salt mines represented by a blue green microalgae and its scientific name is Aphanothece halophytica. The most important characteristics of this organism are the high competitiveness by space, oxygen and nutrients in the brine, moving to organisms that do not represent damage to the brines.

The good organisms are represented by a crustacean branchiopod common in the saltworks and known commonly as brine shrimp (Artemia). This organism definitively creates a balance between all the microorganisms of the brine, because they are part of his feeding, as long as they are of the necessary size for his oral cavity.

The Artemia is considered like a filter and purifier organism of the brines, nevertheless, the populations of this crustacean can undergo environmental modifications in his population by natural causes (lack of dissolved oxygen), weather causes (hurricanes) or mechanical causes (pumping brine systems).

It is important to always maintain an ecologically healthy population in salt ponds where the salinity offers to an adapted atmosphere for its reproduction and feeding (elimination of bad microorganisms).

ISYSA has more than 10 years dedicated to the reproduction of Artemia in laboratory, to give a "biological maintenance" for the salt production system.

Results

The most important result in this study is the Artemia reproduction in the laboratory. The conditions for this reproduction are handle with an optimal culture means for their reproduction, consisting in a brine (14° Be) with temperature (23 – 25°C) and oxygenation controlled and providing alive food represented by the Dunaliella viridis microalgae.

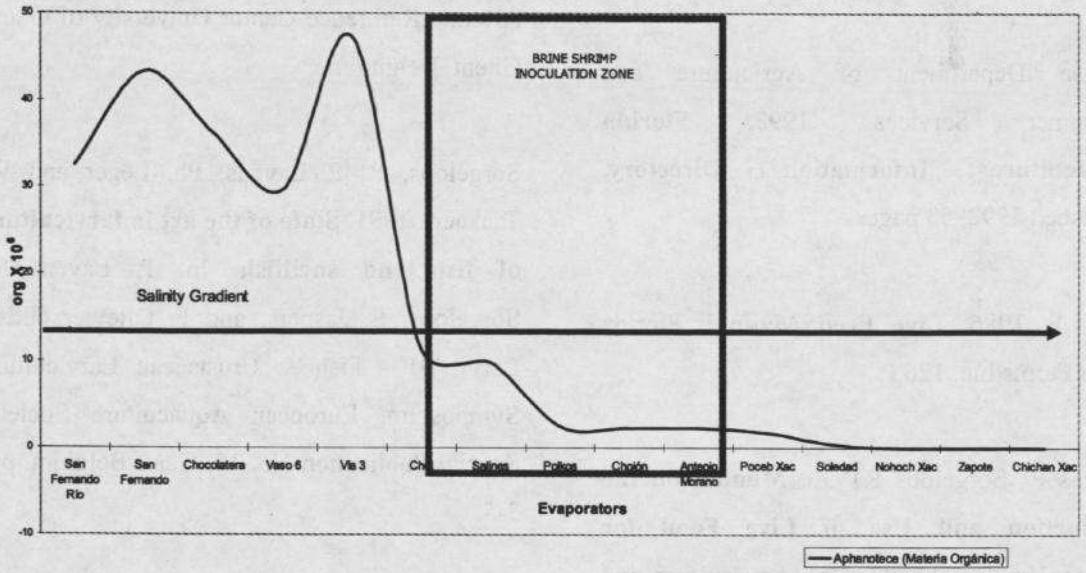
ISYSA at the moment has 18 fiber glass tanks with capacity of 800 liters each one in their laboratory of biology and aquaculture. The sequence of reproduction in each fiber glass tank allows realizing a continuous inoculation of Artemia in the evaporators every day. In average are inoculate 40 liters of brine with an average density of 3,435 organisms by liter (being a combination of all biology stages of this organism).

Figure 1. Fiber glass tanks for Artemia reproduction

The inoculations are realized directly in salt ponds where Artemia´s do not suffer a shock of drastically changes in salinity or temperature and where the food availability is appropriate. On the other hand, the populations of Aphanothece halophytica have their maximum growth in these same pools, reason why the Artemia takes advantage of this food availability controlling from this point the populations of bad organisms.

Figure 2. Brine shrimp inoculation

From this point where the inoculations are realized, the behavior of Aphanothece halophytica modifies completely losing the opportunity to grow in ponds where the salinity, oxygen and the nutrients could increase their populations and harm the quality of the brine. The following graph shows to the behavior of A.halophytica throughout the system of evaporators and the point where the inoculations of Artemia are realized.



Graph 1. Behavoir of A. halophytica in presence of brine shrimp.

The balance of the populations of microorganisms avoids the exponential growth of the populations of A.halophytica, at the same time, with a good handling of the depths of brines in each pond (with pumping stations management) the balance occurs allows the entrance of the solar light to the bottoms activating the metabolic processes of the benthic microorganisms, increasing the competition by the capture of nutrients.

Conclusions

It is important continuously to evaluate the behavior of the good and bad microorganisms throughout the saline ponds system. This allows taking the suitable decision to maintain a good quality of brines.

One of the recommendable activities to control and to equal the populations of organisms is a controlled program of inoculation, evaluation and handling Artemia.

The A.halophytica is highly competitive with other microorganisms mainly the planctonics due to its metabolic behavior and formation of great mucilaginous communities that move to organisms of less adaptability easily, mainly, to the salinity changes. A. halophytica changes its behavior once the Artemia is systematic introduced in salt ponds where the conditions are optimal for its reproduction. The Artemia is the organism that provides a balance in the communities with organisms that can reach salinities by above of 14° Be, and gives as result one improves in the quality of brines.

Bibliography

Borowitzka M, Borowitzka L. 1988. **Dunaliella. In: Microalgal Biotechnology**. BOROWITZA M, BOROWITZA L. (eds.) Cambridge University Press. N.Y.

Florida Department of Agriculture and Consumer Services. 1992. **Florida Aquaculture Information Directory.** Published 1992, 53 pages.

Hoff, F. 1986. **Live Feed Manual**. Florida Aqua Farms Inc. 126 P.

Lavens P., Sorgeloos P.1996. **Manual on the Production and Use of Live Food for Aquaculture**. Laboratory of Aquaculture and Artemia Reference Center University of Ghent Ghent, Belgium.

Sorgeloos, P., P. Lavens, Ph. Leger and W. Tackaert. 1991. **State of the art in larviculture of fish and shellfish**. In: P. Lavens, P. Sorgeloos, E. Jaspers, and F. Ollevier (Eds). Larvi '91 - Fish & Crustacean Larviculture Symposium, European Aquaculture Society, Special Publication No. 15, Gent, Belgium. pp. 3-5.