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Feasibility of Bioethanol Production from Organic Whey

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***Abstract*— the disposal of whey is a worldwide problem. Large quantities of whey are produced as a by-product during the manufacture of cheese and casein, and this must be disposed of or processed in an environmentally acceptable way. Since most of the components are of small molecular weight and soluble, they can quickly deplete oxygen levels in natural water systems: the COD (Chemical Oxygen Demand) of raw whey is about 60 kg m-3. The key to the utilisation of this resource has been changing the perception of whey from a 'waste material' to an 'opportunity' for further processing.**

In this article, a case study on the waste minimization of a cheese industry by reuse of whey after a chemical treatment has been investigated. Our results indicated that the compounds of partially or fully hydrolyzed whey represent a significant resource in particular (proteins, peptides, fat, fatty acids, mono and disaccharides as lactose ....) Who can be subsequently used in different areas: Renewable energies (bio ethanol production), technological, nutritional and medical industries.

***Keywords*— dairy industry, chemical treatment, environment.**

I. INTRODUCTION

Whey is a by-product of the dairy industry in which the principal components are lactose, proteins and mineral salts [15]. Approximately 47% of the 115 million tons of whey produced world-wide every year are disposed of in the environment [10].

This represents a significant loss of resources and causes serious pollution problems since whey is a high strength organic pollutant with high BOD5 (Biological Oxygen Demand) and COD (Chemical Oxygen Demand), with values of 40,000– 60,000 mg/l and 50,000–80,000 mg/l, respectively ([5]; [7]). More than 90% of whey BOD5 is due to lactose ([9]).

Whey, or serum derived from dairy's industries, was seen as an opportunity for bioethanol production. Sweet way, such as those derived from the production of cheese, was already being used to make lactose powders. Acid whey from the production of lactic and sulphuric casein are not suitable for this (as they contain high levels of sulphate ions and lactose acid), but it was seen that they could be used to ferment the lactose to ethanol.

The technology to process deproteinated whey into ethyl alcohol was developed in Europe about 20 years ago and was purchased from Ireland by the Anchor Ethanol Company in the late 1970s. Since that time two plants have been established, at Tirau (using a continuous fermentation process) and Reporoa (using a batch fermentation process). The combined annual production of these two plants is 11 000 000 litres of ethanol. Two further independent distilleries based on whey have subsequently been built in New Zealand, producing an additional 6 000 000 litres. The recovery of ethanol from a previously waste stream is a good example of technology being applied to rectify a problem.

Treatment methods of whey have been studied intensively during last decade years. Problems of the pollutants removal from waste water cheese industry were increased with fast industrialization. These waste waters are produced large volumes and must be absolutely treated before discharge.

Due to the high organic content of whey, regular treatment processes such as the activated sludge process are completely inappropriate (e.g.[8]).

However some treatment process such as anaerobic membrane process (e.g.[13])., reverse osmosis (Re et al., 1998), electrodialysis and ion exchange (e.g.[11]), and chimical traitement can be used.

The objective of our work is to study the biochemical and physic-chemical characteristics of the wheyr dairy's industry before and after the chemical treatment.

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II. MATERIAL AND METHODS

Whey samples were collected from the Alouani dairy industry's Company located in the region of Belghanem Ghardaia's city is the leading producer in its sector in the province. The unit is a modern structure can produce 2160000 liters / year of milk, although the daily reject of whey is normally between 500 and 1000 liters / day.

Samples were performed in accordance with standards. Whey samples were collected and transported in a cooler to the laboratory biomass, Unit for Applied Renewable Energy Ghardaia. Direct measurements (temperatur, pH, Conductivity...) were performed. Physicochemical and biochemical analyzes of wastewater were effectuated.

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A. The study of physicochemical and biochemical *variability of whey protein rejection:*

1. Analysis Physical-chemical Rejection.

Which to assess the physico-chemical quality whey Biochemical

B. 2. biochemical Characterization of whey protein

In this part of work, we will focus more specifically on biochemical characteristics of whey to conduct this study; we chose to use a more advanced milk analyzer device and its derivative 'Lacto Star "type Funk Gerber.

Lacto Star is a new unit of analysis of milk and fermented milk products like whey with cleaning, rinse the cleaner product or `use the following three options: (Base, acid and distilled water), with a heating up to (40 ° -45 °) and zero point calibration for fully automatic analysis quickly and reliably identify the following main ingredients:

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- Concentration minerals.
- SNG or SNF (solids not fat).
- The Protein Concentration: are important components dissolved in the whey because of their nutritional qualities. And on many proprieties functionally.
- The concentration of fatty material.
- Concentration of lactose: The main whey sugar is lactose, a disaccharide formed by the association of a molecule of glucose and one molecule of gelatos.

And physico-chemical characteristics, such as:

- the conductivity at 40 °.
- Freezing: The freezing point is the temperature of transition from liquid to solid state. This is one of the most stable constant milk. (Calculated with a resolution of 0.001 ° C value).

The resolution of the measurement is of 0.01% for all ingredients.

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III. RESULTS

A. Analytical Study of Physico-Chemical and Biochemical of whey protein before and after Treatment Chemical Properties:

1. The composition of wastewater

1.1 The Biochemical composition of rejection (whey)

The study of the Biochemical composition of the whey gave the results shown in Fig 1.).

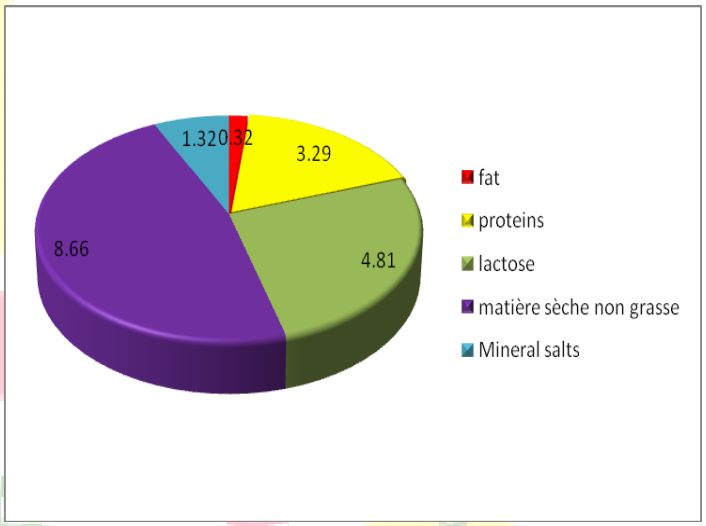

Fig. 1 Biochemical composition of rejection (whey) of the dairy industry case (dairy Alwani)

The physico-chemical characteristics of rejection (whey) are shown in the Figure below.

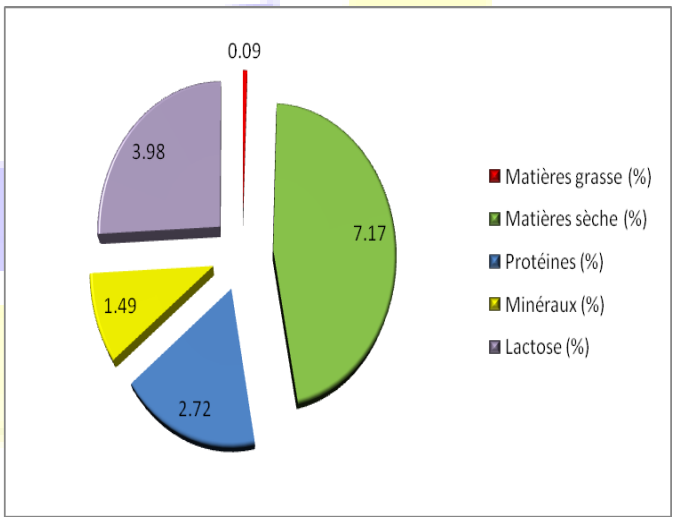

Fig. 2: Physico-chemical characteristics of rejection (whey) of the dairy industry case (dairy alouani).

2. Hydrolysis of whey by sulfuric acid (H2SO4):

In our experiment we investigated the effect of chemical and physico-chemical discharge (whey) of the dairy industry case (dairy Alwani) with sulfuric acid (H2SO4). The results obtained, as a function of hydrolysis time, with sulfuric acid (H2SO4).

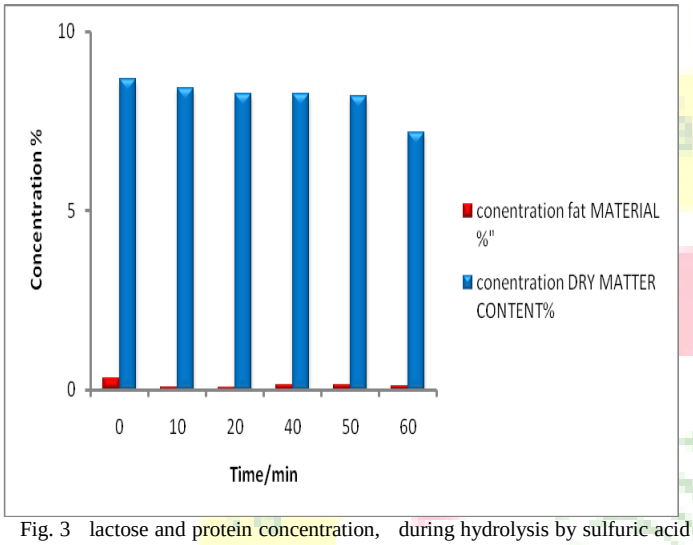

Fig. 3 lactose and protein concentration, during hydrolysis by sulfuric acid (H2SO4) acid (0.5 M) at 45C ° whey

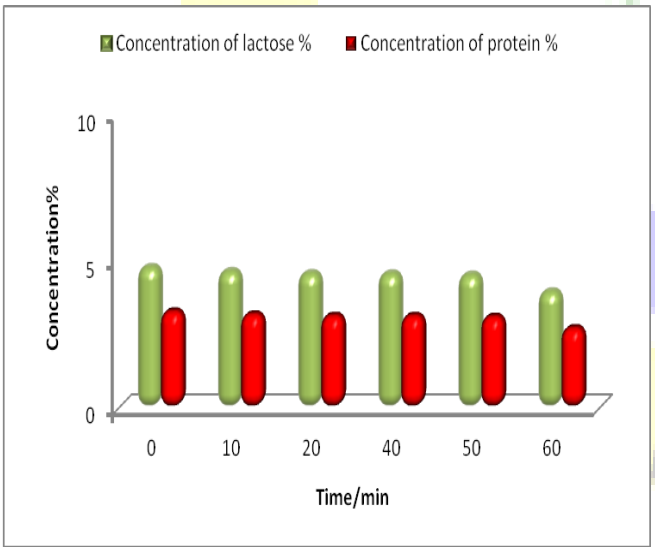

Fig. 4 Kinetics of hydrolysis of whey with sulfuric acid (H2SO4) (0.5 M) at 45C ° whey Dry matter and Fat .

2.1. Effect of chemical treatment on the biochemical change of whey components

The results of determining the rate of whey constituents over time is presented in fig:5

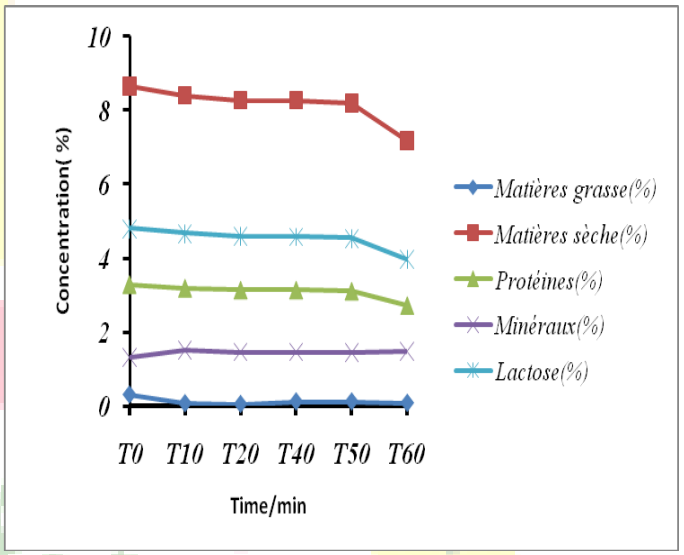

Fig. 5 The Kinetics hydrolysis of the different ways component by sulfuric acid (H2SO4) (0.5 M) at 45C °.

IV. DISCUSSION

Our result shows that there is a reduction of protein levels during hydrolysis thereby increasing the large-products resulting from this last more simple and which are: polypeptides, peptides, and amino acid oligopeptide. On the other hand the decrease in lactose resulted in the formation of two monosaccharides D-glucose and D-galactose during hydrolysis. The measurement of pH and conductivity during hydrolysis shows a significant increase in conductivity against an expressive decrease in pH (reversible relation). Compounds hydrolyzed whey are therefore of great interest in economic terms, its proteins are using the can as a supplement in animal feed and exploited for their functional and nutritional properties in the food industry (e.g.[16];[7]) . The lactose is converted to other compounds such as organic acids (acetic acid, propionic, lactic and succinic) or biofuel (bioethanol) obtained by microbial fermentation ([2]; [11]; [14]).

V. CONCLUSIONS

The The present study clearly establishes that reuse of whey after chimical traitement is an effective method for waste minimization from dairy industry. The results obtained show that hydrolyses process of whey have a hazardous effect. However classical treatment methods of whey have a high cost and by-products of them such as sludge is another problem for environment. Moreover, some other reuse methods of whey such as lactose production and production of concentrated protein are also possible and these methods are used already in some industry.

According to our opinion obtained products the partially or fully hydrolyzed whey represent great importance which leaves us to suggest that the latter may be subsequently exploited and enhanced to:

On the one hand, to limit the pollution caused by this by-product. On the other hand, can also be used in different areas: nutritional, technological as a Renewable energies productions of, economic, food and medical industries..

The recovery of bioethanol from the whey's dairy's industries is a good example of technology being applied to rectify a problem of pollution wastewaters dairy's industry.

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