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Organoleptic Changes of the Fermented Autolysate of Fish

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Abstract: In Benin, fermented autolysates of fish are neglected. This neglect is largely due to their strong smell and lack of knowledge of their nutritional value. Knowledge of certain physicochemical parameters during the fermentation process may allow to know the chemical changes that occurred during the transformation of the fish autolysate. Thus, a kinetic fermentation study of three different autolysates based on electrical conductivity (EC), total dissolved solids (TDS) and pH is done to understand the origin of the consumption rejection of fermented autolysates in Benin. The obtained results show that the electrical conductivities vary between 3077µS and 3206µS for tuna, between 3049µS and 3216µS for the bass, between 2700µS and 2975µS for catfish. Tuna, bass and catfish have arerage TDS of 2040mg / L, 2029mg / L and 1847mg / L, respectively. As for pH, they vary from 7.70 to 8.71 for tuna, from 7.96 to 8.80 for the bass and from 7.92 to 8.29 for catfish. The analysis of the kinetics of electrical conductivities and of TDS reveals that the latter are identical and present three different phases, namely a regression which corresponds to a grouping of the particles in the medium, an increase which shows the fluctuation of the particles and a stabilization which indicates the end of the fermentation. Analysis of pH kinetics shows that the fermentation medium is basic. This proves that the particles in suspension of the fermentation medium are dimethylamine, trimethylamine, ammonia, etc. The fermented autolysates of fish are rich in amino acids and fatty acids (protein and lipid breakdown products), and their strong smell is due to volatile bases resulting from the reaction of amines.

Keywords: Fish Autolysate, Fermentation, Chemical Modifications, Chemical Approach

1. Introduction

The fermentation of fish is a process of treatment and conservation aimed essentially at obtaining a particular flavor. During the fermentation of the fish, it oozes an autolysate which is a by-product of this conservation process [1]. Fish autolysates are the result of partial digestion of fish proteins by proteolytic autolysis of whole fish or by-products of seafood processing [2]. Fish autolysates are produced from fresh whole fish or by-products from fish processing. The liquid that is produced is then deoiled by centrifugation and concentrated by evaporation. The autolysate is then stabilized with antioxidants and acids [3]. Fish autolysates are nowadays used in many fields: animal nutrition, human nutrition (flavorings, fish sauce), cosmetics, and dietetics [4]. Because of their particular chemical composition and organoleptic characteristics, fish autolysates are generally neither consumed in their pure form nor in large quantities, but they can, in many ways, serve as an ingredient. Their main use is in the preparation of broths, concentrates and compressed soups. They are then mixed with various substances that can namely include: meat extracts, dried and crushed vegetables, aromatic vegetable powders. The fish autolysate can be incorporated into sandwich stuffing or sauces and added as an ingredient to various foods (vegetables, pasta, semolina, etc.). It is also involved in the preparation of compound food for animals [3, 5].

In Benin, because of its strong smell, the autolysing of fish is of no importance to processors who are unaware of its nutritional value [6]. Little is known about how eating behaviors lead to food choices [7, 8]. Food is not just about eating; its consumption is rooted in rules, behaviors and etiquette. This implies that food consumption and food choice are shaped by the context, cultural and / or socio-economic [9, 10].

The aim of this work is to understand what causes the neglect of the autolysat by the population of Benin. For that, is considered a chemical approach to know the organoleptic modifications intervened during the fermentation of the autolysate of the fish.

To get there, firstly; there was a kinetic study of the fermentation of three different autolysates based on electrical conductivity (EC), total dissolved solids (TDS) and pH; and in a second step, statistical analyzes are also made.

2. Material and Methods

2.1. Biological Material

Three species of fish namely tuna, bass and catfish were used for the production of the autolysate.

For the production of tuna, bass and catfish autolysates; 3kg of tuna and also 3kg of bass were bought at the port of COTONOU; 3kg of catfish are taken at the experimental catfish aquaculture site (Wetland Research Unit) of the Faculty of Science and Technology of the University of Abomey-Calavi (UAC) of the Professor Emile FIOGBE.

2.2. Production Equipment of the Autolysate

Practical materials such as a knife, hetero-fermentation bacteria and fermentor are used for the production of the autolysate.

2.3. Usual Laboratory Equipment

In addition to glassware, it was used a HI 98129 digital pH meter and a CO 310 conductivity meter

2.4. Method of Production of the Autolysate

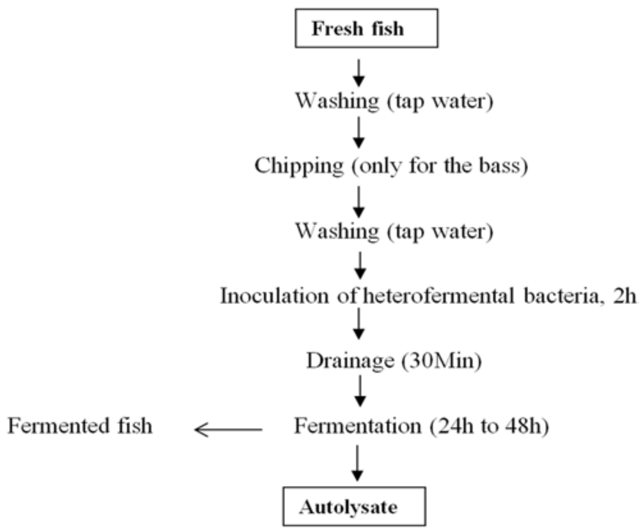

Figure 1. *Production diagram of fermented fish autolysate.*

A mass of 3kg of each type of fish is introduced into the fermentor which is hermetically closed. The fermentation process according to the method described by Dossou-Yovo [11], is launched. After 24h to 48 hours of fermentation, the fermenter has been reopened and a brownish solution is extracted: it is the autolysate. The diagram in Figure 1 shows the production method of the autolysate used for the current study.

2.5. Expression Methods of Fermentation

Three different products namely tuna autolysate, bass autolysate and catfish autolysate were analyzed. To obtain a sample of each product, some steps were followed: using a graduated pipette, take 10ml which is introduced into a volumetric flask of 100ml and complete with distilled water until gauge line then homogenize and finally spill the contents of the vial into a beaker. The beakers are hermetically closed because fermentation occurs in an anaerobic environment.

The parameters namely electrical conductivity (EC), total dissolved solids (TDS) and pH were taken.

A HI 98129 digital pH meter and a CO 310 digital conductivity meter enabled to take these different measurements. It is with the CO 310 digital conductivity meter that both the electrical conductivity (EC) and total dissolved solids (TDS) were taken.

For measurements, the probes of each device were just introduced into the contents of the beakers. The measurements were taken regularly every hour for 8 hours, then 27 hours later until 32 hours.

3. Results and Discussion

3.1. Results

The analyzes carried out allowed us to have the kinetics of electrical conductivity, TDS and pH. This also allowed us to make a comparative analysis of the electrical conductibilities, of the TDS, the pH of the tuna, the bass and the catfish.

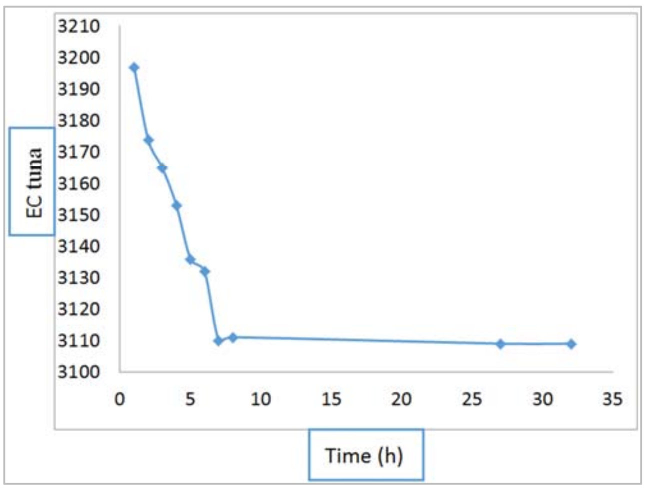

Figure 2. *EC kinetics of tuna autolysate.*

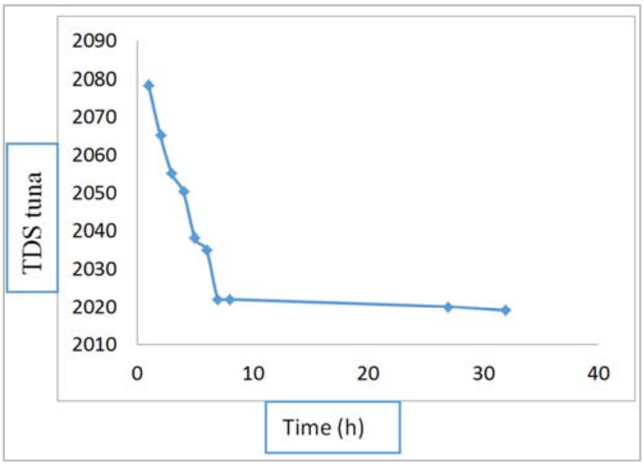

Figure 3. *TDS kinetics of tuna autolysate.*

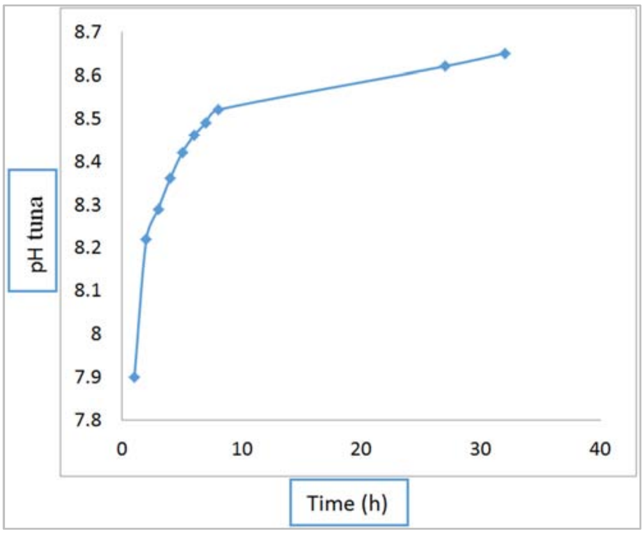

Figure 4. *pH kinetics of tuna autolysate.*

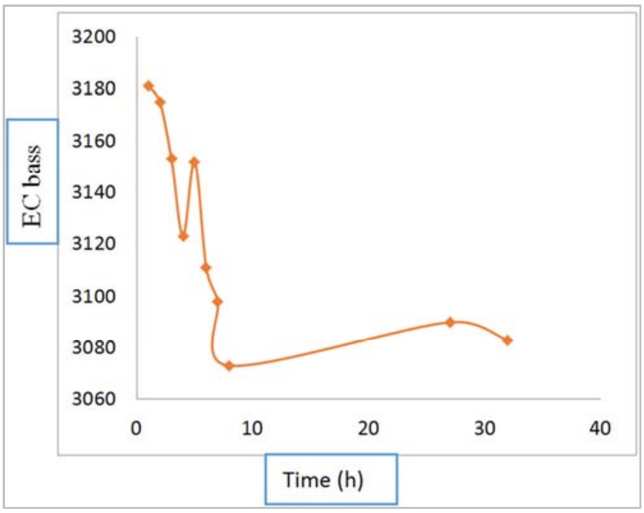

Figure 5. *EC Kinetics of bass autolysate.*

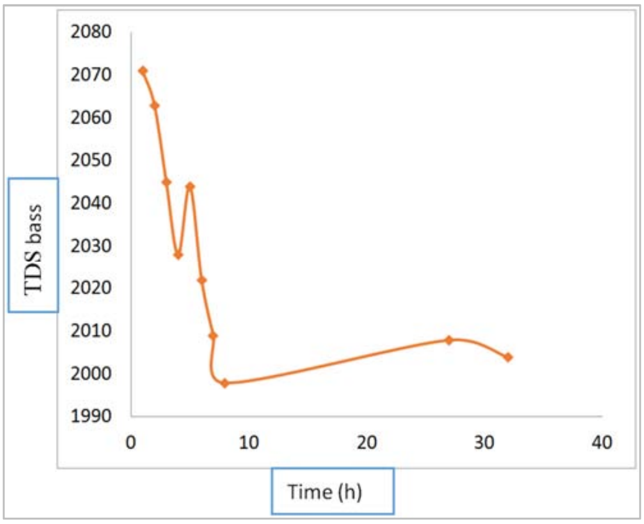

Figure 6. *TDS Kinetics of the Bass autolysate.*

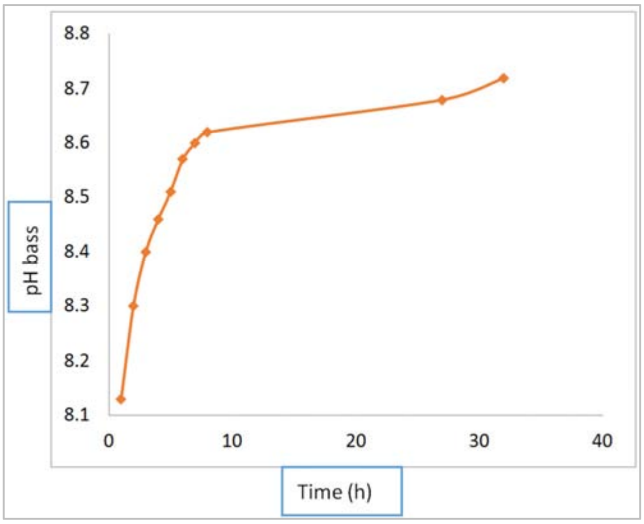

Figure 7. *pH kinetics of the bass autolysate.*

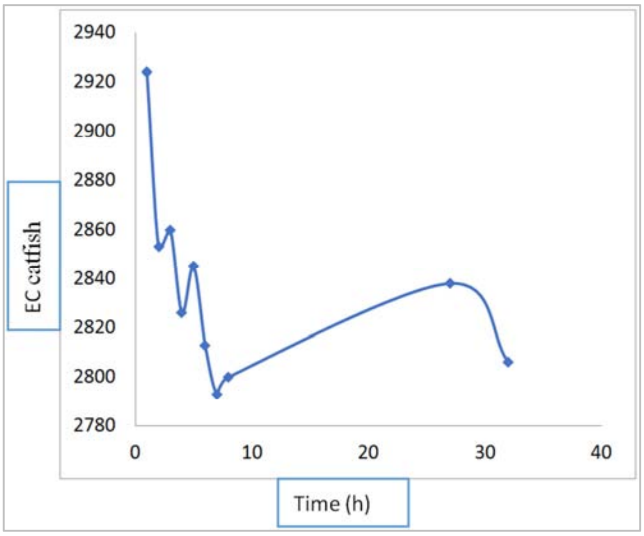

Figure 8. *EC kinetics of the autolysate of catfish.*

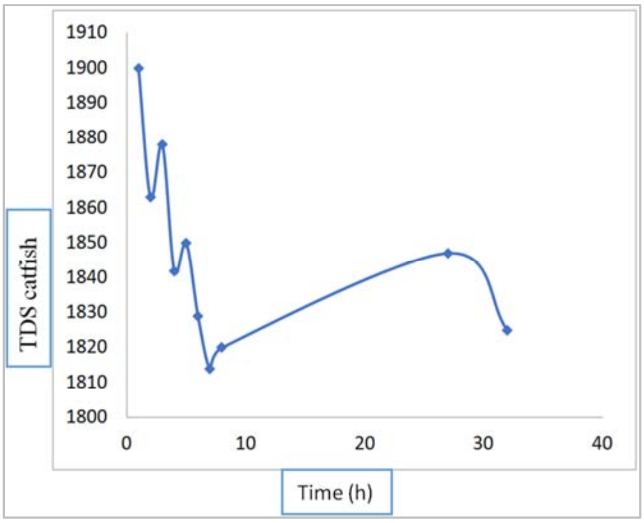

Figure 9. *TDS kinetics of the autolysate of catfish.*

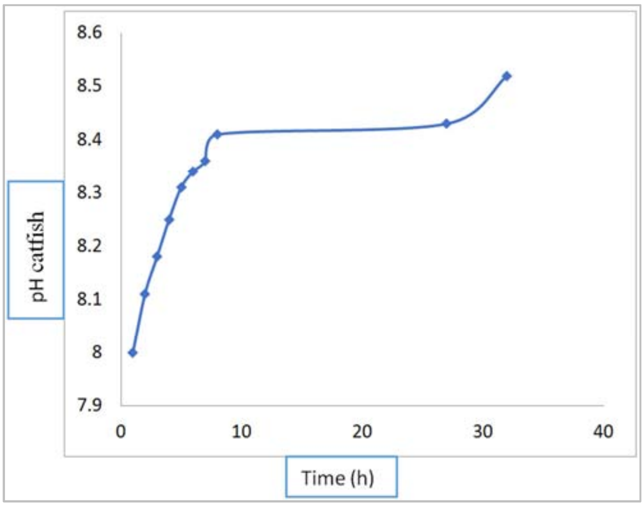

Figure 10. *pH Kinetics of the autolysate of catfish.*

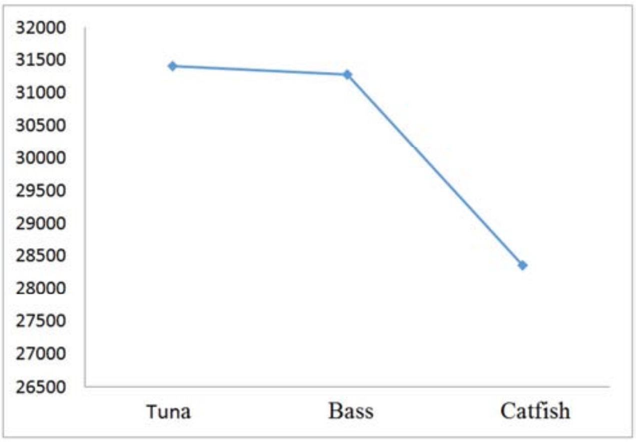

Figure 11. *EC comparative analysis of the autolysate of tuna, bass and catfish.*

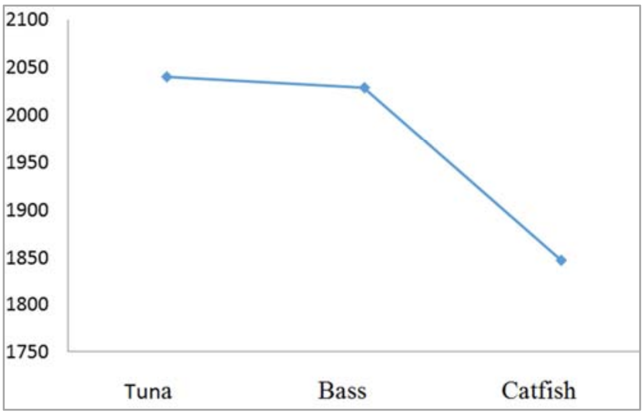

Figure 12. *TDS comparative analysis of tuna, bass and catfish autolysate.*

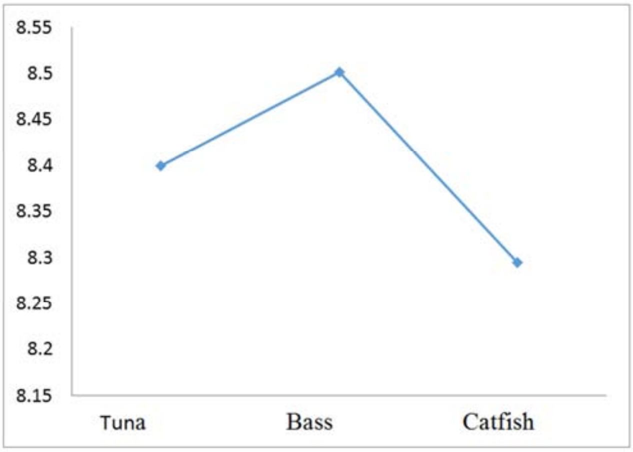

Figure 13. *Comparative pH analysis of the autolysate of tuna, bass and catfish.*

3.2. Discussion

The electrical conductivity of a solid or liquid material, provides information on its ability or the capacity to conduct an energy underpinned by ionized particles. The pH on the other hand gives the potential of hydrogen of the medium; that is, the degree of acidity or basicity of the medium. TDS provide information on dissolved substances. We are dealing with a fermentation product, so all these parameters have a correlation of information on the initiation or not of the fermentation.

Figures 2 and 3 respectively show the kinetics of electrical conductivity and TDS of tuna. The curves of these figures look the same. By observing these curves, it is noted a regression of the values from 3197µS to 3110µS and from 2078mg / L to 2022mg / L in the first seven hours of solubilization followed by a slight stabilization of 3110µS and 2020mg / L of between seven hours and thirty-three hours.

Considering the fermentation of the bar, Figures 5 and 6 respectively provide information on the kinetics of the electrical conductivity and TDS of the bar autolysate. There is a similarity in these kinetics. There is a slight regression of 3181µS at 3123µS and 2071mg / L at 2028mg / L in the first four hours, an increase of 3152µS and 2044mg / L in five hours. There is a regression at 3070µS and 1998mg / L respectively at the eighth hour then comes an increase of 3090µS and 2008mg / L at twenty-seven hours, it finally follows a slight regression to 3083µS and 2004mg / L to thirty -two hours.

As for the fermentation of catfish, Figures 8 and 9 are respectively the evolution of kinetics of electrical conductivity and TDS catfish. The curves, respectively of the electrical conductivity kinetics and TDS of the catfish, such as those of tuna and bar, are also identical. They show an alternation of regression and increase. Thus it is noted an alternation of regression of 2924µS at 2853µS and 1900mg / L at 1863mg / L in the first two hours, then an increase to 2860µS and 1878mg / L at three hours. It is noted after another alternation of regression of 2826µS and 1842mg / L at four hours, then an increase at 2845µS and at 1850mg / L at five, and then a regression at 2793µS and 1814mg / L at seven. It is noted after an increase of 2793µS at 2838µS and 1814mg / L at 1847mg / L between seven hours and twenty-seven hours, and finally a regression at 2806µS and at 1825mg / L at thirty-two hours.

It should be noted that the kinetics of electrical conductivity and TDS of bass and catfish have no stabilization phase, just like that of tuna; this would be because the autolysates of bass and catfish were obtained the same day well before that of tuna and therefore undergo another process of fermentation digestion that was not complete in our analyzes. This is in line with the work of Montel [12], who felt that different fermentation processes are responsible for obtaining desirable flavors.

The analysis of EC and TDS kinetics of the three autolysates reveals three phases, namely a regression, an increase and a stabilization of EC and TDS.

Regression is a grouping of particles in the medium. This grouping would lead to an impoverishment of the medium in dissolved particles at once to a decrease in electrical conductivity.

The increase gives information on the fluctuation of the particles leading to a multiplication of particles in suspension, that is to say ionized bodies; this shows that chemical changes would have occurred during the fermentation process. These results confirm the work of Pearson [13], which states that during fermentation, enzymatic degradation of nucleotides and nucleosides occurs, resulting in the formation of inosine, hypoxantine, ribose, and the like formation of dimethylamine, then decomposition of proteins with subsequent formation of ammonia, indole, hydrogen sulphide. Then a bacterial reduction of trimethylamine oxide into volatile trimethylamine [14] gives off an odor of ammonia.

The stabilization indicates somehow the end of the fermentation process triggered. This stabilization can be explained by the fact that the medium contains metabolites and reaction products which are themselves inhibitors and from a certain concentration block the fermentation.

Figures 4, 7 and 10 reflect the evolution of pH kinetics. These pH kinetics show early basic pH that grow with time. This growth is due to the evolution of enzyme activities and the solubility of proteins. It should be noted that Sainclivier's [15] studies have shown that the activity of enzymes and the solubility of proteins have an effect on pH. Other authors, such as Pearson and Hiltz [13, 16] also pointed out that during the fermentation, there is formation of trimethylamine (TMA) [17], dimethylamine (DMA), indole, ammonia, substances that confer basicity on the activity environment.

Figures 11, 12 and 13 show the comparative study of electrical conductivities, TDS and pHs respectively of the autolysates of tuna, bass and catfish. It is found that tuna has the highest electrical conductivity (Figure 11) and TDS (Figure 12); then comes those of the bass, and finally those of the catfish. This is explained by the fact that tuna with a higher protein content (23g per 100g of flesh) and whose degradation was less influenced by lipids. The statistical analyzes of the electrical conductibilities show, on the one hand, that there is a significant difference between the electrical conductivities of the three fish ($p = 0.000 < 0.05$). On the other hand, there is no difference between the electrical conductivities of tuna and bass ($p = 0.446 > 0.05$). The statistical analyzes of the TDS also confirm that there is a difference significant ($p = 0.000 < 0.05$) between the TDS of the autolysates of the three fish, while there is no significant difference ($p = 0.414 > 0.05$) between the TDS of the tuna and bass autolysates. The difference in electrical conductivity and TDS of catfish with respect to the electrical conductivity and TDS of tuna and bass is due to its low protein content compared to those of the others. As for the comparative analysis of pH (Figure 13), the bass has the highest pH compared to those of others. This is because the lipids of the last two fish would prevent the fluctuations of organic substances; because according to Paule [18] the catfish has a higher lipid composition (9.15g per 100g of flesh) than that of tuna (4.9g per 100g of flesh) and bar (3.9g per 100g of flesh Statistical pH analyzes reveal that there is a slight difference between the pH of catfish and those of tuna and seabass ($p = 0.002 < 0.05$); which reflects the high fat content of catfish compared to other fish. It should also be noted that the pH depends on the protein content.

It thus emerges that during the fermentation of the autolysate, a fluctuation occurs leading to suspended particles which are nothing other than nitrogen compounds, that is to say volatile bases such as trimethylamine, dimethylamine and ammonia [19]. These volatile bases would be the basis of organoleptic modifications. This is consistent with the work of Essuman [20] who also found that these volatile bases were associated with the organoleptic and textural changes of the fish during fermentation.

4. Conclusion

The organoleptic changes of the autolysate are due to the degradation of organic molecules (proteins and lipids) into amino acids and fatty acids. This shows the nutrient richness of the fish autolysate. Volatile bases that are nothing but reaction products of amino acids are at the origin of the strong smell of the autolysate of the fish. The monitoring of the fermentation process can thus make it possible to obtain the desired flavors and to stop the undesirable degradations.

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